

and prevent its being turned with facility. Other paraffine-makers use closed horizontal retorts, like those used in gasworks. These are charged once every twenty-four hours, and afterwards opened and cleaned for receiving a fresh charge—a process which at first sight appears more expensive and complicated than the continuous action of the vertical retort. The retorts at Addiewell Works, we are informed by Mr. Young, distil $1\frac{1}{2}$ tons of shale in twenty-four hours each, and the shale yields from 36 to 40 gallons of crude oil per ton. The temperature of distillation is about 1000 degrees Fahrenheit, and at this degree the hydrocarbons contained in the shale are all volatile; they escape from the retort-trough, the only opening provided for that purpose, viz., a branch pipe passing from the upper part of the retort to a large cast-iron main running along the entire row of retorts in a slightly inclined position, so as to allow the liquids formed by condensation to run off into a reservoir. The retorts are arranged in two parallel straight rows, having the main pipe between them, and discharge all their gaseous contents into the latter, which acts as the first and simplest condenser for the least volatile compounds. A surplus of solid carbon, varying in its percentage within very wide limits, is left in the shale after the extraction of all volatile matter; it is not sufficient in quantity to allow the extracted shale (a mixture of clay and carbon) to be used as a fuel, and the only application made of this shale refuse is the manufacture of bricks. The volatile products which leave the retorts are mixtures of all possible forms of hydrocarbons of the solid, liquid, and gaseous kind, all converted into vapour by the heat, but ready to assume their natural state of aggregation successively as each is cooled down to its point of liquefaction. The great bulk of the heavy oil condenses in the main pipe itself; the lighter or more volatile portions come to the liquid state at a later period, when the gases have passed a series of vertical pipes similar to those used in gasworks for condensing the tar. These pipes are about 4 in. diameter, and are placed in rows, each row allowing the condensed liquid to collect separately, and by these means a succession of more and more volatile kinds of oil is obtained in the successive positions. The length of piping forming this condenser we understand to be about 12,000 ft. There is still a certain proportion of permanent gas remaining after this condensation, and this, after being deprived of adherent naphtha—carried with it by a kind of priming like that of the water in a steam boiler—and after being purified from ammonia, is used as a fuel in the steam boilers of the works, being carried into the centre of each flue by a pipe about 3 in. in diameter, ending just over the grate, and projecting a long brilliant flame in a horizontal direction right along the centre of each flue. The fire-door end of the flue trough which the gas-pipe enters is built up with brickwork, having a number of interspaces for the admission of air. Another portion of the gas, still further purified, is used for illuminating the works and neighbouring houses, and at Bathgate the paraffine works supply the town itself with gas.

(To be continued.)

PARIS EXHIBITION.

Awards of Prizes to Group 8, Class 74, Agricultural Exhibition at the Island of Billancourt.

We have copied the following correspondence respecting the above awards, which probably may be interesting to our readers, from some of the London papers:

"Paris Exhibition.—The following special awards have been made to English and American firms who took part in the great agricultural exhibition at the island of Billancourt: 1st grand prize to Messrs. Ransome and Sims, of Ipswich; 2nd ditto, to Messrs. J. and F. Howard, of Bedford; 3rd ditto, to Mr. McCormick; 4th ditto, to Mr. C. R. Markham, for the successful introduction of the cultivation of quinine into British India. Second class prizes, consisting of a gold medal and an *objet d'art*, have been awarded to Messrs. Walter Wood and Co., Messrs. Smyth and Sons, of Peasenhall; and Messrs. Garrett and Sons, of Leiston. English subjects not being permitted to receive foreign decorations, a special silver medal has been awarded to Mr. John Head, one of the partners of Messrs. Ransome and Sims, who are the only English manufacturers thus honoured at Billancourt."

In relation to this, Messrs. Howard addressed the following letter to the papers:

"Sir,—In the paragraph under the above head, inserted in your impression of this morning, we observe a notice of the awards at the agricultural exhibition at Billancourt. As the statement is incorrect, and calculated to convey an erroneous impression, perhaps you will allow us space to state the facts."

"The first and only 'grand prize' has been awarded, not to Messrs. Ransome, as stated in your notice, but to M. Decrombecque, of Lens, in the north of France. In 1866 a portion of the island of Billancourt was allotted to this gentleman to afford him an opportunity of showing a new

system of cultivation, and the implements used therein. The latter were designed and constructed by ourselves. For this exhibition the grand prize of 10,000 francs was awarded to M. Decrombecque. Nine 'grand gold medals' have been awarded. First on this list stands the Emperor of Austria, fourth and fifth are the names of Messrs. Ransome and ourselves, the medals to each being precisely of the same value, viz., 40l. Mr. McCormick stands next for his American reaping-machine.

"The awards of prizes at Billancourt from time to time during the summer have caused the public to confound them with those of the Exposition Universelle. We think it well, therefore, to say that these Billancourt awards have nothing whatever to do with the Grand Exhibition in Paris, at which our names stood at the head of the lists of awards for agricultural machinery; M. Albaret, the eminent French manufacturer, being placed second."

"The special silver medal alluded to as having been awarded to Mr. Head, in lieu of a decoration, has been well earned by that gentleman. He is the only English manufacturer of agricultural machinery who has resided in Paris throughout the Exhibition; and he has rendered considerable service to the jury and executive, as well as to his brother manufacturers from England."

"One word in conclusion on the question of foreign decorations. Our names, as well as those of some other English exhibitors at the Paris Exhibition, were recommended for the Grand Cross of the Legion of Honour; but owing to the regulations adopted by Great Britain such honours were withheld, while they were bestowed on rival manufacturers from other countries. So long as members of our Royal Family and our nobility receive orders and decorations from foreign courts, is it consistent or just to debar private Englishmen from similar marks of recognition and distinction from the French and other Governments?"

"Your faithful Servants,"

(Signed) "JAMES AND FREDERICK HOWARD."

Messrs. Ransome have replied as follows:

"SIR,—We request you kindly to insert the following remarks on a letter from Messrs. J. and F. Howard which appeared in your last issue, and must have been written by those gentlemen under a misconception of the position conferred by the awards of the jury to ourselves and others who took part in the Paris Exhibition."

"We have before us official documents which prove—

"1st. That the Billancourt annexe was an integral part of the Exposition Universelle, and under the direction of the same commission which had the direction of the agricultural part in the Champ de Mars."

"2nd. That the Grand Prizes referred to in the disputed paragraph have been awarded by the same juries (Groups 8 and 9) who sat in the Champ de Mars."

"3rd. That all the awards made by those juries carry the same value as those which have been awarded by the other juries of the Exposition Universelle."

"4th. That the nine gold medals mentioned by Messrs. Howard are styled 'Grand Prix' in the official awards; that they are gold medals of 1000 francs each, and are of the same importance as those awarded on the 1st of July to Messieurs Penn, Napier, Whitworth, Siemens, and others. That the 10,000 francs prize awarded to Decrombecque is beyond these—is of an exceptional character, and does not affect the question as to which manufacturer of agricultural machinery stands first on the list of Grand Prizes."

"5th. That although the Grand Prizes are of the same value throughout the Exhibition, and, when awarded for dissimilar manufactures or products, are of the same importance, yet where two or more Grand Prizes have been awarded for the same speciality, the jury awarding them has always classed the recipients in the order of their merit."

"6th. That our firm was placed before Messrs. Howard, and before every other British or foreign manufacturer of agricultural machinery taking part in the Exhibition, because the jury for Group 8 found that our successes in the experiments made by the jury for Class 74 were more numerous, and our merit consequently greater."

"7th. That the list in which Messrs. Howard's name stands first, M. Albaret's second, Messrs. Garrett's fifth, and ours seventh, is the list of awards of 'Médailles d'Or,' which are the next inferior awards to the 'Grand Prix,' and were conferred very soon after the opening of the Exhibition, without any trials whatever."

"We therefore claim that the first place on the list of awards, and the highest honour given to any British or foreign manufacturer of agricultural machinery who took part in the Exposition Universelle de Paris, 1867, has been bestowed on us."

"It is the second place which has been given to Messrs. Howard."

"The special award of a silver medal to our partner, Mr. Head, a distinction conferred on no other British or foreign manufacturer of agricultural machinery, adds further honour to our position."

"We think that Messrs. Howard are mistaken as to their or any other firm having been recommended for the Grand Cross of the Legion of Honour. That, which is the highest dignity of the Order, is never bestowed on manufacturers, however eminent they may be."

"We have only to add that the official documents on which we rely will lie at our London office, No. 9, Gracechurch-street, for fourteen days, commencing on Thursday next, and that any one who will do us the favour to call may freely examine them."

"We are yours faithfully,"

"RANSOME AND SIMS."

"The Orwell Works, Ipswich, Nov. 16, 1867."

HULL DOCKS.—It appears that the total area of the Hull docks and basins is about 84 acres. In 1775 the aggregate burthen of the vessels frequenting the harbour was 109,491 tons; after the lapse of 91 years—that is, in 1866—the total had grown to 1,343,819 tons.

JUSTICE'S ROTARY ENGINE.

A FEW weeks ago we mentioned, in our "Notes from the North," a new form of rotary engine, designed by Mr. William Justice, of Dundee, and constructed for him by Messrs. Low and Duff, engineers, of that town. Since then Mr. Justice has given a description of his engine to the Institution of Engineers in Scotland, and we now publish engravings of it on the next page, these having been prepared from a tracing with which we have been supplied by Mr. Justice. Our illustrations comprise a side elevation, end elevation, plan, and transverse section through the cylinder, and these views will enable us to describe the construction of the engine. Before doing this, however, we may remark that our engravings show one form of the engine only; the latter is, however, capable of being differently arranged, as we shall explain presently.

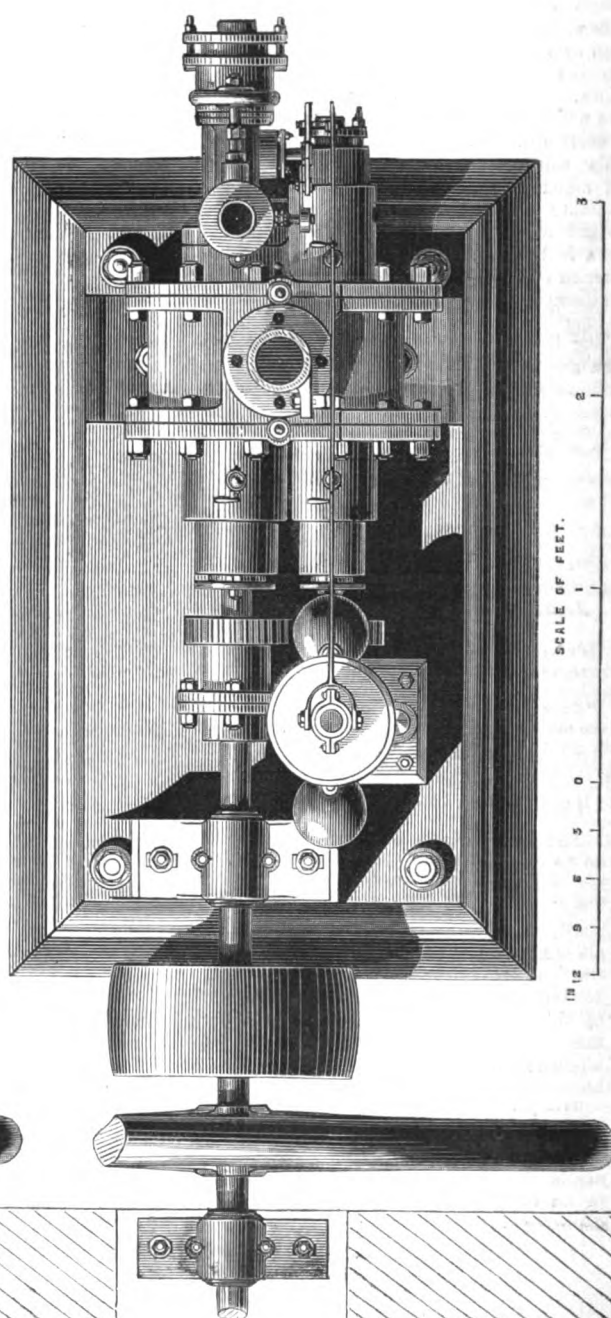
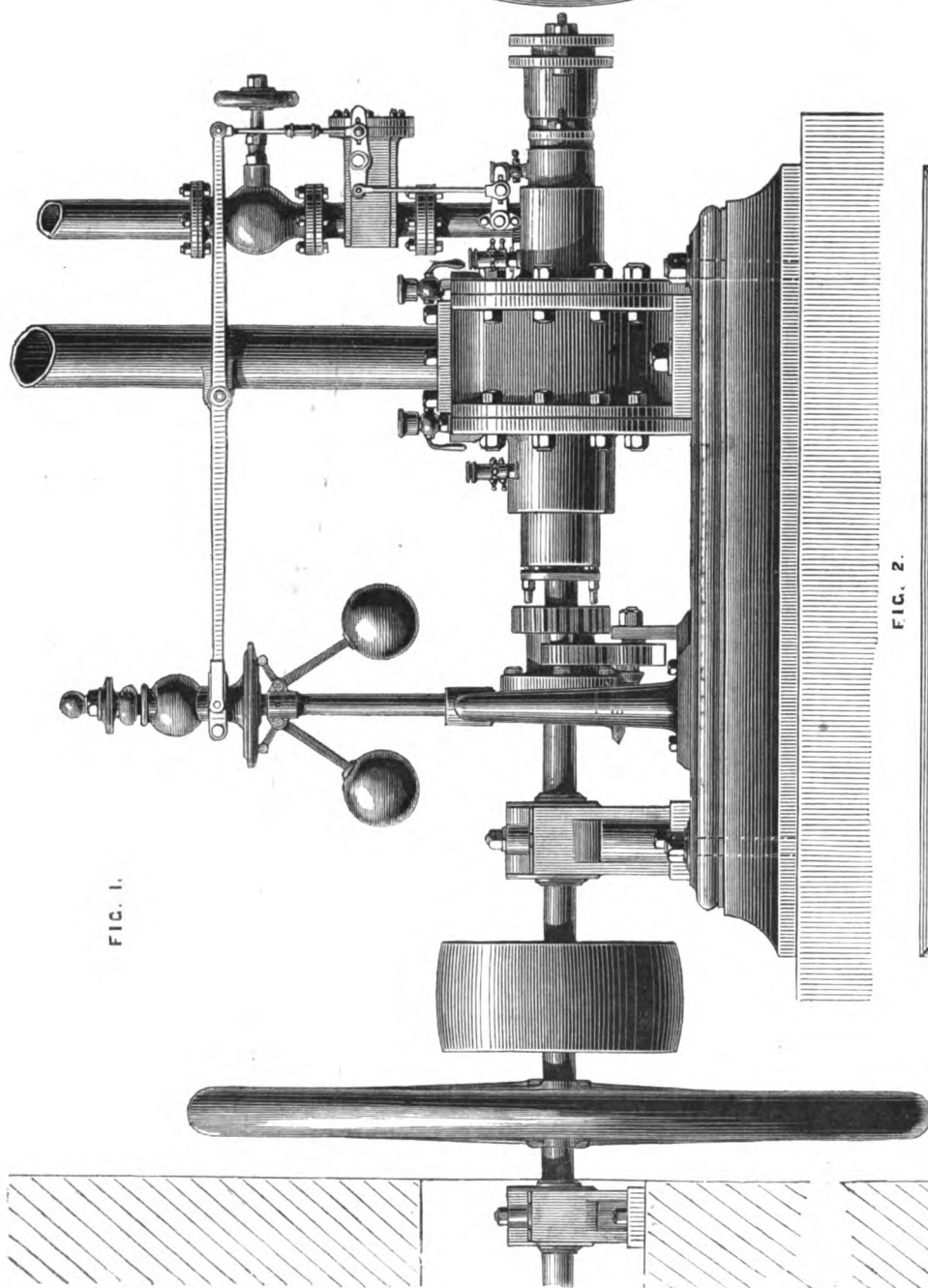
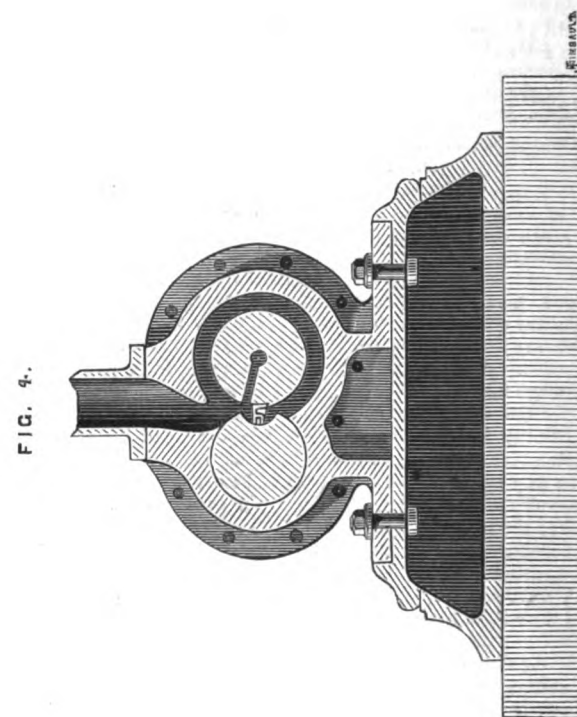
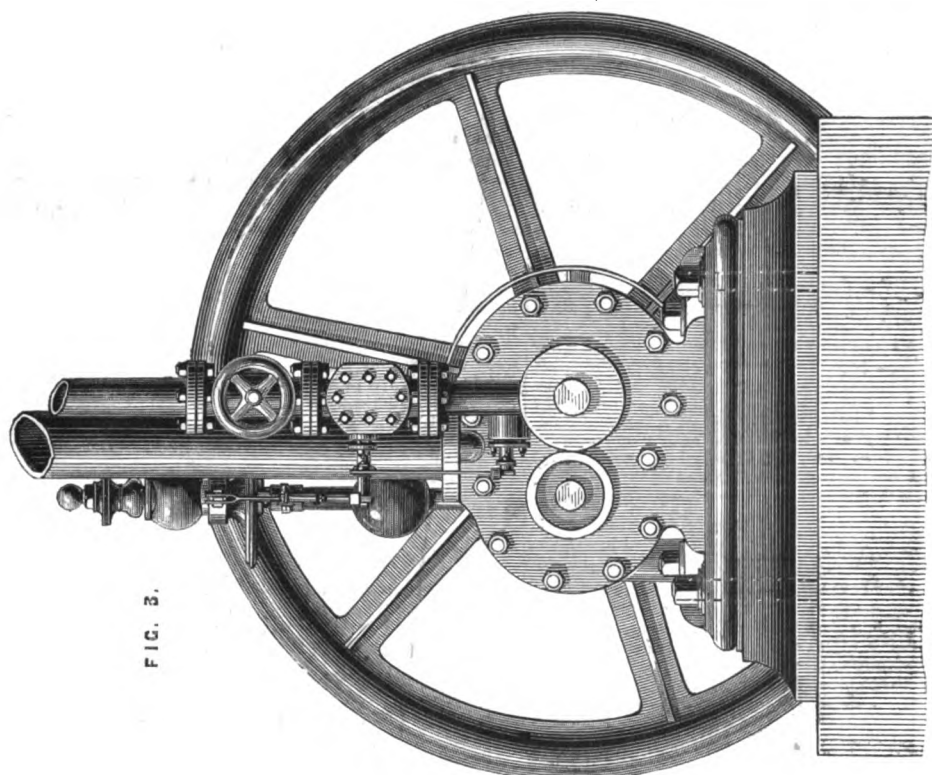
In the engine shown in our illustrations, the steam is led by the steam-pipe to a valve-chamber situated at one end of the cylinder, this chamber being furnished with a port or passage which, during a certain portion of the revolution of the piston, communicates with a radial port, by which the steam is led into the hollow axle by which the piston is carried. From the central passage in this axle the steam passes into the cylinder through the radial port shown in the transverse section, this port delivering the steam immediately behind the piston. When the piston is in the position shown in the section, no steam is passing through the steam-port, the whole of the interior of the cylinder being in free communication with the exhaust, and the supply of steam being shut off from the hollow axle by the solid portion of the valve-chamber covering the axle-port leading to that chamber. At the same time, it will be seen that the piston is just on the point of passing what is termed the "steam-abutment," this being a solid cylinder turned so as to fit accurately against the axle carrying the piston, and having a recess cut out of it, to an involute curve, so as to allow the piston to pass freely when it arrives near the position shown in the section. The abutment and piston-axle are of the same diameter, and they are geared together so that they revolve at the same speed. Their surface speeds being thus the same, they are merely in rolling contact, and the wear which would be caused by one rubbing on the other is avoided.

Referring to the section, it will be seen that where the piston has moved past the recess in the abutment (the motion of the piston being in a direction contrary to that of the hands of a watch), the latter will shut off the communication between the radial port and the exhaust-passage. When this is the case, the other axle-port comes into communication with the port in the valve-chamber, and steam is thus admitted between the piston and the abutment cylinder. The admission of steam is continued during any required portion of the revolution, according to the arrangement in the valve-chamber, and the piston is of course driven round by the pressure of the steam against it until the edge of the piston passes the opening to the exhaust-pipe, when the escape of the steam takes place. The action of the engine is thus very simple, and the distribution of the steam is effected without the employment of any reciprocating parts whatever. The axles of the piston and abutment are led through stuffing-boxes, which can be readily packed when required, and provision is made for taking up the end wear of the piston. No adjustment is provided for taking up the wear between the abutment cylinder and its casing, but the surfaces in contact are so large, and the pressure to which they are exposed so slight in proportion to their area, that it is probable that the engine would run for a very long time before any perceptible wear took place. Altogether the engine is very simply constructed, and it is stated that the cost of a 5-horse engine on this plan, with steel shafts and gun-metal bearings, does not exceed 40l. The engine that has been set to work at Dundee has, we believe, given great satisfaction.

We stated at the early part of the present notice that the engine can be constructed in other forms than that shown in our engravings. In one arrangement two piston axles with their pistons are employed, the abutment cylinder being placed between them. In another form the central abutment is dispensed with, and the two piston axles are made to roll on each other, thus causing them to form a mutual abutment. In this arrangement of engine (which is reversible) the steam is admitted through one of the axles to both cylinders by the same means as already described, the two pistons being propelled in opposite directions by the action of the steam on their respective blades or teeth. When it is desirable to reverse the engine, this is accomplished by shutting off the steam from the one axle, and admitting it through the other, the same thing being attended to with the proper exhaust port. There is still another arrangement on the double-acting principle, which may be considered as the most important of all those yet described. This arrangement consists of one revolving piston, provided with two blades diametrically opposite to each other, placed between two revolving abutments with two involute recesses in each, also diametrically opposite to each other, and the abutments being geared outside, as formerly described for the first arrangement. It will be observed that, in this arrangement of the engine, all the various parts are truly and thoroughly balanced both in mechanism and also in the admission and action of the steam; thus producing perfect equilibrium of action and diminishing wear.

THE CLEVELAND IRON TRADE.—The tone of the Cleveland pig-iron trade is slightly weaker; the stock in store at Middlesboro' is about 71,500 tons. Deliveries are about an average, and show no decrease. The foreign shipments have been scarcely so active as usual, and have been principally for Antwerp, Dunkirk, and Stettin. The foundries of the neighbourhood are only moderately supplied at present. The manufactured iron trade of the Cleveland group does not improve.

JUSTICE'S ROTARY ENGINE.
 CONSTRUCTED BY MESSRS. LOW AND DUFF, ENGINEERS, DUNDEE.
 (For Description, see preceding Page.)



PUBLISHER'S ANNOUNCEMENT.

Advertisements cannot be received for insertion in the current week later than 5 P.M. on Thursday. The charge for advertisements is three shillings for the first four lines or under and eightpence for each additional line.

The price of *ENGINEERING* to annual subscribers, receiving stamped copies at places three miles away from the General Post Office, is 1l. 1s. 8d. If credit be given, the charge is 2s. 6d. extra, subscriptions being payable in advance.

Cheques and money orders to be made payable only to Mr. Charles Gilbert.

Office for Publication and Advertisements, No. 37, Bedford-street, Strand, W.C.

ENGINEERING is registered for transmission abroad.

D. Van Nostrand, 192, Broadway, New York, is the sole American agent for *ENGINEERING*, and is authorised to receive all Subscriptions and Advertisements from America for this paper.

Le bureau d'*ENGINEERING* pour la France est 15 Quai Malaquais, Paris, chez E. Lacroix, Directeur des Annales du Génie Civil.

Subscriptions for the *ANNALES DU GENIE CIVIL* are received by Mr. Charles Gilbert, the Publisher of *ENGINEERING*, of whom also the *NOUVEAU PORTEFEUILLE DE L'INGENIEUR DES CHEMINS DE FER* may be obtained, price 9l.

MEETING NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, November 26, at 8 P.M. Continued Discussion upon Mr. Byrne's paper, "Experiments on the Removal of Organic and Inorganic Substances in Water."

ENGINEERING.

FRIDAY, NOVEMBER 22, 1867.

THE TITLE OF THIS JOURNAL.

THE ungrammatical and hardly explicable habit of some of our correspondents of speaking and writing of this journal as "*THE ENGINEERING*" causes constant confusion of its title with that of another paper, called "*The Engineer*." We may best illustrate this by the following instance: An eminent firm, whom we need not name, offered us, a few months ago, and unsolicited, drawings of the largest and finest example of marine-engineering yet constructed. These drawings, when completed, were sent, nearly a fortnight ago, and by error, to the *The Engineer*, the set intended for that journal having been received only this week, and with an explanation of the mistake, by ourselves. It is not unlikely that the engravings from these drawings will appear, this week, in our contemporary. If they do, our readers will know that they were engraved from materials especially prepared for us. We shall not, in that case, engrave from the drawings now in our hands; but should our contemporary be unable to produce its engravings before next week, we shall then give engravings also of the same subject. With one or two exceptions, where we have acceded to special requests, we have never allowed engravings to appear in our pages after their appearance elsewhere in the newspapers, it being the fact that all subjects of real importance to our profession appear first in *ENGINEERING*. We make no objection, however, to their reproduction afterwards in other journals.

THE ENGINES OF THE HERCULES.

THE engines made for the ironclad frigate *Hercules* hold a place, among all other marine machinery, corresponding to that of St. Peter's among cathedrals. They are the very largest pair of screw-engines ever made, and will work to the highest actual power, although they are nominally of 50 less horse power than the *Warrior's* and 150 less than the *Minotaur's*. In finish they are, as they now stand in the factory of Mr. Penn, equal to the best of his admirable workmanship, and this is so well known, and has been so long admired, that especial praise in this case would be needless, if not out of place.

The effective diameter of the cylinders of the *Hercules's* engines is 118 in., which is 2 in. less than that of a single pair of screw-engines already made by another maker; but the former have 47 in. trunks, as in all Mr. Penn's screw-engines, and their actual diameter is 127 in., with a stroke of 4 ft. 6 in.

The general design of these, as of all other screw-engines by the same maker, is nearly the same as that of his first trunk engines, those made many years ago for the *Arrogant* and the *Encounter*, of 350 horse power, 55 in. cylinders, and 3 ft. stroke. We might actually republish the drawings of the *Bellerophon's* engines, which appeared in *ENGINEERING* of March 16th, 1866, affixing a different scale, and making but very slight alterations, and they would faithfully represent the twin *Titans* of the *Hercules*. Since the time, however, when the engines of the *Arrogant* and *Encounter* created such a stir in the world of marine engineering, with their double-acting, full-stroke, quick-going air-pumps, and india-rubber air-pump valves, Mr. Penn has led all his competitors in the march towards fast piston speeds and a high ratio of actual to nominal power. The great pistons of the *Hercules's* engines are to make 65 double strokes or 585 ft. per minute, and it is not improbable that they may be worked on trial even faster, just as the *Bellerophon's* pistons made 75 double strokes of 4 ft. or 600 ft. per minute. The ratio of indicated to nominal power, too, in Mr. Penn's later engines is six, and even this is had with a fair rate of expansion. When these high speeds were first attempted, the valves of the double-acting air-pumps were quickly knocked to pieces. Canvas backed with metal, and finally with india-rubber, were tried; and eventually discs of plain india-rubber were found to be perfect in their action, the only difficulty, at first, being that Mr. Macintosh could not then make the thick sheets of rubber which he and other makers now produce with so much facility. Like the famous wood bearings, the rubber air-pump valves were first practically tested, and their success established by Mr. Penn. But for the former, we should now be compelled to employ excessively large, slow-moving air-pumps, reducing the speed by gearing or levers, or employing separate engines to work them. But for the wood bearings, we may say that it would have been impossible to work screw-engines, especially with large and heavy screws, with success for any length of time. The adoption of counter-weights, too, first in Mr. Penn's engines for the *Himalaya*, greatly smoothed the way to high speeds. And during all this progress Mr. Penn has retained the characteristically light proportions of his engines, and that with success. As an instance of this lightness of design, if we may employ such a term, we may refer to his engines in the late Paris Exhibition, and which weighed as they stood, in working order, but without boilers, only 74 tons, although they were of 350 nominal horse power.

The general arrangement of the engines of the *Hercules* closely resembles that of the engines of the *Bellerophon*, of which we published engravings in March last year (*vide* page 166 of the first volume of this journal); but several important alterations have been made in the constructive details. What these alterations are we shall explain presently. The engines of the *Hercules*, like those of the *Bellerophon*, are trunk engines, with the two cylinders placed together on one side of the screw-shaft, the condensers, air-pumps, &c., being arranged opposite them. The diameter of the cylinder, as already stated, is 127 in., the trunks being 47 in.; and the annular area of each piston is thus equal to that of a circle 118 in. in diameter. The stroke of the pistons is 4 ft. 6 in. The engines are rated by Messrs. Penn at 1200 horse power nominal, but as it is intended to run them at 65 revolutions per minute (giving a piston speed of 585 ft. per minute), it is estimated that they will develop at least 7200 indicated horse power when the steam is being cut off at one-third of the stroke. Judging, however, from the excellent performances of the engines of the *Bellerophon*, and of other engines turned out by Messrs. Penn, it is very probable that the power actually given out will be found on the trials to be considerably over that just mentioned, the speed very likely reaching 70 revolutions per minute. Although, however, such a result as this is extremely probable, it is only just to the makers to say that they themselves have in no way held out any expectations that a speed of 65 revolutions per minute and an indicated power of 7200 horses will be to any extent exceeded.

As in all Messrs. Penn's later engines, except those of very small size, the cylinders and cylinder-covers are thoroughly steam-jacketed, and care is taken that the jackets are kept properly supplied with steam. The supply of steam to the jackets is perfectly independent of that to the cylinders, and from the lowest points of the jackets drain-pipes are led and connected to a pipe leading to the hot well. On this last-mentioned pipe is a cock which is kept constantly open, to such an

extent that, in addition to discharging all the condensed water from the jackets into the hot well, it allows a constant but very slight leakage of steam to take place. The fact of this leakage of steam taking place indicates that the jackets are certainly full of steam; and if it should cease, then it is merely necessary to open the cock to a greater extent to ensure the discharge of the water from the jackets.

The steam on its way from the boilers to the engines is led through a separator, in which by far the greater part of the water carried by the steam (owing to priming or condensation) is deposited, and from which it is blown off at intervals. This separator is arranged on a simple plan, which has long been adopted by Messrs. Penn. It consists merely of a kind of deep box, with the opposite sides of which the steam-pipe from the boiler and its continuation to the engine are connected. Across the box, between the inlet and outlet pipes, is carried an inclined plate extending from the top of the box to below the level of the steam-pipes, and all the steam passing through the separator has to dip under this plate. The effect of thus suddenly diverting the current of the steam is found to be that it is made to deposit the greater part of the water carried by it in the separator, from which, as we have said, it is periodically blown off.

The distribution of the steam is effected by double-ported slide-valves driven by ordinary link motion, and by separate expansion valves worked by separate eccentrics. The slide-valves are placed vertically at the sides of the cylinders, and they are fitted with square rings at the back for taking off the back pressure. The gridiron expansion-valves work in a horizontal position on faces cast on the top of the main valve-chests, and their stroke can be varied so that they shall cut off the steam at from one-third to one-sixth the stroke. As it sometimes happens, when the engines are stopped, that a partial vacuum may form in the main valve-chest when the expansion valves are closed—in which cases it would be difficult to move the latter—means are provided for admitting steam, when necessary, direct to the main valve-chests without passing through the expansion valves. For this purpose the casing above each expansion valve is connected with the corresponding main valve-chest by a curved pipe furnished with a throttle valve, this valve being of course kept closed during the ordinary working of the engines.

In addition to the main slides, the cylinders are fitted with small auxiliary or starting slides, which can be readily worked by one man, and by their aid the engines can be kept slowly moving, when necessary, with the main links in mid-gear. These auxiliary slides each merely consist of a small ordinary slide-valve placed in a valve-chest at the top of each cylinder, this valve covering ports communicating with the two ends of the cylinder and with the condenser in the ordinary way. These auxiliary slides, which have been long used by Messrs. Penn, enable engines of the very largest size to be handled with perfect facility, and they form an infinitely more simple and perfect arrangement than the complicated steam and hydraulic reversing gears, which in some cases have been applied to effect the same purpose.

Another detail which forms a special feature of Messrs. Penn's engines is the arrangement of the cylinder relief-valves. In addition to the ordinary escape-valves fixed to each cylinder-cover, each end of each cylinder is provided with a relief-valve, arranged in a manner patented by Messrs. Penn. These valves are fitted to the passages leading from the ends of the cylinders to the auxiliary slide-valves, and they open into chambers connected by pipes with the separator. Each valve is an ordinary conical valve, pressed down on its seat by a light brass spring exerting a pressure of about 2 lb. per square inch of the area of the valve. As the valve-chambers are connected with the separator, however, there is at all times—unless the stop-valves on the boilers are shut—the full pressure of steam in the boilers exerted on the upper sides of the relief-valves, the gridiron stop-valve by which, as we should have before stated, the supply of steam can be instantly shut off from the engines, being situated between the latter and the separator. The pressure per square inch on the top of these relief-valves is thus that due to the pressure of the steam in the boiler *plus*, say, about 2 lb.; and if the pressure in the cylinder becomes greater than this amount owing to the presence of water or to compressor, the valves lift and relieve it, any water discharged by them flowing back into the separator, from which it is blown off, as already mentioned. It will be seen that the relief-valves arranged in this way are much more sensitive than those ordinarily fitted, as the latter have to be loaded to 10 lb. to 2 lb. per square inch above

the maximum boiler pressure in order to ensure their being kept tight. In fact, in engines fitted with Messrs. Penn's valves, the latter are, when the engines are running with the links near mid-gear, frequently heard to lift at each stroke, showing that they are relieving the compression which the early closing of the slide-valves to the exhaust would otherwise cause to take place near the end of each stroke. Another advantage of Messrs. Penn's valves is, that if, from any dirt getting on their seats, they do leak, they only leak steam, and not air, like ordinary relief-valves, and therefore do but comparatively little injury to the vacuum. Ordinary relief-valves are, as we have said, also provided, but are intended only to come into action on extraordinary occasions, and it would certainly be preferred by the makers that they should never come into action at all. They are provided with small supplementary valves which can be opened by the pressure of the foot on a lever conveniently placed on the main platform, and they are so fixed on the cylinder-covers that, when removed, they uncover an opening or manhole through which the condition of the pistons and cylinders can be inspected.

We must now say a few words about the surface condensers. They are cylindrical in form, and each contains 7052 solid drawn copper tubes, $\frac{3}{4}$ in. in diameter outside, and 7 ft. 6 in. long between tube-plates. The total number of tubes is thus 14,104, and the surface exposed by them amounts to 20,768 square feet. The tubes are fixed in the tube-plates with compressed wooden ferrules, these ferrules surrounding the ends of the tubes, and being interposed between the latter and the holes in the tube-plates. The steam is allowed to circulate amongst the tubes, and the condensing water is forced through them, being supplied by a pair of Appold's centrifugal pumps, one to each condenser. These pumps are driven by an independent pair of engines, similar in design to those made for the "Sappho" (now re-named the "Eclipse"), and exhibited by Messrs. Penn at the late Paris Exhibition. The centrifugal pumps are arranged so that they can be made to draw from the bilge, and they are capable of delivering 120 tons of water per minute. The condensers are also fitted with injection pipes, and are arranged so that they may be used as ordinary injection condensers, if occasion should require it.

It is in the constructive details of the condensers that some of the main points of difference between the engines of the Hercules and those of the Bellerophon occur. In the case of the latter engines the casing of each condenser consists of three parts, there being a central barrel and the top and bottom castings. The two tube-plates were secured between the flanges of the upper and lower castings and the corresponding flanges of the barrel. There was thus at the level of each tube-plate a double joint, and it was possible—although, considering the splendid workmanship turned out at Messrs. Penn's factory, highly improbable—that air might leak in through two of the joints into the condenser. To avoid this, each tube-plate is, in the case of the Hercules engines, jointed to an internal flange cast in the condenser-casing, and if these joints do leak, they can only leak water. Each condenser-casing is made in but two pieces, a base piece and an upper portion, and although the joint between the two parts comes above the lower tube-plate, and is thus an air joint, there is but very little danger of its leaking, as it is but a single joint very conveniently situated for facing and making. The steam, we should mention, enters the condensers, and the condensing water is forced in at the bottom of the tubes, the currents of steam and water thus passing in opposite directions. The air-pumps, bilge and feed pumps, are all arranged very much as in the Bellerophon, and are worked by rods direct from the pistons. The air-pumps are double-acting, and are fitted with india-rubber valves. In the case of the Bellerophon's engines, the water was lifted into the airpumps through the foot-valves; but, in the engines for the Hercules, the lower tube-plates of the condensers have been kept above the level of the air-pump, so that the water flows into the latter by gravity, haing valves being employed. This is decidedly an improvement.

Steam will be supplied to the engines by eight boilers placed in two boiler-rooms, four in each. The boilers are to be placed in the wings of the ship, the stoke-hole being amidship. The boilers will be provided with forty furnaces, each having a grate 8 ft. long by 2 ft. 10 in. broad, and the total area of grate surface will thus be 907 square feet, equal to about .75 square foot per nominal horse power, whatever that term may mean, or say about .125 square foot for each estimated actual horsepower. The total heating

surface amounts to about 23,100 square feet, equal to 19 $\frac{1}{2}$ square feet per nominal or, say, 3.2 square feet per indicated horse power, as estimated. Of this total surface, 19,792 square feet are tube surface, the boilers containing altogether 3600 tubes, each 7 ft. long and 3 in. in diameter. The boilers are to be fitted with superheaters, these being placed in the upper part of the boilers, so as not to interfere in any way with the ventilation of the stoke-hole. Each of the eight superheaters will contain 140 tubes 5 in. in diameter and 2 ft. 8 in. long, and the total amount of superheating surface will thus be 3908 square feet, equal to about 3 $\frac{1}{4}$ square feet per nominal or about .54 square foot per estimated indicated horse power.

The engines will drive a two-bladed Griffiths screw 23 ft. 6 in. in diameter. The screw is not fitted with lifting-gear, but the screw-shafting is provided with disconnecting and brake gear. Of the mechanical finish of the engines it is scarcely necessary to speak. The fact of their being made by Messrs. John Penn and Son is of itself the very best guarantee for the quality both of the workmanship and materials. In concluding our account of the engines of the Hercules, it will be interesting to mention the weights of a few of the principal parts. The crank-shaft weighed in the rough 34 tons 16 cwt.; the screw-shaft, 24 tons; each cylinder, 32 tons 17 cwt.; and the screw-propeller, 23 tons 10 cwt. The total weight of the engines, boilers, water, and spare gear will not exceed 1090 tons, or less than 3 cwt. per estimated indicated horse power.

TURRET SHIPS.

CAPTAIN SHERARD OSBORN has fired another shot, in the shape of a letter to the *Times*, at the Controller's department of the Admiralty, wherein, he states, the design of the turret ship *Monarch*, now building at Chatham, "was born of an attack of indigestion." She is, he goes on to say, "neither hog, dog, nor 'devil,' and 'her turrets might as well be mounted 'upon the top of the First Lord's old hat' as where they are, with 14 ft. or 15 ft. of freeboard beneath them. This is good sailor lingo, and will be relished by thousands who, having no very definite notions of their own, further than that the Admiralty officials must be wrong in nearly everything, like to see them roasted with such fun as the gallant captain thus pokes at them. But gallant captains are not always (nor often) naval architects nor engineers, and however they may incline to ridicule professional opinion, it must, if well founded, prevail in the end. Captain Osborn believes in the low freeboard of the monitor type of vessel, and he pitches his shot at the *Monarch* because she has four or five times as high a freeboard. We fully enjoy and laugh at his fun; but the richest fun is that which is tempered with the best reasons, and there are reasons which he altogether overlooks. We will not discuss the precise design of the *Monarch*, but we can, without going into the calculi, or into the metaphors of sailor's rhetoric, show the respective advantages of, and objections to, high and low freeboards, as given to fighting-ships.

No man-of-war's man need, of course, be told that considerations of mere comfort should not be allowed to interfere in any way with the fighting qualities of a war-vessel. But if, with a practically irresistible armament and a practically invulnerable hull, the comfort of the men *can* at the same time be secured, so much the better. We have to remember that, although it is of the last importance that our ships of war should be the most perfect fighting-machines for their purpose in existence, they are but seldom actually engaged in fighting, and we must all hope that they will be as little engaged in fighting in the future. We may be building ships of war which, however formidable and shot-proof, may never fire a gun in the whole course of their future existence, except at practice or as a salute; and of those that may go into action—and blow the enemy out of the water, too—they may not fight for, in all, more than twenty-four hours out of, perhaps, as many years, during which they may be flying the flag. And yet during their twenty-three years and three hundred and sixty-four days of inaction, or in steaming at half-boiler power from station to station, these ships must be the homes each of hundreds of officers and men. Amphibious as the sailor is, he does like, after all, to live above water, and had much rather mess and hang his hammock 'tween decks than in the hold. No engineering or naval architecture is ever likely to cure him of this liking.

So we find that a war vessel must be more than a fighting-machine, although it must not be less, and

must be one of the very first order at that. It is from this point that we can properly examine the question of freeboard. If the ship shows a high broadside out of water, she presents a corresponding mark to the enemy, who can hit a three-decker nine times out of ten, where he might not hit a bumboat once. And if we have two ships which have the same displacement, or, which sailors can understand better, which would, if placed in a huge pair of scales, weigh exactly alike, and if one of these ships is nearly all under water, and the other shows her whole length for a height of 15 ft. or 20 ft. out of water, and if both are to be covered with armour of the same weight or tonnage for each, it is plain enough that the ship which shows the least out of water can carry thicker plates than the other, which must have her iron spread over three, four, or five times the same exposed surface. So far the comparison is against high-sided armoured ships, because, with a given thickness of plates, they must carry the increased weight of armour corresponding to their greater exposed surface, and the weight of 5 in. iron on the sides of a ship 300 ft. long, and rising 20 ft. out of water, is more than 1200 tons; whereas with the same dead weight of iron the same ship, if cut down to a freeboard of 4 ft., might be plated 2 ft. thick, dismissing, for the moment, the consideration of the plating below water, or rather supposing this to be the same in both ships. The ship with the low freeboard thus not only has less surface exposed to fire, but that surface may be, in the inverse proportion, covered with thicker plates, thus constituting a double advantage. This is a very great double advantage; but it is the *only* double or single advantage which a low freeboard can give to an armour-plated war ship.

But the monitors carry but two, four, or, at most, eight guns, and fire from but one, two, or four turrets along their length, each turret being but about 24 ft. in diameter. Now these turrets present almost the only mark for an enemy's fire, and they must, therefore, be very heavily plated if the gunners inside are not to be knocked out of time by pointed chilled shot. If, however, and just for the sake of supposing such a thing, a vast screen of coal-tarred canvas were to be stretched for the full length of the turret ship, and to a height, along each side, of 15 ft. or 20 ft., the enemy might be rather puzzled to know *what* part of the ship to fire at, and would probably pop his shot as often through the drapery of the fictitious fore-castle and poop as against the more substantial turrets.

Now we are where we can get a step further. Suppose, instead of such a canvas sham-broadside, our ship had an iron skin, no thicker than that of a merchant steamer, but covering the same area, and let her still be a turret ship, or, at any rate, let her guns be protected by one, two, or four thoroughly armoured turrets, or "boxes," or "central batteries," or whatever they might be called, and let her be protected, near the water-line, by as heavy armour as even Captain Ericsson or Mr. Bourne would propose for any monitor. And, even, to go further, let the turrets be mounted, as Captain Osborn puts it, "on the top of the First Lord's old hat," or, in other words, *above* the whole breadth and height of the iron skin just supposed. It needs no long-winded explanation to show that such a ship would present a large amount of out-of-water accommodation for her officers and men when on a station, or when cruising, and that, so far, she would be more habitable, and probably more seaworthy, than a monitor. When the hour of action *did* arrive, let the officers and men go, according to their respective duties, into the turrets and below, and leave the more habitable portion of the ship to be fired at and through, as if its sides were no more than so much painted sail-cloth. Practically, this is how the *Monarch* is being built. She will be comfortably habitable for the ninety-nine hundredths of her probable future existence; and when the tug of war *does* come she will, even if neither "hog, dog, nor devil," prove a very ugly customer indeed for the enemy. He will probably expend three-fourths of his powder and shot upon her freeboard, to the damage of no one, while she is pounding back from her heavy rifled guns, which are so protected that they cannot be silenced. We recommend Captain Sherard Osborn, who is a gallant officer and a jolly sailor, to overhaul his reckoning before he again writes so confidently to the *Times*, opening fire upon a question which he does not understand quite so well as he should.

A BLOW AT TRADES' UNIONS.—The South-Eastern Railway Company have given notice of an intended application to Parliament for powers to establish savings banks and other provident institutions for the benefit of their workmen.

THE "CHALK FARM RAILS."

THE steel rails put down, in May, 1862, in the station-yard of the London and North-Western Railway, at Chalk Farm, have become famous by their extraordinary durability and toughness. At one point where the goods traffic is almost incessant, sixteen "faces," or eight entire rails, of wrought iron had been worn out between May, 1862, and August, 1865; whereas two Bessemer steel rails, laid in the same line, and sustaining the same traffic, had worn down, at the last named date, but $\frac{1}{4}$ in. on one face only, never having been turned. One of these rails was then taken up and presented to Mr. Bessemer, at his request, as a memorial of the extraordinary service it had withstood. It was naturally a most interesting point to ascertain whether the steel of which this rail had been made had suffered any molecular deterioration under the passage of nearly one hundred millions of tons of traffic. To settle this point, the rail was cut in two, and a portion of it drawn into fine wire of excellent quality. The other half of the rail, 8 ft. in length, was tested at Mr. Kirkaldy's Experimenting Works, the tests being made at the instance of Mr. Price Williams. It was tested along with six other steel rails by various makers, and all of which, with one other exception, were new. Nine iron rails were also tried, all of them, with one exception, new; and three rails, having iron stems and steel tops, were also tried.

The results of these tests are given in Mr. Price Williams's well-known paper as follows:

The rails were subjected to a bending strain, in the direction of their depth, the strain being applied midway between 5 ft. bearings. As the rails were of different sectional areas, the strains given in the following table are in pounds per square inch of the sectional area:

KIND OF RAIL.	Strain per square inch of sectional area.	Deflection.	Result.
STEEL.			
Crewe, 1866, new ...	10,463	7 $\frac{1}{8}$ in.	Broke.
J. Brown and Co., new ...	10,281	8	Canted.
Bessemer Chalk Farm rail, slightly worn ...	10,334	5 $\frac{1}{2}$	Canted.
Cammell and Co., 1864, new ...	10,061	4	Broke.
Bessemer's Chalk Farm rail, much worn ...	10,677	6 $\frac{1}{2}$	Canted.
S. Fox and Co., 1865, new ...	8,263	9 $\frac{1}{2}$	Canted.
" 1864, new ...	8,504	8	Broke.
STEEL AND IRON.			
Crewe, 1866, new ...	7,639	10 $\frac{1}{2}$	Broke.
S. Fox and Co., new ...	7,651	10 $\frac{1}{2}$	Canted.
" " ...	6,854	11 $\frac{1}{2}$	Broke and canted.
IRON.			
Crewe, 1866, new ...	6,245	4 $\frac{1}{2}$	Broke and canted.
Ebbw Vale, 1866, new ...	6,134	7	Broke.
Crewe, 1866, new ...	5,703	4	Canted.
Rail from Chalk Farm, much worn ...	6,103	1 $\frac{1}{2}$	Canted.
Ebbw Vale, new ...	5,230	2 $\frac{1}{2}$	Broke.
Flange rail, new ...	4,915	4 $\frac{1}{2}$	Broke.
Bridge rail, new ...	2,374	4 $\frac{1}{2}$	Broke.
Bridge rail, new ...	1,960	5 $\frac{1}{2}$	Broke.
Bridge rail, new ...	1,970	6	Broke.

The tests of these rails, taken at random, fully proved the great superiority of steel over iron. And it deserves special remark that the steel rail which had then withstood the heaviest traffic ever known upon a single rail was the toughest of all. After withstanding a load of more than 30 tons applied midway between 5 ft. bearings, and deflecting nearly 5 in., it canted, and could not be further tested, except it had been first heated and straightened. There was evidently no molecular deterioration or change of structure in the steel of this rail, notwithstanding the unprecedented service which it had borne.

Its fellow rail remained in service, as we have elsewhere described, till March last, or until nearly five years after it was first put down, when, having outworn twenty-two faces of iron rails adjoining it, without having itself been turned, it was greatly bent sideways, or in the direction of its least resistance, and broken into three pieces. This was done by a heavy engine being thrown off the line in a collision exactly upon this rail. The fractures showed a fine and excellent quality of steel, as perfect as that of the best new steels now made.

THE ABYSSINIAN TELEGRAPH.

ARRANGEMENTS have been made for organising a telegraphic service in connexion with the Abyssinian expedition, by means of which it is hoped that both India and England will be kept informed of the progress of the expedition. The Egyptian lines either now extend, or are being rapidly completed, to Souakin, and it is intended that a line shall be constructed between that port and Mussowah, or whatever other point may be determined on for the debarkation of the troops. Flying lines will also be constructed to keep up communication between the army and the coast; but, for field operations, it is intended that Captain Bolton's portable signalling apparatus shall be employed. Signalling with this apparatus can be carried on with great rapidity, the signals being long and short flashes corresponding with the Morse alphabet, the long flashes being about a second and a half in duration, the short flashes half a second. In the daytime the object is made to appear and disappear, but for short distances a bat, flag, or handkerchief are said to be sufficient. At night the signals are made by the exposure and obscuration of a single light, and for this purpose Captain Bolton has produced a portable apparatus which is effectual for distances up to twenty-five miles. The telegraphic service is under the direction of Captain Mallock, and his staff will comprise three superintendents, six assistant superintendents, fifteen line inspectors, and thirty efficient signallers.

Besides the above, a camp post-office is to be established, to accompany the expeditionary field force, and it is believed that a special steamer will be employed on this service between Mussowah and Aden. Letters, papers, &c., for this force will require to be addressed to "The Field Force, Abyssinia."

AN IRONMASTER'S VIEW OF STEEL.

IN one sense, it is matter for regret that the large and growing demand for steel rails must necessarily cripple the rolled-iron trade. In the same way the general adoption of wrought iron, instead of cast iron, for railway bridges has deprived the ironfounders of many heavy contracts, although probably few, if any, of these gentlemen would deny the immense superiority of malleable iron over cast. Indeed, at one time rails themselves were made of cast iron.

The superiority of steel, as compared with wrought iron, has now been so fully proved, and is so widely admitted, that we fear the owners of rolling-mills must make up their minds to the inevitable consequences. If, however, they believe that they can still successfully dispute the superiority of steel, it is but natural and proper that they should do so; but we trust that but few will do so merely in support of their own trade, and with little or no reference to accumulated facts.

The letter of our Pendleton correspondent, "J. B.," is not an unnatural expression of the opinion of a mill-master, exclusively interested in iron as distinguished from steel, but it is in several respects incorrect, and in others unfair, although not, perhaps, intentionally so. Forgetting that about two millions of steel rails have now been made, he cites the case of one which broke in falling from a truck, while we know of several instances of iron rails doing the same thing; he cites the case of another steel rail which broke between the fish bolts, and of a steel connecting-rod which appears, by his own account, to have been broken by a false blow of the steam-hammer.

To all this the answer is that the steel which broke, except, perhaps, that in the connecting-rod, was of bad quality, greatly inferior to that of which literally hundreds of thousands of tons have now been made. Railway companies ordering steel rails have only to stipulate that one of every fifty, to be taken at random, shall withstand the fall of a heavy weight from a considerable height, and they will find manufacturers perfectly willing to take their orders, and having no difficulty in meeting the test. As to toughness under twisting tests, steel rails exhibited in London in 1862, and still to be seen, have been twisted closer than any iron rail we ever saw, "twisted like a corkscrew." The steel rail in the Queen-street tunnel, Glasgow, to which "J. B." refers, had worn but $\frac{1}{4}$ in. under 11,000,000 tons of traffic, made up of 321 engines and 1600 vehicles every twenty-four hours, the rail being in a tunnel always damp, and on an incline on which the brakes had generally to be put on. At this rate it required rather less than a year to produce the wear mentioned; but the wear has little or nothing to do with time in the abstract, but depends upon the traffic, or, to express it better, the tonnage over it, and the engineer to the North British Railway considered the service

of this rail so good as to specially communicate it, and unsolicited, to us for publication. No iron rail ever yet made has borne such a traffic with so little wear.

As for steel-topped rails, they have been extensively tried upon the London and North-Western Railway, and we have ourselves seen scores of the steel heads which had stripped or peeled off the iron. The testimony of all the officers connected with the permanent-way department of the company will be found to be unfavourable to the use of steel-topped rails.

As for rails of the very best quality which ironmasters have been able to make, receiving 94 a ton for them, they have been abundantly tested upon the Great Northern line, and found to be, although good, altogether inferior in durability to steel.

We are compelled to make every allowance for an ironmaster's view of a threatened abandonment of his favourite material, to understand how, at this late day, he can raise a question as to the superiority of steel over iron rails, and after the leading engineers and railway managers have so fully made up their minds upon the whole question.

THE GREAT INDIAN PENINSULA RAILWAY.

AS the result of an inspection of the works in progress on the south-eastern section of this line, up to the point where it will unite with the Madras line, an interesting report of their condition at the commencement of the present year has been sent into the Bombay Government by Captain White, the deputy consulting engineer for railways in that presidency. The publication of this report has, we believe, been somewhat unusually delayed, owing to correspondence which has been going on between the Government of Bombay and the authorities at Hyderabad on the subject of feeders to that part of the line which passes through the Nizam's territories. A good idea can, however, be obtained from it of the present state of advancement of the works, while it affords positive information as to the probable period of the completion of the line, which will afford direct railway communication between Madras and Bombay. The report relates to the 159 miles of railway from Sholapore to Raichore, where the junction of the Bombay and Madras lines takes place; and Captain White is of opinion that, with the exception of the viaduct over the Kistna river, communication between Bombay and Raichore will be completed before the close of 1869; and he allows another year for the break at the Kistna to be closed. The earthwork on the contract embracing the 70 miles from Sholapore to Koolburga was, when inspected by Captain White, in a very forward state, 95 per cent. of the embankments having been completed. Of the cuttings 12 per cent. had been excavated. The contract period for opening this portion of the line for traffic is March 31, 1868; but owing to the backward state of the masonry works, which had been stopped pending the result of a demand made by the contractors for higher rates, the inspecting engineer saw little prospect of this time being kept, and names a year later as the probable period of the time being opened to Koolburga. On the last section of 88 $\frac{1}{2}$ miles, between Koolburga and Raichore, there are two heavy masonry works, the Kistna and Cangnee viaducts. The design for the Kistna viaduct consists of fourteen 142 ft. girders and fourteen 30 ft. land arches, seven on each bank. The clear span between the piers, which are 12 ft. thick, is 138 ft., and the rail level is 8 $\frac{1}{2}$ ft. above the bed of the river. Some modifications in the plan of this viaduct are proposed, so as to increase the waterway, and its construction, being a work of such magnitude, is likely to delay the perfect completion of the south-eastern branch of the Great Indian Peninsula Railway to Raichore some twelve months beyond the period at which it is estimated that the entire line, with this exception, will be opened for traffic. The design for the Cangnee viaduct consists of fourteen land arches of 30 ft. span, seven on each bank, and eleven 78 ft. girders, the clear span between the piers being 74 ft. From the foregoing it will be seen that, within the next three years, the line of direct railway communication between Madras and Bombay will, in all probability, be fully completed on the Bombay side, and the through communication will then be established between the two presidency towns.

STEAM TO THE RIVER PLATE.—Messrs. Tait have established a bi-monthly line of steamships between London and the River Plate, and their second vessel left Gravesend last week on her way out.

HILL RESERVOIRS.

In a recent article on the subject of forests in India, and the effects which their clearance had on the water supply of the country, we alluded to the necessity which existed for the construction of hill reservoirs, in order to store up the rain-fall, and prevent its flowing unchecked down the hill-sides, forming the water-shed of the several rivers, and thereby causing severe floods. This subject has already received some attention, and Sir Arthur Cotton urged the necessity of forming reservoirs on the Neilgherries more than thirty years ago. Dr. Balfour has also written two valuable papers upon the subject. But nothing has yet been done, and we can, therefore, only glance over what has been proposed. And first as to the water-supply from the Nuggur and Baba Bodeen hills, which contain the sources of the Toongabuddra river. To this river the vast territory known as the Ceded Districts, as large as Ireland, and (if we except a few mangy baboos) almost devoid of trees, looks for its future fertility. The Choardy, Toonga, Budra, and Huggary are the affluents which form the Toongabuddra, and, if the means of raising two crops is ever to be furnished to the lands within reach of the projected irrigation works in the Ceded Districts, large reservoirs must be formed in the hills on the upper courses of these streams. The most favourable sites are probably at the ancient tank of Mudduck Masoor, on the Choardy, at Mudala, on the Toonga, and at Luckawally, on the Budra.

South of Nuggur, from Munjerabad to the Neilgherries, the whole of the streams rising in the hill districts go to form the mighty Cauvery, a river on the waters of which depend the irrigation of a great part of Mysore, of that marvellously rich garden of Tanjore, and the projected conversion of the arid plains of Coimbatore into one sheet of cultivated land. Reservoirs have been proposed both in Coorg and Wynaad, and a very thorough examination of sites on the Bowany and Moyaar—the rivers that drain the Neilgherry and Koondah hills—was made in 1856 by Mr. Fraser, an engineer of the Madras Public Works Department. Detailed plans and estimates were then completed for a great reservoir on the Manal Kava. Another was proposed at a site about a mile below the junction of the Moyaar and Bowany rivers, where a bund might be thrown across a valley. The two rivers drain a catchment basin of 1600 square miles, the greater part of which is on the Neilgherry and Koondah hills. Another site for an artificial lake was suggested by Mr. Fraser, at a place called Palavur, on the Bowany river. Here a bund 852 yards long would form an artificial lake 45 miles round, with a capacity of 507,250,000 cubic yards of water; the whole area being now a wild and uninhabited jungle. Above Palavur, there are several other good places for forming reservoirs on the Bowany; but on the Moyaar there are no favourable sites, though comparatively small basins might easily be formed. Finally, on the Neilgherries, the streams flowing through Love Dale, and from Bishop's Down and Marjanaad, unite in an extensive flat, where a large reservoir might be formed. The bund would be placed across a narrow gorge at the lower end of the flat, and would form a lake capable of holding 70,000,000 cubic yards of water. In the Pulney hills Colonel Douglas Hamilton has pointed out the site of an extensive ancient lake, which might be converted into a great reservoir; and there is a project for turning the waters of the Perryaur, which now run to waste in the Cochin backwater, over the eastern side of the Travancore hills, and thus converting Madura and Ramnad into a garden rivalling Tanjore in fertility. The damming of the Perryaur will form a lake several miles in circumference. It may also be added that there is a very extensive tract of mountainous country extending from the Anamallays to near Courtallam, which is almost entirely unknown.

From a careful investigation conducted by Captain Oakes, the engineer of the Tanjore division, it would appear that the clearance of forests hitherto made on the hills has not yet appreciably affected the irrigation in the delta of the Cauvery. Although the floods have been higher from 1856 to 1865 than from 1846 to 1855, on the Cauvery anicut, yet, owing to the duration of the floods during the former years having far exceeded that of the floods of the latter, and owing also to the fact that the height of the water at the Cauvery anicut throughout the period from 1856 to 1865 differed but little from that from 1846 to 1855, Captain Oakes concludes that the high floods of late years are attributable rather to a greater fall of rain than to the clearance of the catchment basin. It must be remembered, however, that the destruction of forests is very far from having reached its limit, that the

rapid surface-draining caused by it already effects much mischief in the hill-districts, and that, as the felling proceeds, these consequences may eventually be felt even in the Cauvery delta.

The construction of reservoirs in the hills is also a matter of great importance for purposes of irrigation. They will relieve the rivers of superfluous water when the floods are high, thus tending to prevent injury to the works, and furnish supplies for irrigation when the rivers are low. Every cubic foot of water which passes over an anicut into the sea, in time of floods, virtually represents so much food for the people recklessly wasted. The storage of water in reservoirs on the hills would prevent this waste, so that, while they are the obvious remedy for the evils caused by the destruction of forests, they are also essential to a thorough system of irrigation.

AN IRONMASTER'S VIEW OF STEEL.

TO THE EDITOR OF ENGINEERING.

SIR,—Will you allow me space for a few more words on the subject of wrought-iron rails *versus* steel rails? I am the more desirous of this because your article on my former letter overlooks the main point I wished to enforce, which was the possibility of further improvement in the quality of iron rails, if proper inducement was offered for doing so. There is also in your article such a redundancy of assertion, and of such a sweeping character, as must fill the minds of all connected with the production of wrought iron with dread, if these assertions can be supported by facts; for, after all, I believe this is an age much given to look for facts, and that theories or assertions, whether from the press or the platform, or any other supposed authority in science, politics, or other matters, are fast becoming of no account, unless based on facts. When, therefore, you state that "steel rails never break," that they are stronger, tougher, and, of course, safer than iron rails, the question naturally arises in the minds of these practical men, of whose opinions you don't seem to form a very high estimate, are these assertions borne out by facts, or are they the sanguine thoughts of a rather enthusiastic and theoretical advocate, not thoroughly acquainted with all the facts connected with the material so persistently advocated?

As a practical man, I will give you one or two facts that I must say rather shake my confidence in the statements alluded to. In my last letter I referred to some steel rails broken in being unloaded from a truck. A few months ago, a friend of mine, walking along a line, a portion of which is laid with steel rails, not many hundred yards from where I write, observed a break across the head of a rail, about 9 in. from the rail end, and, on taking hold of it, found, to his astonishment, he could lift the piece entirely out from between the fish-plates; in fact, the rail had broken with a longitudinal fracture along the web, through the bolt-holes; and, but for this timely discovery, the consequences might have been serious to life and property. Another fact: whilst visiting one of our new steel works this year, I stopped to examine a steel connecting-rod nearly finished, about 18 ft. long and 5 in. diameter, intended for a beam-engine; the rod was resting on the anvil, under the steam-hammer, one end in the crane sling; the other end, or rather a portion of the rod, about 4 ft. long, had just dropped on the floor, broken, I was told, by a false blow from the hammer. How many blows from a falling weight this would have stood will not require much calculation.

These are facts that have recently come within my own knowledge. I have no doubt whatever but similar facts could be multiplied to a great extent, if inquiries were made at all places where this material has been much used. If you or any of your readers require it, I will furnish names, places, and dates of the occurrences I have named. That opinions respecting the uncertainty of Bessemer steel are held by parties competent to judge, and perfectly disinterested in the matter, is also shown by the result of the application made to the Board of Trade, last year, to allow a less sectional area in railway bridges made from steel plates than when made from wrought-iron plates. The decision not to allow this was, I have no doubt, come to after a careful examination and consideration of all the facts bearing on the uncertainty of the material.

Such facts as I have herein named will show the danger of replacing iron rails with steel rails of any lighter section, and, therefore, no saving in weight can safely be calculated upon without dangerous risk to life and property. No doubt some steel rails have stood the tests you name; but he would be a bold advocate who would assert such to be the general character of the Bessemer material; and I could furnish records of the tests good wrought-iron rails have been subjected to, which would bear favourable comparison even with the severe tests you name.

As to toughness, the wrought-iron rails twisted like a cork-screw, and exhibited years ago, and the specimens any iron-master can show of wrought iron bent and twisted in all manner of shapes, will surely be sufficient answer to the claim you make for superior excellence for steel rails in this respect. In durability, I admit the superiority of steel rails over wrought-iron rails as now made; but even in this respect I think you very much overrate Bessemer rails. The diagram of a steel rail which had been in use about twelve months, as given by a correspondent in *ENGINEERING*, October 11, 1867, shows nearly an eighth of an inch wear in that time. If the wearing of this rail proceeds in the same ratio for the next four or five years, it will be quite apparent that the rail would then require to be renewed, I have no hesitation in saying that wrought-iron rails, of ordinary make, can be seen that have been in use this length of time, and subject to as severe traffic as your correspondent names, with little or no more

wear than this diagram indicates; and that for an extra 20s. per ton any experienced rail-maker could produce a rail that would wear as well.

As a general rule, there is no doubt but what steel will wear longer than iron, and for this reason I suggested the adoption of steel-topped rails. I am informed that in Germany this system of rail-making is being adopted with good results, but the steel employed is not Bessemer steel, and this may account for the success which, I understand, has attended their efforts in the production of steel-topped rails. I did not recommend the use of steel in rail-heads to strengthen the rail, believing good wrought-iron rails to be, as I said before, sufficiently strong for all practical purposes. Your analogy, therefore, of a cast-iron beam with wrought-iron flanges, is rather beside the question. Unfortunately, railway directors have hitherto, as a general rule, pursued the policy of buying the cheapest rails they could get, and, in consequence, manufacturers have not been tempted to improve the quality of their rails, but to produce a cheap article.

If some of our principal railway companies could be induced to follow in the footsteps of the coal proprietors of Lancashire (who have offered a premium for the best coal-cutting machine), and offer a premium for the best wrought-iron rail that can be produced, allowing a mile or two on some of the principal lines (where all can be subject to an equal amount of traffic) to be laid with rails from different makers, I have no doubt but our iron manufacturers have sufficient public spirit to enter into such a competition, supply the rails for trial, and leave the verdict, after two or three years' wear, to the decision of an impartial tribunal.

Yours truly,

J. B.

Pendleton, Manchester.

A REMITTANCE.—The want of an international money-order system is often felt by considerable numbers of persons. In the case of the late Paris Exhibition it was an absolute necessity, and, managed as it was by the British executive, was of incalculable service to thousands. We this week received a small remittance from Vienna, consisting of a gold five-franc piece, a French silver piece of fifty centimes, an Italian silver piece of twenty centesimi, a twopenny British postage-stamp, and an *ein gulden* note, worth about eighteen pence, all enclosed in a registered letter!

LABUAN COAL.—The Labuan Coal Company, whose mines, in that distant colony, are now capable of raising 250 tons of excellent steam coal daily, and which is priced there at 20s. a ton, is in danger of being broken up in consequence of legal difficulties with the colonial Government.

FATAL BOILER EXPLOSION.—A boiler exploded yesterday week at Messrs. Illingworth's works at Bradford, and two men were killed.

THE DOUBLE-SHIFT SYSTEM IN COAL MINING.—Mr. John Nixon, one of the largest coal-owners in Wales, has written a letter to the press, ably and earnestly urging the adoption of the double-shift system of mining in all fiery collieries in Wales, instead of the single-shift system universally practised there. The arguments are too numerous and lengthy for our columns, but we may observe that Mr. Nixon strongly recommends an amendment to the Mines Inspection Bill, enforcing the system of double shifts universally practised in Northumberland and Durham.

THE WIVERN'S GUN.—The gun, of which the breech was lately blown out in one of the turrets of the Wivern, was a 10 in. smooth-bore, weighing 12½ tons. The gun was being fired with round shot and 30 lb. charges. Happily, no one in the turret was injured.

AMALGAMATION.—Parliamentary notices have been given of an intended application for either the amalgamation of the South-Eastern and Brighton Companies or their union under a joint management, with power also to work the London, Chatham, and Dover Railway. Notice has been given also with reference to the withdrawal of the Edinburgh and Glasgow from the North British amalgamation.

THE QUEEN'S TRAIN STOPPED.—Her Majesty was detained in her special railway train to Windsor, on Saturday last, for upwards of half an hour, in consequence of the breaking, as is reported, of one of the valves of the engine.

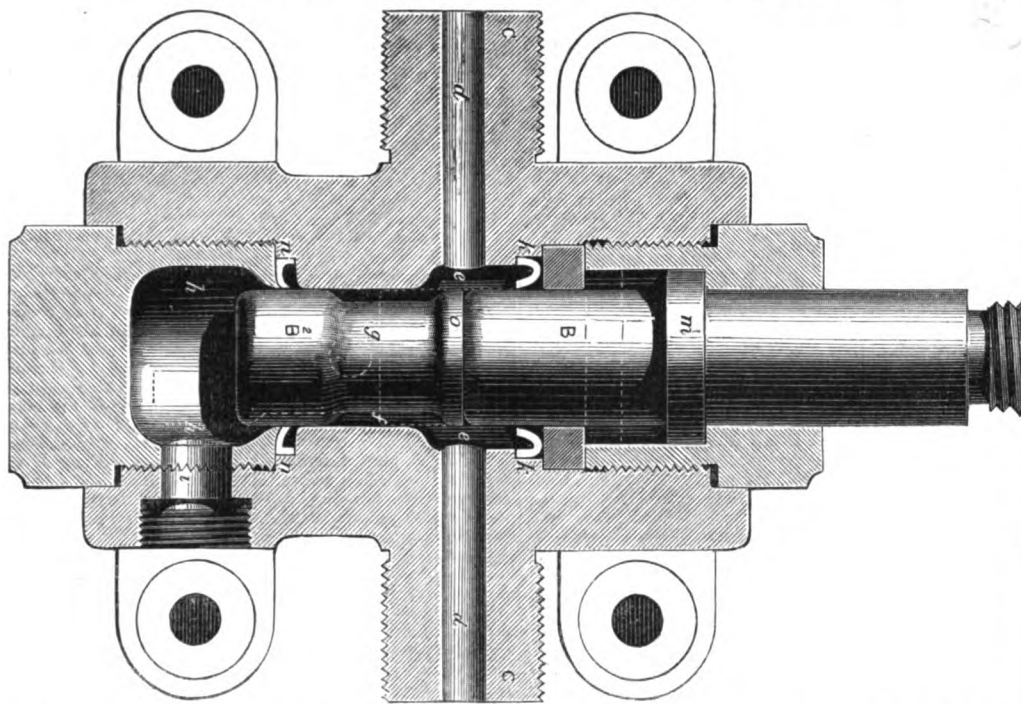
MADRAS IRRIGATION AND CANAL COMPANY.—The report of the directors of this company states that the whole line of main canal from Soonkasala to Cuddapah, 190 miles in length, was now in hand, and although they could not add that much progress had been made since the general meeting in May last they were satisfied that as much as possible, under the circumstances, had been done by their staff. Water had not been permitted to pass the 22nd mile from Soonkasala, in order that all due precaution might be taken to render the banks below that point perfectly sound and safe. Much satisfaction had been expressed by the chief engineer at the manner in which this division up to the 43rd mile had been dealt with by the two executive engineers in charge. On the Nellore division, from Cuddapah to the sea, comprising about 80 miles of main canal, the whole of the surveys and plans had been completed. As to the upper and lower Bellary sections from Wallavapoor to Kurnool, about 180 miles in length of main canal, the final decision of the Madras Government had not yet been received, but might be soon expected.

TESTING IRON BY ELECTRICITY.—The series of experiments undertaken by Mr. Saxby at Chatham Dockyard for testing the quality and description of the iron in the 9-in. and other armour-plates, as well as the various qualities of iron in general use at the establishment, by means of electro-magnetism, have now terminated, and a full report of the results will be prepared for the information of the Admiralty.

PASSENGERS AND GUARDS.—On a line where the communication has been in use in certain trains for about eighteen months, the apparatus has only been put in operation on four occasions. Three were perfectly legitimate uses of the apparatus, and only the fourth was culpable, that of a traveller who wished to satisfy himself "whether it would act."

FENBY'S HYDRAULIC VALVE.

CONSTRUCTED BY MESSRS. J. B. FENBY AND CO., ENGINEERS, BIRMINGHAM.



In the course of our article on "Shipbuilding Yards," which appeared in this journal a few weeks ago (*vide* page 361 of the present volume), we pointed out the advantages which would result from an extended use of hydraulic power in shipbuilding establishments and works of a similar character. In an establishment having a number of punching and shearing machines, and other tools in which a reciprocating motion is required, scattered over a large area, the provision of a system of pipes supplied with water under a high pressure would enable the power to be distributed from an engine occupying a central position, with far less loss of effect than is occasioned by the employment of shafting in the ordinary way. In some few works, indeed, hydraulic power is even now extensively employed, as, for instance, in the fine steel works of Messrs. Vickers, Sons, and Company, at Sheffield, described by us a few weeks ago, and Messrs. Tangye's, of Birmingham; but its advantages are as yet far from being sufficiently appreciated, and shipbuilding firms have, we believe, almost altogether ignored them.

One of the great objections that has been urged against the application of hydraulic power to punching, shearing, rivetting, and similar operations, is, that there has hitherto been a difficulty in giving a sufficiently rapid action to the various machines. In the case of a punching-machine worked by hydraulic power, the water has to be admitted to and released from the hydraulic cylinder at each stroke of the punch, and to effect this two valves, each actuated separately, have so far been generally employed. These valves have also been usually made of the ordinary screw pattern, and they could not therefore be worked with any great degree of rapidity.

To avoid this inconvenience Mr. J. Beverley Fenby, of Birmingham, has recently designed and patented the ingenious hydraulic slide-valve of which we annex an illustration, our engraving representing the valve in longitudinal section. The construction of this valve, which is exceedingly simple, is as follows: The cylinder or casing, A, of the valve is bored out to different diameters at various parts of its length, as shown in the engraving, and it is fitted with a ram or piston, B, also of varying diameter. On the cylinder, A, are the screwed lugs, C, C, having holes, *d*, communicating with the chamber, *e*. To one of these, lugs, C, the pipe from an accumulator or other reservoir of pressure is coupled, whilst the other lug is either stopped off or coupled to the next valve if a series of presses be used.

A lug, D, on the under side of the valve, having a hole, *g*, forming a communication between the chamber, *f*, of the valve and the cylinder of the press, serves to connect the hydraulic press alternately with the feed and exhaust chambers of the valve, *h* being the exhaust-chamber communicating with the pump-tank by the exhaust-pipe coupled at *i*. The ram, B, is carried out through the cupped leather, *k*, and connected to any suitable means for moving it either by hand or power.

The collar, *m*, on the ram, B, serves to limit the stroke of the ram as required. The central chamber, *f*, is separated from all communication with the exhaust-chamber, *h*, by the cupped leather, *n*, when the ram is drawn outwards, so as to bring its full diameter at B² to fit the said collar. The cupped leather, *o*, carried by the ram, which is made in two parts for the insertion of the said leather, makes or breaks joint according as it is moved into the chamber, *e*, or chamber, *f*.

If the cupped leather, *o*, is exactly at the juncture of the chambers, *e* and *f*, the part, B², of the ram will simultaneously close the passage from *f* to *h*, and the presses will neither advance nor recede, the valve being neutral. The ram may be drawn completely out of the cylinder, and new leathers inserted without breaking any of the pipe-joints. The valve is necessarily, from its arrangement, perfectly balanced, and its

construction renders it impossible to open both feed and exhaust simultaneously, as is now sometimes done with the ordinary valves, occasioning a loss of water, and consequently waste of power. This valve, with accumulator power, enables a hydraulic press to be worked with extreme rapidity, for punching, shearing, forging, and all similar uses. Messrs. J. B. Fenby and Co. have had one of these valves at work at their works at Birmingham for three months, fitted to a double-acting press, which has been found capable of making fifty strokes of 3 in. per minute.

In fact, the limit of speed lay in the impossibility of reciprocating the valve more rapidly with the hand lever used; but it is evident the valve may be moved in any other way preferred for each case that arises. In the valve above mentioned, the one set of cupped leathers lasted for the three months' work, and were renewed on the 14th instant through the collar at *o* being destroyed by a small piece of brass turning, which, apparently having been borne along the feed-pipe, cut the leather in passing it.

The advantages possessed by the valve we have described will be readily understood by all who have had any experience in the working of hydraulic machinery, and we have no doubt that it will soon be extensively applied to hydraulic punching and shearing machines, cogging-machines, and other tools of a similar character. For hydraulic forging presses also it is particularly applicable. We may add that the valves are tested by the makers to a working pressure of 5000 lb. per square inch, and that at this high pressure the cupped leathers are found to stand well.

THE SANDWICH ISLANDS.—A monthly steam navigation service has been inaugurated between Honolulu and San Francisco. The Government and people of the Sandwich Islands appear to be steadily increasing in importance.

SHEFFIELD.—The demand for railway *matériel* has slightly improved at Sheffield. In other respects, local industry is far from active, and most of the trades' unions have more than the average number of men "on the box."

BARCELONA.—Extensive works continue to be prosecuted with a view to the improvement of the port of Barcelona, which is the most considerable Spanish harbour on the Mediterranean. The depth of water is to be increased to about 33 ft.; two piers are to be carried out from east to west, so as to enclose a space of 286 acres; and ships of the heaviest tonnage, even war-frigates, will be able to enter. The cost of the works on hand is estimated at 450,000*l*.

ACCIDENTS IN THE STREETS.—No less than seven persons were killed in the last week of the Registrar General's return by being run over or against by horses or vehicles in the streets of the metropolis; 153 deaths have been caused in this way in the metropolis in the first forty-six weeks of the present year.

THE LATE PROFESSOR MCGAULEY.—A committee of influential gentlemen, with Sir David Brewster as their chairman, is in course of formation, with the purpose of raising a fund in aid of the widow and family of the late Professor McGauley, who died very suddenly a few days ago. His labours in literature and science were varied and important, and those who knew him will be desirous of testifying their respect for his memory by contributing in aid of his widow and children. The office of the committee is at that of the Inventors' Institute, 21, Cockspur-street, Charing-cross; and the honorary secretaries are Messrs. John Imray and F. H. Doyle.

NEW MAIL CONTRACT.—A Government contract with the P. and O. Company has been concluded, and is to come into operation in February next, which provides for a weekly mail between Suez and Bombay, as was maintained during a recent brief experiment, and all the mails are to be dispatched on fixed days of the week, instead of fixed dates of the month.

THE INSTITUTION OF CIVIL ENGINEERS.

At the second ordinary general meeting, session 1867-68, on Tuesday, the 19th inst., Mr. John Fowler, President, in the chair, a report was brought up from the council, stating that, under the provisions of Section IV. of the Bye Laws, the following candidates had been admitted as Students of the Institution:

Name of Candidate.	Recommended by
James Abernethy, jun. ...	James Abernethy.
Francis Henry Ashurst ...	P. P. Brereton.
Edward William Baylis ...	H. P. Stephenson.
Edward Bazalgette ...	J. W. Bazalgette.
Nathaniel St. Bernard Beardmore...	Nathaniel Beardmore.
Henry Percy Boulnois ...	J. W. Bazalgette.
Edwin Lane Campbell ...	H. P. Stephenson.
David Alexander Carr ...	W. H. Barlow.
Frank Cheesman ...	James Easton.
John Charles Coode ...	John Coode.
Charles Edward Cowper ...	Joseph Beattie.
John Harcombe Cox ...	W. B. Lewis.
James Murray Dobson ...	John Hawkshaw.
Edwin Noel Eddowes ...	Edward Woods.
John Brendon Everard ...	John Brown.
Charles Richard Fenwick ...	Thomas Fenwick.
Charles Flood ...	James Abernethy.
Walter Foster ...	W. H. Barlow.
Thomas Robert Gainsford ...	John Brown.
John Baron Hyde Gandy ...	H. P. Stephenson.
Herbert Thomas Hare ...	James Easton.
Owen Jones ...	James Easton.
William Hubert Kinch ...	William Cudworth.
Charles Henry Grey Jenkinson ...	Charles Douglas Fox.
Charles Le Lievre ...	Sir Charles Fox.
Frederick Gother Mann ...	W. H. Barlow.
William Joseph Marshall ...	Joshua Field.
Henry Thomas Munday ...	J. M. N. Harkness.
John Newman ...	J. M. N. Harkness.
Philip Algernon Herbert Noyes ...	G. W. Hemans.
William Partridge ...	William Cudworth.
George James Perram ...	W. H. Barlow.
John Kirby Rodwell ...	W. Shelford.
Robert Baxter Rose ...	Thomas A. Walker.
William Shield ...	John Hawkshaw.
George Shortrede ...	Charles Douglas Fox.
Richard Hombersley Tomlins ...	W. Shelford.
Douglas D'Arcy Wilberforce Veitch ...	William Clarke.
William Henry Venables ...	James Easton.
Richard Warburton ...	James Easton.
Walter Frank Waterfall ...	W. H. Barlow.
Thomas Roberts Watts ...	James Easton.
Hubert Frederick Eardley Wilmot ...	Edward Woods.
Francis Wentworth Smyth Windham ...	Edward Woods.

THE SOCIETY OF ARTS.

The following arrangements have been made for the meetings previous to Christmas:

November 20.—Opening address by Wm. Hawes, Esq., F.G.S., Chairman of the Council.

November 27.—"On the Diplomatic and other Conferences held recently in Paris with reference to International Coinage, Weights, and Measures." By Leone Levi, Esq., Professor of Commercial Law in King's College, London.

December 4.—"On the Relation between Health and Wages." By J. H. Stallard, Esq., M.D.

December 11.—"On Industrial and Scientific Education; with Notes on the Systems pursued, and the Works produced, in Continental Schools, as exemplified in the Paris Exhibition, and Suggestions for the Establishment of Trade Schools in England." By Ellis A. Davidson, Esq.

December 18.—"On the Principles that Govern the Future Development of the Marine Boiler, Engine, and Screw Propeller." By N. P. Burgh, Esq., C.E.

The chair will be taken at eight o'clock.

THE POST OFFICE AND THE TELEGRAPHS.—The project of placing the telegraphs throughout Great Britain and Ireland under the management of the Post Office Department has been under the consideration of Ministers of different Governments for the last three years, and now a Bill has been drawn up, which will be introduced into Parliament with all convenient speed, for the purpose of accomplishing this much needed reform in our agencies of telegraphic communication. The measure, which will, we understand, be first brought in as a private Bill, enables the Postmaster-General, with the consent and approbation of the Lords Commissioners of Her Majesty's Treasury, or any two of them, to purchase and acquire the whole, or such part or parts as he may think fit, of the electric and other telegraphs, wires, posts, pipes, tubes, and other works, instruments, and materials, lands, stations, offices, tenements, hereditaments, and buildings, Parliamentary, prescriptive, and other rights, powers, privileges, and patents, and all other property whatsoever, of all or any of the companies, corporations, or persons engaged in transmitting, or authorised to transmit, messages for money or other consideration, by means of electric or other telegraphs or mechanical agencies, between any places in the United Kingdom of Great Britain and Ireland, and to enable such companies, corporations, or persons, or any or either of them, to sell, convey, or dispose of the same accordingly. It also provides for vesting the same when so purchased in Her Majesty's Postmaster-General and his successors, and enables him and them, after the passing of the intended Act, to exercise all the rights, powers, and privileges which, before such transfer, had or might have been enjoyed and exercised by the said companies, corporations, or persons, or any of them, and to levy tolls, rents, rates, duties, and charges, and to create exemptions from the payments of tolls, rents, duties, and charges. The Bill further makes provision for the winding up of companies, &c., which may sell their property, rights, and charters to the Government, and also for the repeal or alteration of existing Acts and charters, and the varying and extinguishing such rights, powers, and privileges as interfere with the action of the intended Act.

ON RECENT MARINE, HYDRAULIC, AND SANITARY ENGINEERING IN SCOTLAND.

THE following address was delivered before the Scottish Society of Arts, by Mr. George Robertson, M. Inst. C.E., on the occasion of their meeting on the 18th inst.:

I propose this evening, as my contribution to the presidential addresses delivered from this chair, to give the society some idea of what has recently been done in Scotland by civil engineers in the way of marine, hydraulic, and sanitary engineering. To do this with any degree of accuracy, I have had to draw largely on the courtesy of my professional brethren; and I beg to return them my best thanks for the information they have given me. The ground is to a great extent untrodden by any of your former presidents; and I hope the short notices I have to give of recent works, or works in progress, may not be unacceptable to a society which has on its rolls upwards of fifty members of my own profession.

To commence with the sea, and with our immediate neighbourhood.

The east breakwater, which was lately completed at Granton, has a total length of 3170 ft. The outer portion, about 1000 ft. in length, was made first, the materials for it having been taken over a temporary bridge which crossed the harbour mouth. The remainder was commenced from the shore end, and joined on to the outlying portion. This breakwater shelters 53 acres from the north-east wind, making the total area of the harbour 130 acres. A timber wharf, 800 ft. in length, has been erected on the west side of the harbour, in immediate connexion with the Caledonian Railway, and fitted up with two 20 ton cranes for shipping coal, and other cranes for general purposes, all worked by steam. Since the year 1835 the Duke of Buccleuch has expended an aggregate little short of half a million on this magnificent private undertaking.

On the opposite side of the ferry, the North British Railway Company have increased the accommodation for their goods traffic by throwing out a pier to the east of the first one, with a sheltered slip for their wagons to be drawn up from the ferry-boat.

The same company are also making a harbour at South Queensferry, consisting of a basin 40 acres in extent, connected with 60 acres of ground for trade purposes. There are to be two piers, one for the passenger traffic across the Queensferry, and the other for the coal and goods traffic. These piers are about 400 yards long, and they are laid out so as to allow engines and trains from the Queensferry branch to approach all parts of them; the object being to enable large vessels to take in a cargo of coal in twenty-four hours. The depth along the goods pier is to be about 12 ft. at low water of spring tides. The quay walls of the piers are designed to give a clear berth, fitted with a steam crane to each vessel, so that it could take advantage of the great depth of water at that part of the Forth, and arrive and depart at any time of the tide.

I have on several occasions described to the society the various works which have been constructed of late years at Leith by the Commissioners for the Harbour and Docks, and will only, therefore, say that the works connected with the present extension of the docks are far advanced, and are being carried out very much in accordance with the original plan. The trade and prosperity of the port of Leith has increased greatly. The dock revenue has risen, since the opening of the Victoria Dock, with 6 ft. more water than the old docks, from about 30,000*l.* upwards of 54,000*l.* per annum. The new dock is to be fitted up with Sir William Armstrong's hydraulic machinery for opening the dock gates and lifting the shuttles of the filling culverts. The cranes and capstans round the dock will also be worked by water power. The pressure of the water is obtained, and kept up, by means of steam power applied to pumps, which force the water, at a pressure of as much as 700 lb. per square inch, through the pipes which convey it to the point of application. The superiority of this system over steam power applied directly lies in the concentration of the steam power into one or more engines erected in places out of the way of shipping or warehouses, and consequently not likely to expose them to the risk of fire, and in the greater care with which it is managed. The value and economy of the principle consist in a large saving of manual labour, and in the rapidity with which work can be executed.

The system of hydraulic machinery round a dock has, not inaptly, been compared to the circulation of the blood; in which the steam-engine represents the heart, the throbbings of which send life and energy through the arteries to the most distant extremity of the body. At Leith the simile will be further carried out, as fresh water there is precious, a return series of pipes, or veins, will bring back the water which has done its work to the heart, to be again circulated through the system. Most of the docks on the Thames, Mersey, Tyne, Wear, and Humber, in England, as well as the Welsh docks, and other places, have this hydraulic machinery; but Leith will be the first port in Scotland to make use of water power as a system.

Several large examples of Morton's patent slips for repairing vessels have lately been constructed at Leith, one for Alexandria being for vessels of 3000 tons. Since the invention of this useful substitute for a dry dock, fifty-six slips have been made at Leith for this country, and seventeen for foreign ports; equal to the repair of vessels of 37,750 aggregate tonnage. To avoid the necessity of enormous wheels for the gearing of the purchase in large slips, Miller's hydraulic purchase has been substituted for toothed gearing.

The harbour in process of construction at Anstruther is meant as a companion to the recently formed one at Dunbar on the opposite shore, both being intended chiefly as places of refuge for the boats engaged in the herring fishing about the entrance to the Forth. The eastern pier, which has to resist the full force of the sea, is to be about 1200 ft. in length, extending from the top of the beach into a depth of 9½ ft. at low water. It is being constructed as a quay, with a protecting parapet 17 ft. above high water. The faces of the walls are formed of free stone ashlar set on edge. The construction differs from that at Wick harbour chiefly in the character of the building above low water, which is all set in Roman cement. This permits of small material being used for backing, as the whole

becomes a monolithic mass in a few hours after it has been built.

At Dundee the Harbour Trustees have lately increased the wet-dock accommodation. The Camperdown Dock has now an area of 8½ acres, with 23 ft. 6 in. on the sill at high water, and 7 ft. at low water, of ordinary spring tides. The width of the entrance is 60 ft., and it is closed by an ingenious floating caisson gate, larger than, but similar in principle to, the one made by Mr. Ower, for the New Dock at Alloa. It is simply an iron box 62½ ft. long, 30 ft. high, and 11 ft. wide, turning on a hinge at one corner when floated a few inches by running off some of the water inside it. Two men on each side work it with the greatest ease. The Victoria Dock has been deepened to the same depth as King William Dock, with which it may eventually be connected, should the entrance locks of that dock and of Earl Grey Dock ever be converted into dry docks. A low-water landing pier has been proposed at the entrance to the Camperdown Dock, and a new line of sea wall extending from the Stannergate on the east to the Magdalen point on the west of the harbour. This will not only lead to the reclamation of 22½ acres of valuable flat ground, which Dundee much wants, but is intended to improve the depth of water at the dock and harbour entrances. These, as well as the Tay ferries, have to contend with sandbanks coming down the river, which are a constant source of annoyance and expense.

The British Fishery Society are engaged in constructing an important harbour in the Bay of Wick, noted for its extensive fisheries of 1000 boats, and also for its stormy seas. The pier will extend about 1500 ft. into the bay, and will shelter an area of 20 acres. The seas here have proved so heavy, that it has been found necessary to substitute greenheart timber, instead of pine, for the staging from which the work is built. The roadway of the quay is 30 ft. in width, and is protected by a parapet on the seaward side, rising 21 ft. above high water. The outer walls are founded on the natural bottom, which consists of large boulders, until they reach a depth of 27 ft. under low water of spring tides. Beyond this the walls are founded on a mound of rubble at a depth of about 18 ft. under low water. The walls are, on the sea face from 10 to 12 ft. and on the inner face about 8 ft., in thickness. The interior between the outer walls is filled with large blocks.

I have not time to notice several smaller harbours and piers lately constructed on the north and west coast, but must proceed at once to the Clyde. The finest pier probably of its kind on this river is the one lately completed at Wemyss Bay. It is made of greenheart timber, and is 500 ft. long and 56 ft. broad.

The new Albert Harbour at Greenock consists of 11 acres of water area, with about a mile of quayage, including 1800 ft. of river quay. The depth is 25 ft. at high water, and 15 ft. at low water, of springs. The sea piers, with perpendicular walls, stone faced, were constructed in the water without the use of cofferdams, by a successful combination of iron piles and granite slabs for facing, and concrete for backing, up to the level of low water. Above this they were built, in the ordinary way, of masonry.

Advantage was taken of the excavation for this basin to form a magnificent esplanade, upwards of a mile in length and 100 ft. wide, to the west of Greenock; the river face being formed by a stone sea wall built to the low-water line. The steamboat quay at present in use, well known for its nasty and inconvenient approach, is to be shifted to the west end of the Albert Harbour. Both the Caledonian and Greenock and Ayrshire Railways have got powers to extend their lines and build stations on the new quay. The quay will be constructed of greenheart, concrete, and stone, and is to be ready for the opening of the Greenock and Ayrshire Railway next June.

At Port Glasgow it is intended to make a wet dock of the present tidal harbour. The port has recently been put in direct communication with the Caledonian Railway, and a swing bridge has been thrown across the entrance of the harbour to carry the rails down to the quay.

The Windmill Croft or Kingsdon tidal basin at Glasgow is 5½ acres in extent, with a depth of 24 ft. at high water of springs. The entrance walls are of masonry upon timber bearing piles and concrete. The entrance is 60 ft. wide on the square, and is spanned by a lattice-girder bridge, swung by hand power, or by hydraulic machinery worked by the pressure of the town water-pipes. The wharves round the basin are of timber, and were completely finished before the greater part of the excavation was done. The water was then admitted, and the dredger set to work to take out 14 ft. in depth over the whole area. An expeditious system of pile-driving has been successfully tried in this work. The piles were driven in bunches of five at once, between guide piles at regular intervals. Three fir piles were placed between two elm piles, the whole resting on one shoe of cast iron, with wrought-iron straps. The five piles were fastened together with wooden dowels and iron dogs, and hooped with one ring over all. The timber panel was then driven by a broad ram worked by steam power; and so successful was the system, that a bunch of five piles, each 35 ft. long, has been driven in three hours. The cost of the Windmill Croft basin, including dredging, swing-bridge, paving, sheds, &c., will amount to about 115,000*l.* Half a mile has thus been added to the quays at Glasgow, making a total quayage of three miles.

The bridge now been constructed over the Clyde by the Union Railway is on the lattice-girder principle, of five water spans, each 75 ft. in the clear, and two land spans of 65 ft. each. The girders rest on granite columns carried upon cast-iron cylinders 8 ft. 4 in. in diameter, sunk to a depth of nearly 80 ft. through the sand to the solid rock and clay which form the bed of the river. The Milroy excavator, by means of which the cylinders were sunk, has been perfectly successful. It consists of a bunch of eight spades, hinged to the outside of an octagonal frame 5 ft. in diameter, the bottom of which they form when closed. The spades hang down, when the apparatus is lowered, as far as it will go, by tackle attached to the outside of the frame. It is pulled up again by tackle at the centre, which raises each spade from the vertical to the horizontal position, enclosing by their junction a quantity of sand. In order to insure the excavator being both kept and forced down, while the spades are being lifted to the horizontal position, two holding-down chains are fixed to opposite sides of the frame, and pass under pulleys

held down at the bottom of the cylinder by long vertical timber spars. During the time I watched the excavator, the frame never failed to come up perfectly full of sand; and I was told that as much as 14 ft. in depth has been taken out in three hours, the average being about 4 ft. per hour. Three hours per diem was the usual time taken up in sinking the cylinders, the remainder of the day being employed in caulking, bolting together, and weighting them; but on one exceptional occasion a cylinder was sunk as much as 25 ft. in one day, the total time occupied in sinking being 6½ hours—in other work 8½ hours. The number of men employed being twelve, including the foreman. The cylinders are afterwards filled with concrete and brickwork.

The upper of the three stone bridges spanning the Clyde at Glasgow is to be removed in consequence of the improvements of the river, and replaced by a handsome structure of iron and stone, in three spans of 120 ft. each.

The state of the river from the sewage pollution is now so bad that the authorities will shortly be compelled to take some active steps for its purification.

The Clyde is a remarkable example of how the improvement of a port affects its revenue. Though it does not by any means follow that deep water in a harbour will of itself alone create trade, or divert traffic from neighbouring places, already centres of business, yet it is nevertheless pretty certain, that when trade has once fixed itself to one place, increased depth of water and increased revenue are closely connected. Thus, in the Clyde in 1800, when the depth of water at Glasgow was only 8 ft. at high water, the revenue was only 3320*l.* In 1825, when the depth had been increased to 12 ft., the revenue had grown to 8367*l.* In 1863 there was 22 ft. of water, with a revenue of 118,083*l.*; while last year the amount was 131,862*l.*, it being intended by dredging to keep up a depth of 24 ft., at high water of spring tides, and 22 ft. at neaps, for the whole way up to Glasgow.

Before leaving the subject of marine engineering, I would draw the attention of the society to the proposal of Mr. Thomas Stevenson, to illuminate beacons and buoys by means of electricity from the shore. I need only do this briefly, for the experiments were fully explained to us during the session. The subject appears to me to be one of great importance, as it is likely to form a new era in maritime illumination. We may hope that the time is not far distant, when such a navigation as Liverpool will be as clearly defined at night as in the day by the illumination of its buoys and beacons.

It is not necessary for me to say much to the society on the importance of proper drainage, and a plentiful supply of good water to every town. Our attention has often been directed to this subject, as well as to the kindred ones of the pollution of rivers and the utilisation of sewage. I need only, for example, refer to the two excellent papers read during the present session, by Mr. Macpherson on the removal of the refuse of this city, and by Dr. Macadam on water supply. There is a general feeling throughout the length and breadth of Scotland, that bad drainage means typhus, and that bad water means cholera. Upwards of eighty towns and populous places have already adopted, in whole or in part, the General Police and Improvement Act, 1862, commonly known as Provost Lindsay's Act.

I cannot undertake to enumerate all that has been done in the way of sanitary improvement in every town, but I hope to be able to give you sufficient to prove that the old Scotch saying, "The clartier the cosier," is fast losing its significance; and that a very great deal has been done of late years towards rendering our cities more healthy, and better supplied with that invaluable luxury—good water.

I commence with the most hydraulic work ever executed in Scotland—important, not only because it furnishes an abundant and pure supply of water to our most populous city, but because it foreshadows that much larger scheme which must, sooner or later, be undertaken for the supply of London.

The great Loch Katrine waterworks, for the supply of the city of Glasgow, have been open now for seven years, and during last year gave an average daily supply of 21,200,000 gallons. In addition to this, 3,500,000 gallons were sent in from the Gorbals waterworks, on the south side of the river Clyde, making the total daily supply to Glasgow 24,700,000. This, distributed over a population of about 600,000 persons, gives nearly 50 gallons per head per diem. Of this quantity about 4½ gallons per head are sold by meter, of which there are upwards of 600 in use, producing a revenue of 20,000*l.* a year.

The drainage area to the works amounts to 72 square miles, and includes Loch Katrine, Loch Achray, Loch Vennacher, and Loch Drunkie. The water of Loch Katrine has been raised 4 ft. above its former summer level by a masonry dam, and it can be drawn down to 3 ft. below the former summer level. This gives a control over the contents of the loch of 7 ft. in depth, with a storage capacity of 910,000,000 cubic feet. The water from this loch alone is used in the supply of Glasgow, and it is very pure, containing only 2½ grains of soluble matter per gallon, with a hardness of 0.8° on Dr. Clark's scale, in which 1° of hardness represents 1 grain of chalk per gallon. The softness of the Loch Katrine water causes a great saving in the amount of soap used for washing in Glasgow.

Loch Vennacher and Loch Drunkie are used for compensation to the proprietors and others having an interest in the rivers Forth and Teith, and furnish a daily supply to those rivers of 40,500,000 gallons. The total storage provided by the works at the three lochs is 1,455,000,000 cubic feet, equal to a supply for 100 days of 50,000,000 gallons to the city and 40,500,000 gallons of compensation, without taking into account the natural flow of the streams running into the loch. At the rate of consumption in January last, this storage is equal to 147 days' supply.

(To be continued.)

AMERICAN STEAM SHIPPING.—The New York and Havre Steamship Company has resolved to discontinue its line, finding it impossible to compete with the French steamers, owing to the want of a Government subsidy. This decision will reduce the number of American steamers plying to European ports to the Atlantic and Baltic on the Bremen line.

SOCIETY OF ENGINEERS.

W. H. LE FEUVRE, Esq., President, in the Chair.
November 18th, 1867.

On the Connection between the Shape of Heavy Guns and their Durability. By ARTHUR H. HOO, Esq., Engineer.

EVER since the invention of gunpowder, there has been an ambition to make heavy artillery, and from the middle of the sixteenth century cannon were cast at Antwerp, which were capable of throwing stones of 600 lb. weight. These early attempts were not very successful, though probably they lasted as long as modern guns of the same capacity. For many generations no further progress was made in such monster weapons, and it seems to have been reserved for these modern times of peace, to develop a far more intense interest in the subject than it received during centuries of war.

In spite, however, of all the attention that has been given to the manufacture of heavy guns, no great dependence can be placed upon their general durability; and yet numerous instances exist where some have surpassed all expectation, while others have failed after a few discharges, from no very evident cause. Indeed, the confusion prevailing over the whole subject, and the disposition to attribute such results to the metal, to contraction, or some equally indefinite cause, both point to a want of clear apprehension of the exact points wherein certain guns maintain their undoubted superiority.

It is remarkable that, while no effort has been spared to strengthen the barrel, and so oppose the cohesive power of metals to resist the forces of explosion, yet it has apparently escaped notice, that in some guns a large share of these forces are actually evaded; not only without deducting from the velocity of the projectile, but with many collateral advantages. It is these accidental departures from the usual types that have always shown such exceptional and surprising endurance.

Both English and American guns have been made in a tentative manner, and it is curious to observe that, with ourselves, old experiences with the 68-pounder have been neglected; while the Americans have, unwittingly, followed and extended them with the best results.

It will be the object of the following remarks to notice different types of guns, and observe the causes whereby some forms possess greater durability than others; to investigate the principles upon which this special endurance depends; following the departures from approved types, and the slow, almost accidental, return to them; and, finally, to deduce the principles for constructing guns, so that they shall approach the limits of ultimate endurance.

Beginning with the cast-iron 68-pounder, with a power and endurance that for long held its ground against all rivals, it will be noticed that the experimental trials of many years past have set its principles at defiance. Now, however, at last the old gun is taken in hand by Major Palliser, strengthened in the only part where weakness was found; the original type maintains its pre-eminence, and shows powers of endurance that have never been excelled.

Although the forces of explosion are equal and opposite in every direction, yet they may be separated into two distinct groups, acting at right angles with each other. In one of these groups are the radial, and in the other the longitudinal forces. The diagram, Fig. 1, illustrates the transverse section of a gun; and the point O a centre from which the explosion proceeds. The six shot arrows, marked c, are the radial groups; while the arrow, D D, is the longitudinal force, which acts upon the case of the bore and upon the base of the projectile. By resolving two of the radial forces, as E F and E G, Fig. 2, they evidently become a tangential strain, F G acting round the circumference of the bore. The nature of the force of explosion is not a simple pressure, like steam, but is much more correctly described as a blow of a hammer upon an anvil, the shot being the hammer and the gun itself the anvil. The longitudinal force is thus a blow due to the inertia of the projectile, and it is received in the first instance by the mass of metal behind the base of the bore, and from thence transmitted a tensile strain along the barrel of the gun.

By so separating the forces of explosion into two classes, the surface of the bore is shown to be exposed to two strains, each acting at right angles to the other, in the manner marked on Fig. 3. As guns nearly always have their lines of fracture at right angles to one or both of these planes, there can be little doubt of the correctness of this classification.

For the resistance of these forces by the cohesive strength of a fibrous material, it will be evident that when the fibres lie parallel to the axis fracture will occur for want of resistance to the radial forces; but if the fibres lie at right angles to the axis there will be no strength to resist the longitudinal force. Guns made in the former manner, out of bar iron, have been blown to pieces at the first discharge, while coil guns are notoriously given to opening the coils like a spring opens when stretched. In order, therefore, to make the best use of such a material as wrought iron, its fibres should lie diagonally across both these forces; and this is constantly done in small arms.

The radial forces being equal, and acting within a circle, are satisfactorily balanced by the usual forms in which guns are made; but the amount of longitudinal strain depends upon the proportions which exist between the weight of that mass of metal which first receives the blow, and the mass of metal contained in the gun exclusive of the breech. If the breech, or that portion of the gun behind the base of the bore, be heavy, it opposes a considerable resistance to the shot, absorbs the force of the blow, and so reduces the longitudinal strain upon the barrel. If the breech be light in weight, the first impact is delivered upon a mass of metal, perhaps no greater than the shot itself. The breech in this case does not absorb the blow, but transmits it at once to the barrel. Time is not given for so heavy a mass to begin its recoil, the longitudinal strain is greater than the tenacity of the metal will bear, and fracture is inevitable. It may happen that the breech is blown off, or that the barrel bursts; but in either case it is the double cross strain that causes great weakness, and any means by which either of them can be reduced will not fail to be beneficial.

The relief which a heavy mass affords in receiving and absorbing the force of a blow admits of many familiar illustrations. The different feelings with which a heavy or a light stone may

be struck when held in the hand are well known; but perhaps the most singular instance of this law may be found in a case which excited much wonder in the last generation, namely, that of a man who was accustomed to exhibit himself sustaining a very heavy stone on his chest while lying on the floor. Several attempts at such force was applied, there was no injurious effect upon him who submitted to such an ordeal. The relief afforded by a heavy weight in these examples gives just the same immunity to a gun. Such a conclusion would lead to the inference that the greatest durability will be associated with the heaviest breech, and the following examples will prove this deduction to be well founded.

All the guns illustrated have been tried and thoroughly proved by practical experience on a large scale; they are drawn to the same scale, with the exception of the two last examples, and are all shown in longitudinal section. In every case the shaded portion represents the breech, or that part which receives the first impact of the blow; so that the proportionate weights between this part and the barrel of the gun will correspond, and general proportions, when proceeding to notice those which represent their longitudinal strength. In the following examples these proportions are given in the nearest round number as to avoid many fractions.

Fig. 1 is the English cast-iron 68-pounder, and the proportion between the breech and the gun are as 1 to 4. Only two of these guns burst at the siege of Sebastopol, and in wrought iron they have been subjected to very severe tests. They are made by welding round discs like thick washers both at high elevations, and one of them had previously fired 2000 rounds. Some were known to have fired 3000 rounds, leaving the bore still smooth and serviceable, while others fired 4000 rounds. The charge was usually 16 lb. of powder, and there was very rapid firing. The endurance of these guns was very satisfactory, and the high elevation naturally placed unusually severe strain upon the two guns which burst.

Fig. 2 illustrates one of Mr. Whitworth's wrought-iron guns and its proportions between the breech and the barrel are 1 to 17. Two 70-pounders of this description, having a hexagonal bore, were used at the bombardment of Fort Sur, and though neither of them burst, yet the slipping of the breech closed the vent at the 11th round, and rendered the guns unserviceable. The opening of a telescope represents very accurately this defect, and it is manifestly produced by excessive longitudinal strain.

Fig. 3 is one of Sir W. Armstrong's 800-pounders, and the proportions between the breech and gun are not unlike in different examples. In the specimen shown it is as 1 to 14; and the guns are well known to be very strong radially, but weak longitudinally, many having blown out the breech. The 12-pounder guns of this description seem possessed of sufficient endurance, one of them having fired 3263 rounds without any injury. He first 104 in. smooth-bore gun (800-pounder when rifled) blew out the breech after firing 264 rounds; the charges in nearly all cases being 40 lb., though some were 50 lb.; one charge was 70 lb., and one was 90 lb. At the discharge with 70 lb. the breech split in the spiral weld; at the succeeding round, with 8 lb., this crack closed, and another opened parallel and near it. The next round, with 90 lb., made a crack parallel to the one in the outer coil behind the trunnions, and after a few more rounds the breech blew out. The proportionate weights between the breech as blown out and the gun were as 1 to 7. The 800-pounder Armstrong gun was originally expected to stand 100 discharges certainly, but might go on to 300 or even 500 before rupturing; but even this moderate estimate was not destined to be realized. The gun weighed 22 tons, was 15 ft. 8 in. long, and was 13.8 in. bore. It was proved at Shoeburyness, and on the 28th March last year it cracked at the 54th round, and since that time there have been no more attempts to make guns on this principle so large. The chief point which has been urged in favour of this class of guns is not their greater durability, or strength over cast iron, but that they always give fair warning, and do not burst explosively.

Fig. 9 (on the 4th sheet) is one of Captain Blake's steel guns, hooped around the breech for greater strength than that part. The proportions between the shaded portion and the rest of the gun are as 1 to 8; and the endurance on a large scale has been exceeded by other guns. A 9-pounder 4 in. bore, with a wrought-iron tube, was fired in the year 1855-6 round for round with a cast-iron service gun of the same calibre. A brass gun was proved at the same time, as well as another specimen, which consisted of longitudinal staves hooped together, the charge was 6 lb. of powder, and the guns were burst after firing the following number of rounds:

	Rounds.
Blakely gun	607
Cast-iron service gun	23
Brass gun	17
Hooped gun	3

This is an interesting series of experiments; but trials on a small scale are no test of endurance to be expected on a large scale, unless every element is exactly carried on in due proportion.

The Spanish guns are made of cast iron hooped with steel, and show a fair endurance, one of 6.4 in. calibre having stood 1866 rounds before bursting; the charge was 7 lb., and the projectile weighed 61 lb.

The French standard navy gun is also of cast iron, hooped with steel rings, seven in number, and each 4.1 in. thick; the bore is 6.5 in., and some are stated to have endured 1000 rounds. Recently it has been found necessary to lengthen the breech; and no doubt the extra weight so applied will enhance the powers of the gun.

The Prussian guns, made of Krupp's steel, do not seem to have ever endured very heavy trials on a large scale, though on a small scale they may be said to give a fair average. A 12-pounder 4.88 in. bore was fired 3000 rounds with charges from 3 to 4.4 lb. of French powder, four rounds were then fired with 6.6 lb. of powder and two balls, and the gun then burst.

After the high average durability of the 68-pounder, it cannot fail to be observed how inferior to it are all these other guns, though constructed of materials much more capable of sustaining sudden and violent strains. At the same time the weight of metal behind the base of the bore is proportionately greater in the 68-pounder than exists in any other gun, and to the re-

lied by this peculiarity must be attributed its surpassing endurance.

There is a very good illustration of the advantages gained by a heavy breech, in some trials made with Mr. Longridge's wire-gun. This was a very light affair, 8 in. bore and 36 in. long, made of brass and mounted on a wooden carriage. In the first trials its breech abutted against a massive stone wall to prevent recoil; and the gun endured without injury repeated discharges from 1 lb. of powder and one shot to 1 1/2 lb. powder two shots. Afterwards it was permitted to recoil; the first shot of 1 lb. of powder and one shot strained the gun, and the succeeding round with 2 lb. of powder and one shot blew the breech 90 yards to the rear. The stone wall was practically a heavy breech, which absorbed the force of the explosion, and this experiment clearly demonstrates the advantages of such an arrangement.

The foregoing examples fairly illustrate the general systems which guns are constructed in this country and in Europe; and there is a marked and very decided change in their appearance between this part and the barrel of the gun will correspond, and general proportions, when proceeding to notice those which represent their longitudinal strength. The most perfect example of this is Fig. 4; the form designed by Admiral Dahlgren. The proportionate weights between the breech and the gun are as 1 to 2 1/2, and a very high endurance is secured. A 30-pounder cast-iron gun of this type stood 2000 rounds without bursting; and in wrought iron they have been subjected to very severe tests. They are made by welding round discs like thick washers both at high elevations, and one of them had previously fired 2000 rounds. Some were known to have fired 3000 rounds, leaving the bore still smooth and serviceable, while others fired 4000 rounds. The charge was usually 16 lb. of powder, and there was very rapid firing. The endurance of these guns was very satisfactory, and the high elevation naturally placed unusually severe strain upon the two guns which burst.

Fig. 5 is the United States 15 in. navy gun, the same as used in the monitors. Great care has been expended upon the manufacture of these guns, and they seem to reach the utmost limits of the cohesive strength of cast iron. The castings are cooled by a stream of water passing through the core; and similar guns of 20 in. calibre have been cast which weigh 140,000 lb. The proportions between the breech and the rest of the gun are as 1 to 2 1/2; and a very high endurance is obtained when the size of guns is taken into account. American No. 7 cannon powder is not so strong as English cannon powder, for 100 lb. American produces the same effect as 88 1/2 lb. of English powder, and this difference must be borne in mind in any comparisons between English and American guns. One of the 15 in. navy guns was fired 900 times at elevations from 0 to 5°, commencing with 35 lb. charges of powder, and rising to 50 lb. charges; 220 rounds were then fired with 60 lb. of powder, and the gun finally burst with 70 lb. charges, the shot in each case weighing 440 lb. The weight of these guns is 42,000 lb., and they recoil 4 ft. when fired in the monitors.

Fig. 6. The 15 in. army Columbiad differs little in shape from the preceding example, but its proportions between the breech and the barrel are as 1 to 3 1/2. It was found too weak in the prolongation of the bore, and has been reduced so as more nearly to resemble the navy gun.

The American Parrott gun is made of cast iron, and generally rifled. A wrought-iron tube, or reinforce, is shrunk over the breech and the reinforce of the gun, with the intention of adding to their strength. At the siege of Charleston, 1863, their endurance was not at all satisfactory, for the average number of rounds sustained by the 100 and 200 pounders before bursting was only 310 rounds. They exhibited two or three forms of fracture, but the most frequent was that shown in Fig. 7. Others gave way with a longitudinal split parallel to the axis of the piece, and, indeed, the two planes, into which the forces of explosion have been separated at the commencement of this paper may be very distinctly traced in the large collection of guns fractured at the siege of Charleston.

Fig. 7 is a 200 pounder Parrott gun, which burst at the 230th round. This was the most frequent form of fracture. The wrought-iron reinforce remained attached to the body of the gun, and the proportions between that part blown backwards and the gun itself are as 1 to 9. The reinforce has added nothing to the longitudinal strength of the gun; and, indeed, done little else than aggravate the strain.

One gun, however, a 30-pounder, showed most extraordinary and unique powers of endurance. Through some accident in its construction, the wrought-iron reinforce was shrunk firmly on the breech, and not on the body of the gun; consequently, its weight and inertia became available to resist the first impact of the discharge; the longitudinal strain was thereby diminished, and the gun relieved from much of its usual load. It does not, however, appear that this reinforce added anything to the radial strength of the barrel, for it was found to be .375 in. too large to fit the cast iron, although part of this amount might be due to the broken pieces escaping; yet it seems to indicate that there was no pressure given by the front end of the reinforce.

After firing 4606 rounds, this gun burst into seven pieces, and the manner of its fracture is shown in Fig. 8. This gun weighed 4200 lb., and was 10 ft. long in the bore, which was 4.2 in. diameter. There was much wear in the barrel; channels 1/2 in. deep and 12 in. long reduced its strength, and probably to this cause must its fracture be mainly attributed. The breech bears a very much larger proportion in this gun to the weight of the barrel than occurs in any other example, namely, as 1 to 2 1/2, and to this exceptional circumstance must its high durability be attributed.

(To be continued.)

PROSTON.—The scheme for dock and river improvements at Proston is postponed for the present.

ATLANTIC TELEGRAPH MACHINERY.

In June, last year, just previous to the departure of the Great Eastern on the Atlantic telegraph-laying expedition, we gave, in this journal (*vide* page 434 of our first volume), a general account of the paying-out and picking-up machinery with which the vessel had been fitted, as well as of the system adopted for getting the cable on board and stowing it. There were, however, many points about the arrangements which could scarcely be fully explained without reference to engravings, and as there are very many of our readers who are interested in telegraph cable machinery, we now publish, on this and the opposite page, illustrations showing the whole of the gear with which the Great Eastern was fitted. Our illustrations, as well as the description of them, have been taken from a very complete paper on the subject read before the Institution of Mechanical Engineers, in January last, by Mr. George Elliot.

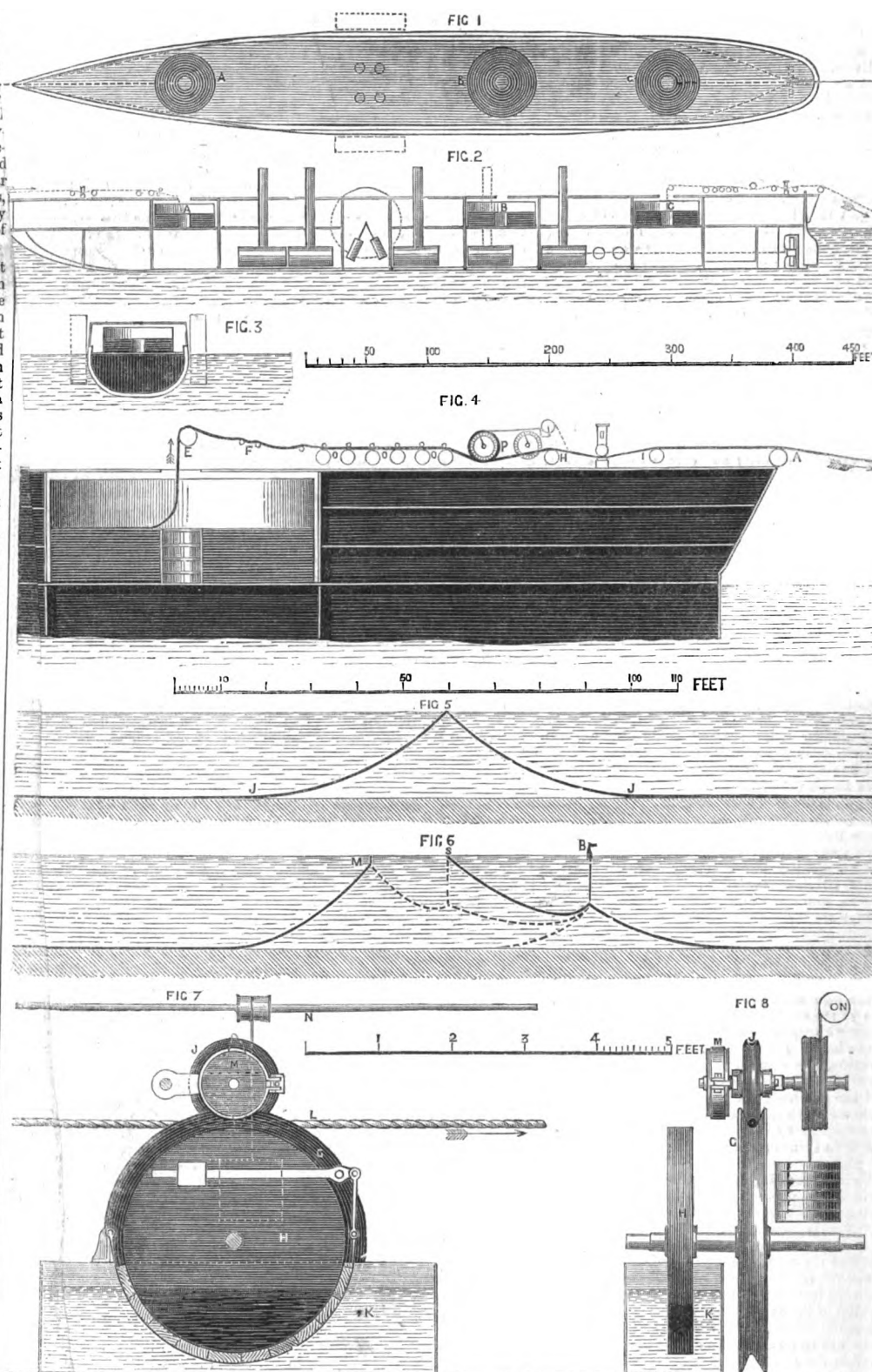
The Atlantic cable of 1866 was coiled on board the Great Eastern in three circular wrought-iron tanks built on the main deck of the ship, as shown in Figs. 1, 2, and 3, annexed. The foremost tank, A, occupied the space which had previously been the fore-cargo space; and the after tank, C, was placed in what had been the after-cargo space. The middle tank, B, occupied what had been the second dining-saloon; and the funnel (shown by the dotted lines in Fig. 2) from the pair of boilers in that position was removed for the purpose, those boilers being thrown out of work during the expedition. Each of the tanks was stayed to the sides of the ship by two flat frames of iron, built on angle-iron framing, and the deck had also been shored underneath by baulk timbers, which were carried through from deck to deck down to the bottom of the ship.

The fore tank was 51 ft. 6 in. diameter, the middle tank 58 ft. 6 in., and the after tank 58 ft.; they were all of a uniform depth of 20 ft. 6 in., and similarly constructed in all respects. The bottoms were $\frac{1}{2}$ in. thick, lap-jointed; and the sides were $\frac{1}{2}$ in. thick in the lower half, and $\frac{3}{4}$ in. in the upper half. The sides were butt-jointed, so as to present a perfectly smooth surface inside, and the bottoms were covered with a thin wood floor to receive the cable. As it was of vital importance that the cable should be kept always under water, to prevent depreciation of the gutta-percha coating, and also to afford the only means of effectually testing its electrical condition, these tanks were carefully made water-tight. In paying out the cable, the water in the tanks was kept somewhat below the level of the top flake, and required to be lowered during the paying out; for this purpose each tank was supplied with discharge valves, and as the bottoms of the coils were above the water-line of the ship, as shown in Fig. 2, it was only necessary to open these valves in order to allow the tanks to discharge themselves completely.

The coiling of the cable into the tanks, out of the hulks by which it was brought from the Telegraph Construction and Maintenance Works at Greenwich to the Great Eastern at Sheerness, was effected, as described in our previous article, in the following manner: The cable was brought up over the side of the ship from the hulk, upon wheels which guided it on to a large deep-grooved wheel driven by steam power; on the tread of this wheel ran a small jockey wheel or roller, pressing the cable down into the groove of the large wheel, so as to give sufficient friction for enabling the wheel to draw up the cable from the hulk. The coiling commenced from the outside of the tank, the end being previously triced up above the tank, leaving a clear end for splicing and testing. The first turn of the cable was carefully laid round the outside of the tank, and the next was laid back close up against the previous turn, and so on until a perfectly flat flake or layer was laid into the eye of the coil, which was left about 9 ft. 6 in. diameter. The cable was then led out direct to the outside of the tank, across the coils already laid; and another flake was commenced precisely similar to the first, this process being continued until the tank was filled. The direction of lay-out of the cable from the end of one flake to the beginning of the next was tangential to the circle of the eye of the coil, as shown at D in the plan, Fig. 1; and the portion of cable crossing the coils was protected from the weight of the coils above by wood battens laid on each side of it, about 3 in. wide and 1 in. thick, with the edges rounded. When the coiling down of the cable into the tanks was finished, eyes were fitted into the centre of each coil, which were telescopic in their construction, so that as the cable was paid out the eyes could be lowered from time to time. Men were stationed in the tanks for the purpose of keeping the cable always clear during the paying out. In paying out, the cable was passed up to the hatch over the centre of the coil, and carried over a large wheel, E, about 4 ft. diameter, as shown in the enlarged longitudinal section, Fig. 4. The cable was then carried in a trough, F, about 2 ft. wide, made of sheet iron, leading to the paying-out machinery; this trough was fitted with rollers at about 10 ft. or 12 ft. intervals to relieve the cable from friction in passing along, until it reached the paying-out machinery, which was placed in the stern of the ship, slightly to the port side. The length of cable in the after tank was 840 knots (1 knot = 6084 ft. = 1.15 statute mile), in the middle tank 865 knots, and in the fore tank 671 knots; and the entire length of 2376 knots was joined up into one continuous length of cable before the laying was commenced. The size of the cable was 14 in. diameter, and its weight 31 cwt. per knot in air, and 14½ cwt. per knot when immersed in water; the breaking strain was 8.10 tons, equal to eleven times its weight in water per knot, so that the cable would just bear its own weight in 11 knots depth of water.

Paying-out Machinery.—In the paying-out machinery the chief object to be attained was to supply some means of checking the cable in the most regular manner possible while passing out of the ship, and also of keeping it in a state of constant tension; and it was required that the amount of this tension should be at all times known, and that it should be regulated by the depth of the water in each particular part of the ocean, and also to some extent by the speed of the ship.

The most important feature is the arrangement by which it was rendered impossible that more than a certain strain should be kept upon the cable during the paying out. A less strain would only involve a slight loss of cable; but any increased strain might possibly damage or even destroy it. The cable on



entering the paying-out machinery was passed over a series of six deep-grooved wheels, each about 3 ft. diameter, one of which is shown in side and end elevation at G, in Figs. 7 and 8. On the shaft of each wheel, G, was fixed a friction-wheel, H, of the same diameter, fitted with a friction strap lined with wood and tightened by a weight on a lever; this friction wheel ran in a tank of water K. Above each of the grooved carry-wheels was a jockey-wheel, J, about 14 in. diameter, pressing the cable, L, down into the groove of the carrying-wheel, G, and hooped with an india-rubber tyre to form a soft cushion, so that no damage might be done to the cable. The jockey-wheel was also fitted with a small friction-wheel, M, having a wrought-iron strap adjustable by a screw. Any one of the jockey-wheels could be lifted up, so as to allow the cable to slip freely through the groove in the carrying-wheel; or, in case of necessity, the whole set of jockey-wheels could be raised at once by a man stationed at a large hand-wheel, like an ordinary ship's steering-wheel, turning the longitudinal shaft, N, which lifted up each jockey-wheel by a chain winding upon the shaft. In practice there were generally about four of these wheels kept at work, but the machine was made with six in case of need.

After the cable had passed through this part of the machinery, called for distinction the jockey gear, and had thereby been subjected to a slight amount of strain, it was led to the main paying-out drum, P, shown in side elevation in Fig. 9, and in end elevation in Fig. 10. The cable, L, entered on the underside of the drum, Fig. 9, and was passed four times round for the purpose of getting a firm hold. Just above the point at which the

cable was led on, a knife-guide, Q, was placed for fleeting or slipping sideways the coils already on the drum, so as to leave a clear lead-on for the fresh cable; this guide was adjustable in both directions with screws, like a slide-rest on a lathe. The shaft, S, of the drum was carried through on each side, one end being fitted with a coupling, R, which will be referred to afterwards in connexion with the picking-up arrangements adapted to this machine; and on the other end were fitted the main friction brakes, T T.

These self-adjusting friction brakes were invented by the late Mr. Appold, and it is interesting to note that they were the identical brakes used in the first attempt to lay the Atlantic cable in 1857. The brake-wheels themselves, T T, Figs. 9 and 10, of which there were two on the shaft, were 4 ft. 6 in. diameter, and 12 in. wide on the tread, which was turned a little convex. On each wheel was fitted a wrought-iron strap lined with wood, and a screw adjustment, U, admitted of any required amount of friction being obtained. On the top of each brake strap was a lug, to which a long rod, V, was fastened, leading to the top of a bell-crank lever, X, with arms in the proportion of 1½ to 1; and to the long arm of this lever was suspended a rod carrying a number of weights, W, which were removable at pleasure for adjusting the strain. The rod was continued below the weights, and had a piston attached to it working loosely in a water cylinder, to prevent any sudden jerking action from coming on the brake. By screwing up the adjustment, U, the brake was made to have sufficient friction for lifting the weights on the suspension-rod.

ATLANTIC TELEGRAPH APPARATUS.

FIG. 9 SIDE ELEVATION OF PAYING-OUT DRUM AND FRICTION BREAKS

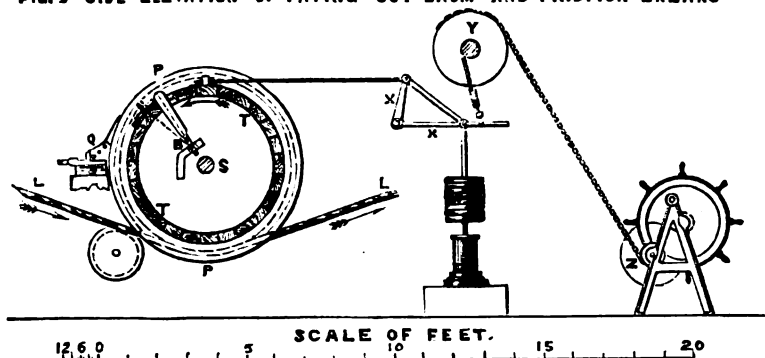


FIG. 13 ELEVATION OF PICKING-UP DRUMS

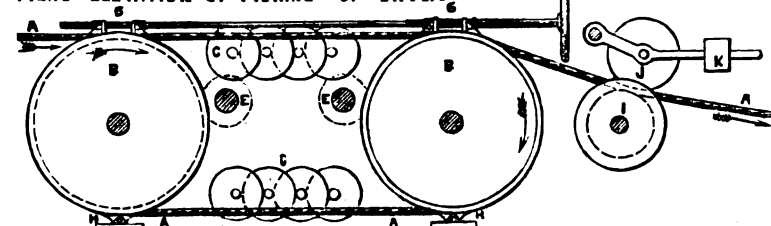


FIG. 10. END ELEVATION OF PAYING OUT DRUM AND FRICTION BREAK

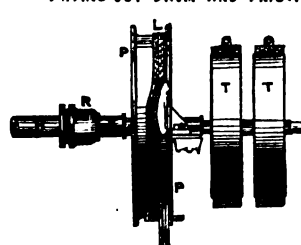


FIG. 11 END ELEVATION

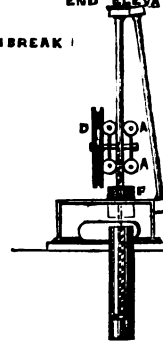


FIG. 12 SIDE ELEVATION

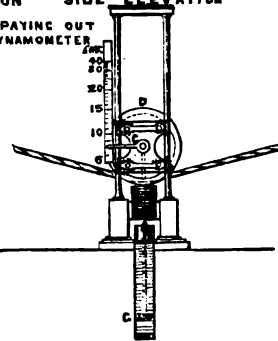


FIG. 14 PLAN OF PICKING-UP DRUMS

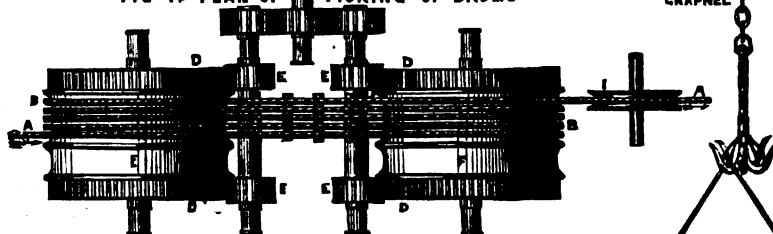


FIG. 15 GRAPNEL

In order to render the brake self-adjusting, so that it should relieve itself whenever binding too hard, the brake strap was cut through, and the ends were attached to a lever, A, in the manner shown in Fig. 9, the lower extremity of the lever being free to move in a slot cut in the stationary bracket, B. When the brake was binding too hard, so that it began to lift the weight, W, too high, the brake strap consequently travelled round and brought the lever, A, into the position shown dotted. The attachment of the one end of the brake strap at the extremity of the lever moved then through an arc of a larger radius than the attachment of the other end of the strap; and the result was therefore equivalent to lengthening the brake strap and slackening the brake off the surface of the wheel, causing the weight, W, to fall back instantly to its original position. The consequence of this action was that when the brake was at work, the lever, A, kept the strap just tight, and the weight, W, continued just oscillating. The two brake-wheels, T T, placed side by side on the drum shaft, Fig. 10, were both fitted precisely alike throughout.

Near the end of the bell-crank lever, X, Fig. 9, a chain was attached leading to a wheel, Y, overhead, and from a larger wheel on the same shaft another chain led to a barrel on a winch, Z. A man standing at this winch by turning the hand-wheel could immediately take all the weight off the brakes, T T. The whole of this paying-out machine was made double, so that in case of any mishap there might be no delay, but the cable might at once be removed from one drum to the other. This provision, however, fortunately proved to be needless, as throughout the expedition there was no failure in any part of the machinery, its action having been in every particular perfect.

The cable, having by these means been sufficiently checked, was passed over the stern-wheel, A, Fig. 4, into the sea, and on its way the actual strain was measured by a dynamometer placed at D, consisting of the following arrangement: Immediately on the cable leaving the paying-out drum, P, it passed over a wheel, H, and at a distance of 23 ft. 6 in. over another similar wheel, I, and in the centre between these two wheels was fixed the dynamometer, D, which is shown in Figs. 11 and 12. It consisted of a wheel, D, weighted to a particular amount and riding upon the cable, L, being guided in a fixed vertical frame by rollers, AA. The amount of deflection evidently varied according to the strain on the cable, and the strain was calculated from the formula obtained by the ordinary resolution of forces, namely, $S = \frac{l}{d} W$ approximately; where S = strain,

and W = weight of dynamometer wheel, D, both in the same terms; l = distance between centres of carrying wheels, H and I, Fig. 4, and d = deflection of cable. The values of d , or amounts of deflection, were calculated for all strains from 7 cwt. up to 40 cwt., and a scale, B, was affixed to the instrument with an index, C, carried upon the wheel, D; so that the strain could immediately be read off at all times by simple inspection. The total weight of the wheel, D, and its suspended weight, F, was 426 lb.; and the rod carrying the weight, F, was continued down to a piston, G, working freely in a cylinder of water, to prevent any sudden jerks of the dynamometer. The ordinary strain in paying out was found to vary from 10 to 12 or 14 cwt., and at no time exceeded 16 cwt.

The paying-out drum was also supplied with steam power for reversing its action and picking up the cable, should any fault occur requiring such an operation. This constituted one of the most important improvements over the arrangements of the 1865 expedition, in which it had been necessary to hand the cable along the side of the ship from the paying-out machinery in the stern to the picking-up machinery in the bow, on any occasion of requiring to haul in the cable; and it was during this hazardous process that the cable was broken and lost in the former expedition. In the present machinery the shaft, S, of the paying-out drum, P, Fig. 10, was prolonged on one side for the purpose of forming a coupling to the picking-up arrangement. It was considered advisable to make all this part of the machinery sufficiently strong to work with, and if necessary even to break the large grapnel rope, which had a breaking strain of

more than 80 tons. The shaft, S, was, therefore, made in its smallest place 7½ in. diameter. There were three points to be specially considered in the design: first, that the moving parts of the machine should be kept as light as possible, so that the momentum of the moving mass in paying out should be as small as possible, and should therefore strain the cable as little as possible, either in case of any sudden and accidental mishap, or when the ship was pitching, and this was of vital importance. Secondly, that the picking-up arrangement should be capable of being brought into action at a moment's notice. And, thirdly, that the strength of the machine should be sufficient to cope with a rope having the uncommon breaking strain of 80 tons. These various requirements were admirably met by the arrangements adopted in accordance with the designs of Mr. Clifford, the engineer of the Telegraph Construction and Maintenance Works, who had also worked out the design of all the machinery employed in the expedition.

In order that the machinery for paying-out might be as light as possible, the picking-up motion was coupled direct to the shaft, S, of the drum itself, as shown in Fig. 10, so that when the coupling was thrown out at a moment's notice, the paying-out machine remained intact and as similar as possible to what would otherwise have been necessary if there had been no picking-up arrangement. This shaft and coupling had to be of the enormous strength necessary to bear a torsional strain of 80 tons, acting at a leverage of 2 ft. 8 in. The shaft ends were squared, and a large wrought-iron coupling, R, capable of sliding along coupled the two shafts securely, and the application of this was simply the work of a moment. On the shaft, H, thus coupled to the drum shaft was fixed a large spur-wheel of 7 ft. 11½ in. diameter and 5 in. pitch. A train of gearing driving the pinion working into this wheel admitted of a ready alteration in speed and power, and was driven by a pair of trunk engines made by Messrs. Penn, having a nominal horse power of 80, but working in this case considerably below that power, as the condensing part of the engine was dispensed with and the steam supplied by the ship's boilers was only 20 lb. pressure. The whole of the spur gear, which was of a very perfect construction, was supplied by Messrs. Jackson, of Manchester, and was manufactured by their wheel-moulding machinery, which secured a remarkably true bearing surface on the teeth. The steam was conveyed to the engines by an 8 in. copper pipe of about 180 ft. length; and as a considerable condensation was anticipated from such a great length of pipe, a separator and superheater were fitted close to the engines, so that they received their steam in about an ordinary condition.

In paying out the cable the portion in the after tank was first taken in, in order to trim the ship, as she was considerably by the stern at starting; the fore tank was next emptied, and the middle tank left to the last, the ends of the cable from the several tanks having been spliced together originally in that order of connexion. When each tank became nearly empty, the ship was slowed down, and it was quite stopped for a short time whilst the paying out of the cable was transferred from one tank to another. This apparently rather delicate operation was effected on both occasions without the slightest difficulty. The whole of the cable in the three tanks was spliced up into one length before the paying out commenced; and the length between each tank was carefully laid in troughs of wet sawdust, so that it could be kept under electrical test; it was also from time to time thoroughly soaked with water. The total length of cable paid out was 1851 knots, and the time from shore to shore was fourteen days, giving an average of 132 knots per day paid out, and an average rate of 5½ knots per hour for the cable. The total distance run was 1669 knots, making the average proportion of slack paid out 11 per cent. The ship was furnished with signal whistles, worked by air pressure constantly supplied from a steam-engine, so that orders could be transmitted immediately, and with the greatest precision, to either the engine-room or the bridges and steering-deck; and probably the ultimate success of the expedition in no small degree depended on this arrangement.

During the whole time of the paying out the machinery was most carefully watched at all points. The drums were fitted

with rotometers, showing the amount of cable which had been paid out; and this amount was carefully noted every fifteen minutes in the ship's log, and the speed of paying out and the speed of the ship were calculated so that a right amount of slack might be allowed.

Picking-up Machinery.—Probably no course made by a vessel across the Atlantic was ever more definitely known and accurately marked on the chart than that made in the year 1865 by the Great Eastern during the attempt to lay the Atlantic cable. When the cable parted in that year, many days were spent in the attempt to recover it; this time was, however, by no means wasted, as the results then obtained proved not only the possibility but the certainty that the cable could be found and raised from the bottom. The difficult task of placing the ship in such a position that it should drift across the line of cable was three times successfully accomplished in the attempts made in 1865 to raise the cable; three times the cable was hooked, and three times the swivels in the rope failed. For days the dragging was determinedly continued by Sir Samuel (then Mr.) Canning, the engineer in charge of the expedition, until every fathom of rope was exhausted, and there was then no hope left for that year. It is intended now to describe the means and the machinery by which the recovery of the cable was at length accomplished. The cable of 1865 had been laid with about 15 per cent. of slack, and this percentage of slack was the great source of hope for the successful recovery of the cable. It was calculated that if the cable could be raised to the surface without hooking it at more than a single point, there would be a light suspended in the water of 9½ knots in length, when in 2 knots depth of water, as shown in the diagram, Fig. 5; and the horizontal distance, J J, would be 8 knots between the portions resting upon the ground, giving an excess of length of 15 per cent. in the suspended bight; and the results of the actual picking up proved this calculation to represent very closely the curve of the suspended cable. The size of the cable was 1½ in. diameter, and its weight 85½ cwt. per knot in air, and 14 cwt. per knot when immersed in water; the total weight of a suspended length of 9½ knots in water was therefore 6½ tons, but, as the breaking strength of the cable was 7½ tons, it would carry the weight of 11 knots of its own length in water before breaking. As, however, the possibility of its recovery in this manner in a single bight was generally considered to be out of the question, it was intended therefore to attempt raising it by degrees only. Three steamships were accordingly fitted with picking-up apparatus, the Medway, Great Eastern, and Albany, for the purpose of grappling for the cable simultaneously in three places: the Medway to grapple to the east and the Albany to the west of the Great Eastern.

The picking-up machinery was entirely new for this expedition, and was constructed for a much greater strain than the machinery employed in the attempts of the previous year. The grapnel, shown in Fig. 15, was simply a very large ordinary boat grapnel made with five prongs instead of three; it stood about 4 ft. high, was fitted with a swivel at the top, weighed about 2½ cwt., and its prongs would carry a strain of about 8 or 9 tons without damage. Shackled to this was a 15 fathoms length of 1½ in. chain, to which was fastened the grapnel rope. This rope was a most remarkable one, being 1½ in. in diameter, and consisting of seven strands, six strands round one; each strand again consisted of six smaller strands of hemp, in the centre of each of which was a wire about ⅛ in. in diameter. The rope was repeatedly tested, and was never known to break with less than 80 tons strain. Its weight in air was about 5 tons per knot, and in water 3½ tons.

At the bow of the ship were fitted four iron girders carrying three cast-iron sheaves about 8 ft. 9 in. diameter; these sheaves were all clear of the ship, and over the centre one the grapnel rope was led on board, as shown at K in Fig. 2. The grapnel rope was led directly to the picking-up machine from the bow sheave, passing through a dynamometer so that the strain could be ascertained at all times. This dynamometer was similar to the one for the paying-out machinery described before, except that it was of a much heavier construction and loaded with a weight 2142 lb. The vertical travel of the dynamometer wheel was

5 ft., the horizontal length of deflected cable 30 ft., and the graduations of the scale ranged from 2 tons to 20 tons.

The picking-up machine was very powerful, as it had to cope with a rope of 30 ton breaking strain, and if necessary to break it. It is shown in elevation and plan in Figs. 13 and 14. The two large drums, B B, each 5 ft. 8 in. in diameter, were fixed on shafts parallel to each other at 11 ft. distance apart from centre to centre. The grapple rope, A A, was passed four times round these two in the manner shown in Fig. 13, passing away on the opposite side from where it entered on. The flitting of the rope was effected by small disc rollers, C C, placed on shafts between the drums, four above and four below; and each part of the rope was flitted after leaving one drum before it entered on the other, thus keeping every portion of the rope clear of the rest. The flitting required much more care in this machine than in the one for paying out, as the shackles and swivels on the grapple rope would capsize on and hold down the preceding coil of the rope on the drum, unless the four coils were all kept very wide apart.

As the strains to which it was expected the machine might probably be put were very great, it was thought advisable not to take the power through the shafts of the drums, B B; and accordingly the drums had spur-wheels, D D, fixed at each side, into which the pinions, E E, geared; and by this means no torsional strain whatever was put on the shafts of the drums. The strain of the grapple rope was divided thus between four spur-wheels, and the pitch of these was only 4 in.; although in the paying-out machine, where this division of strain could not be effected, the spur-wheels were 5 in. pitch. Each of the drums had a brake, F, fixed to it, and both the brakes were worked by one shaft, G G, with two screws on it, carried fore and aft along the machine over the brakes. All the strain of the brakes was carried by brackets, H H, on the sole plate, and in no way by the screw-shaft, G; and this is believed to be rather a novel application of the brake-strap, and may be worthy of remark.

The machine was driven by a pair of trunk engines, precisely duplicates of the pair employed in the paying-out machine; and these engines, together with the picking-up machine itself, were made by Messrs. Penn. There was also a system of gearing similar to that belonging to the paying-out machine, for admitting of a change of speed and power; the slowest speed, when the engines made 80 revolutions per minute, was about $\frac{1}{4}$ knot per hour, and the quickest about $\frac{1}{4}$ knots per hour. The machine was supplied with a draw-off wheel, I, and jockey-wheel, J, having an adjustable weight, K, so as to keep the grapple rope, A, well taught on the drums, B; and a rotometer was added for measuring the length of grapple rope overboard. When the picking up of the cable was in progress, the grapple rope was delivered from the picking-up drums into the fore tank, which was at that time empty.

The process of grappling was as follows: The exact line of the cable having been marked by a couple of buoys put down by nautical observation, the ship was brought into a position about 3 or 4 knots north or south of this line, according to the direction of the wind and current, so that the ship might be drifted slowly across the line of the cable. The new cable of 1866 had been laid at a distance of about 30 knots southward of the line of the old cable, so as to avoid all risk of injury in the process of grappling for the old cable. In a depth of 1900 fathoms (nearly 2 knots), about 2200 fathoms length of grapple-rope, with the chain and grapple as before described, was lowered with great care, taking about an hour or an hour and a half for the purpose. Whilst the grapple was being lowered, accurate observations were continuously taken of the indications given by the dynamometer, and the grapple striking the bottom was almost immediately indicated by a diminution of weight, as it and the chain weighed rather more than half a ton. About a couple of hundred fathoms of additional rope were then paid out, and the dynamometer from this time was most strictly watched; averages of the indications were taken every few minutes, and many hours frequently passed before there was the smallest change in these averages. It was interesting to observe how steadily these averages remained at about $8\frac{1}{2}$ to $9\frac{1}{2}$ tons, dependent upon the length of grapple rope out, and the strength of the wind and current. An indicated rise of 5 cwt. was generally considered satisfactory evidence that the cable was once more hooked, and this seldom proved wrong; no attempt, however, was made to haul in the rope until the strain rose 2 tons above the average. As soon as a strain of $10\frac{1}{2}$ to 12 tons was observed the ship was brought up by her engines to ease the strain, and the operation of picking up commenced; the strain then generally rose to about 14 or 15 tons, and continued at this amount until the bight of the cable was raised off the ground, after which time it gradually lessened. The attempt was once made to raise this bight direct to the surface without assistance from the other ships, and it proved successful, the cable coming a few feet above the water with a strain of about 64 tons. There was, however, a heavy swell on at the time, and the pitching of the ship broke the cable through.

After many ineffectual attempts, the cable was at length successfully raised in the following manner: It was hooked by the Great Eastern, and the bight being raised about 900 fathoms from the bottom, was buoyed there, as shown at B in Fig. 6; the buoy attached was of the largest size, weighing $8\frac{1}{2}$ tons, and capable of supporting a weight of 13 tons. The Great Eastern then again grappled for the cable about 3 or 4 knots westward at S, and again found it; the Medway found it at the same time at M, about 2 knots westward of the Great Eastern. The Great Eastern then commenced hauling in, signalling to the Medway to do the same, and to break it if she could not bring the bight to the surface; this she accordingly did, the cable breaking about 200 fathoms below the surface. The Great Eastern in this manner had a loose end of about 2 knots to the westward, and had immediately a much reduced strain to contend with. Ultimately the end was successfully brought on board, the electrical circuit to Valentia was once more established from the ship, and the movement of the small speck of light on the galvanometer scale by the current received from Ireland indicated the success of the undertaking. The recovered end was speedily spliced on to the remaining portion of cable coiled in the tanks on board, and the paying out of the 680 knots necessary to complete the cable to Heart's Content was effected without interruption.

TRAFFIC ON INDIAN RAILWAYS.

THE following statement, showing the comparative abstract of traffic on the guaranteed railways throughout India for the first and second quarters of 1866 and 1867 respectively, furnishes, perhaps, as good a criterion as may be obtained of the relative prosperity of those lines. The net earnings are not included in this statement, but these may be approximately ascertained by referring to the table of railway statistics which appeared at page 377 of our present volume, and in which will be found an account of the percentage of working expenses to total receipts on each line.

	East Indian.		Eastern Bengal.		Calcutta and South-Eastern.		Punjab.		Delhi.		Madras.		Great Southern of India.		Great Indian Peninsula.		Bombay, Baroda, and Central India.		Sindh.	
	1867.	1866.	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£	£
FIRST QUARTER.																				
Total earnings ...	645,730	570,403	34,894	35,412	2,533	3,371	23,430	27,849	Nil.	Nil.	111,065	107,873	14,410	8,585	521,822	512,656	114,966	117,719	34,190	28,080
Mean mileage open ...	1,131	1,129½	118½	110	28	28	246	253	...	...	645	611	127	79	831½	699	306	306	109	108
Average receipt per week ...	49,671	48,877	2,684	2,724	195	259	1,802	2,142	...	...	8,545	8,298	1,108	660	40,140	39,435	8,843	9,055	2,680	2,156
Average receipt per week per mile open ...	43.0	38.8	23.7	24.7	7.0	9.2	7.3	8.4	...	...	13.2	13.6	8.7	8.3	48.2	56.4	29.0	29.5	24.1	20.0
SECOND QUARTER.																				
Total earnings ...	561,173	497,553	43,008	32,456	2,327	3,004	26,983	24,816	1,015	Nil.	119,436	101,922	14,608	10,659	444,512	300,505	146,704	119,026	29,476	24,622
Mean mileage open ...	1,131	1,129½	118½	110	28	28	246	253	27	...	645	611	127	79	852	701½	306	306	109	109
Average receipt per week ...	43,167	38,273	3,308	2,496	179	281	2,075	1,909	96	...	9,187	7,840	1,123	820	34,193	23,116	11,285	9,202	2,267	1,894
Average receipt per week per mile open ...	38.1	33.9	29.2	22.7	6.3	8.2	8.4	7.5	3.5	...	14.2	12.8	8.8	10.4	40.13	32.9	36.8	30.0	20.8	17.4

The reason why nothing appears with reference to the Delhi line is that its first section was only opened in April last. We cannot explain why the mean mileage open on the Punjab Railway was less by seven miles in 1867 than it was in 1866, unless the branch

from Sheer Shah to Moulton has been abandoned. Should this explanation be incorrect—and we have received no information relative to such being the case—the difference appearing in the statement must, we should think, be owing to a clerical error.

KURRACHEE HARBOUR.

THE progress of improvement gradually taking place in the state of Kurrachee harbour is too unmistakably shown by the results of surveys which were taken in January and May last by the superintendent of the works, to leave any doubt as to whether those works ought to be continued. A comparison of the areas of sections at those dates with their areas in January, 1858, and in January, 1866, show very conclusively the extent to which they have increased or diminished respectively by the shifting or removal of the different sand banks. It would be useless here to go into detail regarding the relative sections, without accompanying such information with a plan of the harbour having the sections marked; we shall, therefore, merely give now the aggregate results as shown by these most recent surveys. Compared with January, 1858, the east channel, which is the one used by the deeper ships with the aid of steam-tugs, was, in January last, about half as long again, and, of course, less direct, but deeper, being nowhere less than 14 ft. at low water, and nearly double the width, its least present width being 925 ft. The old west channel disappeared in 1862, and a new channel of rather greater depth, being nowhere less than 11 ft. at low water, and about three times the width, having now a least width of 720 ft., has opened at the middle of the bar, and is used by ships of light draught to sail in or out. Compared with 1858, the bar is considerably weaker, the distance between the 20 ft. line in the harbour and the same line outside having decreased from 2440 to 1870 ft., or by about one-fourth. The bar is also generally lower than in 1858. As regards the harbour between Manora and Keamari, the gain of water space has continued to the extent shown in the accompanying table.

DATE.	Area in acres between entrance and upper end of Keamari anchorage.		
	Below low water S.T. datum.	Below 14 ft. datum.	Below 20 ft. datum.
January, 1858 ...	924	881	109
January, 1867 ...	1040	393	161
Increase in acres ...	116	12	52

showing an increase of area at low water of $12\frac{1}{2}$ per cent., at 14 ft. below low water of 3 per cent., and at 20 ft. of $47\frac{1}{2}$ per cent. The enlargement of the water-space may be further judged of by the fact that between January, 1858, and May, 1866, a quantity of sand has been scoured out of the harbour, amounting to nearly 48 millions of cubic feet, or about two millions of tons. The differences in areas shown between the surveys of January and May last exhibit a slight preponderance in favour of increase. Comparing the survey of May, 1867, with that of January, 1858, twenty-seven sections show an increase in most cases uniform and generally large, eight show a slight decrease, and four a considerable decrease. These last-mentioned sections lie for the most part to the eastward of the proposed line of entrance. Comparing May, 1867, with May, 1866, twenty-three out of the sections 1 to 35 show an increase, and thirteen a decrease; but the balance is greatly in favour of increase, not only as to the number of sections, but difference of areas. There has been a decrease in low-water area in the lower sections since the survey of May, 1866, but this is accounted for by the increase which has lately been given to the high-water area of the same sections by the removal of Deep-water Point.

A very important step now appears to be the diversion of the Chinna Creek waters, so that their scour may be brought into play, with a view of maintaining a good navigable channel up to the new jetty. Nothing, too, has yet been done towards the construction of the Manora Breakwater, beyond the formation of the approach at the foot of the cliff, and the preparation of experimental concrete blocks. A variety of experiments are at present in progress on these blocks, in order to determine whether Portland cement or artificial hydraulic lime should in future be adopted. Either material, it is thought, is likely to give good results, but the comparative cost of the two remains yet to be determined. Lieutenant Merewether, in his report on the search for stone for the

breakwater, states that facilities for obtaining durable stone in large blocks are questionable, but that a supply of stone suitable for the base of the work is obtainable in the vicinity of Cape Mouze.

Now the necessity at all for this breakwater very naturally leads us to the question as to the amount of shelter with which the entrance to Kurrachee harbour should be provided, and, on this point, we believe, some misunderstanding at present exists in the minds of the profession generally, as to what has been recommended on this subject by the originators of the scheme, and by Mr. Parkes, who is now their sole representative. Messrs. Stevenson, in their report, insisted very strongly upon the necessity of a complete shelter from the south-west seas, and as their conclusion professed to be adverse to that of Mr. Parkes, it has, perhaps not unnaturally, been therefore assumed that Mr. Parkes does not think that shelter is necessary. This, however, is erroneous. By referring to the printed volume of selections from the "Records of the Government of Bombay," on this subject, a copy of which will be found in the library of the Institution in Great George-street, Westminster, it will be seen that Mr. Parkes had frequently urged this very subject upon the Government. Neither Mr. Parkes nor Messrs. Stevenson have, however, committed themselves by defining any particular area as requiring shelter; but Mr. Parkes has long ago pointed out the possibility that Mr. Walker's original design might require some extension in this respect, and this suggestion will be found in his reports of March, 1864, and September, 1865. On the subject of *shelter*, therefore, the opinions of Mr. Parkes and the Messrs. Stevenson are certainly not at variance, so far as the principle is concerned; but as the questions of *degree* and of *detail* have never yet been discussed between them, it is impossible to say how far their views may ultimately be found to coincide on those points.

The question as to the continuance of the works at Kurrachee harbour is now, we believe, only awaiting a visit to the spot by the Governor of Bombay, after which we hope to be in a position to report what measures may have been determined on with reference to this interesting subject.

BELLEVILLE'S INEXPLOSIVE BOILER.

TO THE EDITOR OF ENGINEERING.

SIR,—The part which, many years ago, you took in the exposition of the theory of boiler explosions justifies the interest which at various times you have taken in the attempts made to construct boilers which, though parts of them may burst, shall not be liable to destructive explosion, as is the case with those containing large quantities of water in a single vessel.

Thus, you were the first to bring to public notice the multicellular cast-iron boiler of American invention; and although the results of experience, as regards its economic working and maintenance do not appear to have realised the fond hopes of the inventor, I hope you will continue to give due prominence in the columns of your journal to all reasonable schemes having in view this very desirable object.

Some months ago you gave a description with full illustrations of an inexplosive boiler, designed and made in France by M. Belleville, and as I have had occasion very recently to see it at work in France, and to ascertain that it is gaining great favour there, and that it is gradually establishing for itself the reputation of being a substantial success in steam engineering, I propose in the following few lines to make a short review of its history, in order to freshen up the subject in the memory of those of your readers who may be interested in it, and by way of dispelling the notion which gets hold of people's mind when a new contrivance is presented to them, that it is but a novel idea not yet sanctioned by the test of experience.

The first attempts made by M. Belleville date as far back as 1850, when he constructed a boiler made of cast-iron water tubes, of which both shape and thickness was altered several times in the vain endeavour to make them answer; the tubes continually broke. A year afterwards he employed gas tubes, the importation into France of English manufactured tubes for steam purposes being then prohibited; the gas tubes, however, gave no better results than the cast-iron ones, because, being imperfectly welded, they cracked invariably after having been subjected a certain number of times to the heat of the furnace and cooled down again.

In 1856 the prohibition upon English tubes was removed, and from that date only has M. Belleville been able to pursue his object with any chance of success; for it seems useless to add that, if he had attempted to make them of copper, the cost of the boiler would have effectually prevented its general adoption.

The boilers which he then made consisted of horizontal rows of tubes placed immediately above the furnace; the tubes were connected with each other at the back, and at the front a thin jet of water was introduced into each of them with a view to instantaneous evaporation; the steam-pressure in the tubes and the amount of feed were to regulate each other by a self-acting process, the steam forcing the water back when the pressure rose above its desired limit, and the water being admitted more freely when the pressure diminished. As, however, in this arrangement the tubes had to be kept continually at a high temperature, which readily rose to a clear red heat when the engine was stopped, both the joints and the tubes were soon destroyed, and the scheme had to be abandoned.

It may here be observed that M. Belleville had thoroughly understood that, in order to render boilers inexplosive, it was

necessary to dispense with the great bulk of water which they usually contain.

His next attempts consisted, first, in a system of ascending spiral tubes fed from below; with these, however, he either obtained exceedingly wet steam or steam so overheated as to be equally unfit for use; afterwards, in a series of three vertical serpentine tubes mutually connected with each other; in this arrangement, however, the tubes were subject to the same cause of destruction as in the arrangement of horizontal tubes first mentioned, namely, that of being burnt through overheating during stoppage. Each of these latter attempts, consequently, had also to be abandoned.

Through all these trials the authorities of the French navy had afforded M. Belleville every facility, and had borne patiently with his successive failures until 1857, when M. Dupuy de Lôme relinquished the hope of ultimate success, and recommended the discontinuance of further experiments upon vessels belonging to the imperial navy.

M. Belleville, however, continued his private experiments, and in 1859 he hit upon the arrangements illustrated by you in the earlier part of this year, and which from that date have undergone no material alteration beyond the addition of the superheater; also he observed that the tubes employed in their construction are all of English manufacture.

M. Dupuy de Lôme, notwithstanding the previous failures, was so satisfied with the design of these boilers that already in 1860 he ordered the steam-tender *l'Argus* to be fitted with them, and these have now done duty for six or seven years with perfect success. A number of other vessels of the imperial navy have since been fitted with them; and we believe at the present time Messrs. Belleville and Co. are making several boilers of great power for the French navy.

That the boilers are inexplosive has been proved by experiments made under the auspices of a commission appointed by the French Minister of Marine upon the demand of the patentees during the earlier stages of his researches. One of his steam-generators, connected with an engine, was heated to a red heat, and the steam pressure raised to the enormous figure of from 27 to 28 atmospheres, when a whistling noise was heard, and the engine stopped. Upon inspection it was found that one of the tubes had burst, and the steam had all escaped into the furnace; but no accident of any other kind had happened.

The other advantages claimed by M. Belleville for these boilers are, saving in time for getting up steam, as full pressure may be obtained in ten minutes to a quarter of an hour; saving in weight of about 40 per cent.; saving in space of about 50 per cent.; easiness of repairs, for if a tube comes to fail it may be replaced without much expense or trouble; and, finally, a saving of fuel, which may amount to 30 per cent. in boilers where the fire has not to be forced. This saving of fuel is not so much apparent in the amount of water evaporated per pound of coal, as in the fact of the superheating of the steam, by which the whole of the heat communicated to the water is rendered available for mechanical work.

The importance of this desideratum has long since been recognised in this country; but I am not aware that it has ever been so thoroughly realised as in the scheme under consideration.

I remain, Sir, yours very truly,
J. J. BIRCKEL.

November 12, 1867.

TELEGRAPH TO INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—At this juncture, while public attention is occupied with the opening up of a better and safer route than at present exists, it may not be inopportune to offer a few remarks on the subject.

At present there are three projected routes, viz., the Red Sea and Aden direct, the Russian and Persian, and the French, Austrian, and Turkish.

To carry lines out to join the Turkish system would be to repeat the blunders already made in that direction. Apart from the insecurity of that system through the almost perpetual internecine strife waged by the wandering tribes, the "hands" employed are a mixed set, few among them being able to understand each other (the English element being quite thrown out) even officially, consequently the vexatious delays and mutilations so loudly and justly complained of are by them daily and hourly perpetrated. With the exception of that section of the line formed by the Persian Gulf cable, this route is a failure, both as regards accuracy and speed of transmission. On the Indian side of the last named section, a land line (the Mekran) was erected, at an immense cost, as an auxiliary link between Gwadar and Kurrachee. It, too, has proved a signal failure, in spite of puffing and endless patching. Clearly, then, there is no safety on this route. As regards the Russian line, it will be pretty much the same as the other, for the work will pass through incompetent hands on its way to Bushire (the hand-over station in the Persian Gulf), thence to Kurrachee, to be placed in the hands of stupid blundering Eurasians and Portuguese, en route to Bombay.

There will be safety, despatch, and intelligibility insured by the adoption of the Red Sea route, from the fact of its passing through civilised countries, and being governed by a staff of eminent engineers and electricians, and its commercial routine overlooked and carried on by competent English telegraphists.

These remarks are evoked by personal experience both at home and in India, and may, I trust, lead to a careful consideration of this highly important matter.

I am, Sir, yours obediently,
London, November 9, 1867. ANGLO-INDIAN.

HARWICH.—Works undertaken at Harwich under the superintendence of Mr. P. Bruff, C.E., with a view to the improvement and protection of Harwich harbour, have been attended with the happiest results. Already about four acres of the "beach end" have been washed away, and vessels of light draught can now enter the harbour at high water by the old leading mark.

INDIAN RAILWAY GUARANTEES.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "Anglo-Indian," in stating the difference between the guarantee arrangements of the Russian and the Indian lines of railway, has not noticed one important provision in the latter, which is, that the guarantee is not restricted to the actual first cost, but extends to all subsequent additions, alterations, or improvements, as shall be properly chargeable to the capital account.

The proper interpretation of the words "properly chargeable to the capital account," has been the subject of careful consideration by the Secretary of State, who, in 1864, laid down certain general rules on the subject for the guidance of the authorities in India. The principle involved in these rules, which is, no doubt, the correct one, is to charge upon capital account the cost of all permanent additions or improvements, and in the case of substituting for an inferior thing one of a superior nature, to charge upon capital the difference in cost.

One of the accidents which have recently occurred upon the Great Indian Peninsula Railway will probably come under one of these rules, which is as follows:—"... If any extraordinary casualty should occur, such as the destruction of a bridge by flood, the case must be regarded as exceptional, and the cost of construction or replacement must be charged to capital or revenue, or divided between them, as may be deemed proper according to the circumstances of the case."

Such accidents as have occurred upon unopened or recently opened portions of the railway will possibly come under the following provision: that the rules "are not to interfere with the arrangement which has been made with each company for allowing the cost of maintenance for one or two years after the opening of the railroad, as the case may be, to be charged to capital."

As the Government have from the beginning exercised the power of control over every detail of construction, such cases of inefficiency in the design of the works upon any of the Indian railways, as may appear from time to time, have occurred with their full knowledge and consent. As far as the Great Indian Peninsula Railway is concerned, it is no doubt very much owing to the rigid economy enforced by the Government in past years that further expenditure is now necessary to perfect the works.

The average cost per mile, partly estimated, of the principal Indian railways may be roughly stated as follows:

Bombay and Baroda ...	£24,000
East Indian, main line ...	22,000
Scinde ...	20,000
Eastern Bengal ...	17,000
Great Indian Peninsula ...	14,500
Madras South-West line ...	12,000
Great Southern ...	10,000
Punjab ...	10,000
Average of the above lines, about ...	17,000

As the Great Indian Peninsula Railway is rather more than one-fourth of the total length of guaranteed railway in India, it holds a very respectable position in the above list, and the fact that its cost is about 2500*l.* a mile below the average, representing a total about three millions, tends to prove that economy has been studied in its construction. Economy may have been carried too far, in a few isolated cases, but the general result will be the saving of a large sum.

There are doubtless exaggerated ideas about the extent of the unavoidable casualties that have recently occurred upon this railway. In point of fact the actual casualties would, if necessary, be covered twice over by the surplus profits of the past half-year in excess of the guarantee. It may be found necessary to make additions and improvements, from time to time, to some of the existing works, and the railway company may find it easier to do so, now that the local Government have awakened from their apathy on the subject, than was formerly the case; but according to the terms of the contract, that expenditure must clearly be borne by the guaranteed capital; and even it were to amount to the extravagant estimate of half a million, the railway will still rank among the cheapest of the Indian lines.

I am, Sir,
Your most obedient Servant,
November 19, 1867. Y.

TOOLS AND TOOL-HOLDERS.

TO THE EDITOR OF ENGINEERING.

SIR,—The absence of our Mr. Smith from home has been the only cause of our not replying earlier to the letter of Mr. Birckel, which appeared in your impression of November 1st.

The engineering firm of Chemnitz, in Saxony, who exhibited in Paris the wheel-cutting engine, copied from the patented machine of a celebrated Leeds toolmaker, and also copies of our patent tool-holders and grindstone, is that of Mr. Zimmerman (not Hoffman or Harmann), who ordered from us, through a Manchester agent, May, 1866, a complete set of the tool-holders we then made, also one of the grindstones for grinding the cutters. These were supplied by us to Mr. Zimmerman, who copied them and exhibited them as his own inventions at the Paris Exhibition, and there represented that he was using them throughout his own works.

About the same date we also supplied Mr. Hartmann, of Chemnitz, with a set of tool-holders, through another Manchester agent. Young Mr. Hartmann had previously visited our works, and seen the tools and tool-holders in use. We went carefully through the Paris Exhibition Machinery Court, but did not see or hear of any other tool-holders or grindstone being exhibited, and can safely say that our system was not exhibited by any other firm.

A gentleman called upon the London agent of the Leeds tool-maker previously referred to, and asked if he could supply a wheel-cutting engine. The agent laid the patent machine before him. He said it was exactly the thing he wanted, and asked for a tracing to lay before the people with whom

he was connected in Germany, promising to send an order back by post. The order never came to hand; but Mr. Zimmerman copied the machine bit by bit. We were told he not only exhibited it as his own design or invention, but also patented it in Germany.

We may also mention that the correct angles of the cutting-tools and the tool-holders exhibited were departed from, and that the copy of the grindstone was a very inferior one, some important portions being left out, apparently for the purpose of producing a lower-priced article.

We cannot too strongly condemn the want of honour on the part of Mr. Zimmerman in these matters.

At the Paris Exhibition, Mr. W. Ford Smith, without making it known to Mr. Zimmerman's representative, made some inquiries respecting the tools and tool-holders, and was informed by him that Mr. Zimmerman was the inventor, that he was using them throughout his works, and that they were excellent tools. When asked by Mr. W. Ford Smith if he remembered Mr. Zimmerman having a set of tools and tool-holders and grindstone from Smith and Coventry, from which these articles were copied, he would not acknowledge it; and when pressed for a straightforward answer, said that we had better ask Mr. Zimmerman about that, as he had had nothing to do with that part of the business.

The insertion of this in your valuable paper will oblige,

Yours most faithfully,

SMITH AND COVENTRY.

Gresley Iron Works, Ordsal-lane,
Salford, Manchester, November 19, 1867.

ENGLAND AND AMERICA.

We reprint from *The Times*, of Friday last, the following interesting letter on the English and American iron trades. The letter, which appeared over the initials J. S., was, we have every reason to believe, written by Mr. James Shaw, of the firm of Shaw and Thomson.

TO THE EDITOR OF THE TIMES.

SIR,—A few remarks upon the iron trade, which is at present so depressed, may not be unwelcome from one who has just returned from a hasty trip through some of the most important rolling mills in the United States and Canada. The causes of the existing stagnation in England lie chiefly within ourselves and are obvious to the most casual observer. The break-down in confidence in railway directors has deprived railway companies of the power to make their customary renewals of permanent way, and has stopped further extension. This accounts for the present low price of rails, and the flat aspect of that part of the trade. The demand was so good two years ago, when everything in railways was so inflated, that a number of new mills were erected, and these are now struggling for an existence. About 1,000,000 tons per annum may be roughly stated as the rail production of England, and it may be computed that our home railways have purchased 150,000 tons less during the past twelve months than in the twelve months preceding.

The general iron trade, especially that part of it depending upon iron shipbuilding, has fared even worse, and, judging from the disorganisation of business in Liverpool, which has been the principal mainstay of shipbuilders during the last few years, there is little prospect of an early revival. Our foreign trade has not been impaired. India, Russia, and America have taken more iron this year than they did up to the same period last year, and the majority of our other markets have been quite as good as usual.

A recovery of the iron trade here will take place simultaneously with a general revival of confidence throughout the country. When that may be no one can tell, but it may be nearer than is generally thought. The Limited Liability Act has brought a number of companies into the iron trade, the effect of which remains to be seen. No trade is more dependent upon the individual energy and secrecy of private enterprise than the iron trade. Any one who looks at the price of shares in limited liability companies will be able to form his own conclusions as to the present prosperity of the trade.

This much may be said respecting our own trade before referring to the same trade in America.

The duty upon rails imported into the United States is \$15 68 c., payable in gold, equal to 3l. 4s. 8d. per ton. The price of English rails of the description usually shipped to America is just now under 5l. 15s. per ton at the shipping port, so that the duty in favour of the American manufacture is equal to a profit of 66 per cent. This is a very considerable protection to the leading iron manufacturers, and one would expect that the American iron trade must be in a particularly flourishing condition. Quite the contrary. The alluring prospect of such a splendidly protected trade has encouraged so much internal competition that this evil is working its own cure, and at this moment the trade is even more depressed there than it is here. Large as the duty is, the ironmasters are still clamouring for more, looking to the paltry expedient of shutting out all foreign imports to cure the desperate game of competition among themselves, which has been fostered by the system of a continually increasing tariff. Large as our production at present may be in excess of a profitable demand, in America it is proportionately greater. Unless a rolling-mill in the States at present has some speciality—and, by the way, you scarcely meet a practical American who does not carry a patent in his pocket—it is not making full time or working at a profit. The most thriving part of the trade is girder iron, which is only rolled at three works, who have formed a combination, by means of which they net very handsome profits. The largest size of this iron made in America is 15 in.; our largest size is 12 in.; while in France and Belgium it is rolled up to 30 in.

Another prosperous business is that at Troy, in the State of New York, where horseshoes, railway spikes, and rivets are made by machinery. The horseshoes are made from a bar of iron at the rate of sixty per minute. In England it is well known how few can be made by hand per day, and they are not superior either in quality or workmanship.

The chief production in the States is rails, and since the conclusion of the war the demand has been greatly curtailed. As

yet the Southern States have made about as little progress in material reconstruction as they have done in political, and their absolute necessities can only be purchased in deferred payments. The rail-makers of America have always fostered a preference and sought higher prices for American rails, because of a superiority of quality as compared with English improved rails. Nothing could be more absurd. Three-fourths of the American new rails are re-rolled old rails, with a thin top of puddled bars, and these old rails are, in most cases, as yet the original rails shipped from England. During the past twelve months about 25,000 tons of old rails have been shipped from England to America, which have been re-rolled to produce the quality said to be so much superior to English.

At the same time it must be said that a better quality of rails could, and ought to be, made in England for the American market.

At present English rails, even with the high duty, do compete in price with American rails, but as a rule English rails are only bought for the construction of new lines or extensions of old ones. The American manufacturer generally renews the line by contracting to re-roll the old rails. Just now, although the stock of English rails in the New York market is scarcely 5000 tons, the demand is so small that shipments from England are discouraged. Usually the stock in New York is 15,000 to 20,000 tons.

Americans have a right to decide their tariffs for themselves, but with the great disadvantages of dear labour, coals, and ore it may surely be said that capital could be far better employed in developing the enormous agricultural riches of the country than in stimulating a trade which, upon its own merits, deprived of a tariff equal to 77 per cent., is unable to compete with other countries. How very much the high price of iron material must hinder the extension of their railway enterprise, which is the very life and soul of their prosperity! The same organisations which have broken loose the chains of slavery should henceforth be used to free commerce from a thralldom so selfish and unwise.

The Bessemer process has been introduced at several works, but the ore of the country is not quite adapted to it, and, so far, it has only been an indifferent success. The Hudson River Railway directors, who bought 5000 tons lately of Bessemer steel rails in England, have resolved to renew their whole line of 150 miles with steel rails.

Shipbuilding is for the most part confined to river navigation steamships, mostly of wood, and few plates are rolled, and only a small quantity of angle-iron.

The foundries thrive better than the rolling-mills, and some of the castings are admirable. At Chicago there is notably a splendid block of buildings, with ornamental cast-iron frontage, which surpasses anything to be seen in England or elsewhere. One observes a readiness in the American character to adopt the most serviceable article, without regard to prejudice or previous custom.

The stove trade is very extensive, and nothing made at Carron or Shotts will rival their productions. Scotch pig-iron is largely imported for that purpose, bearing a duty of \$9 per ton, equal to 65 per cent. on present price, which of course is paid, as all duties are, by the consumer in the higher price of the article he buys.

In agricultural machinery the iron used is considerable, and American ingenuity in that direction is ahead of every other country.

The nail trade is not so active as it usually is, and the makers who cut nails (a very large trade) especially complain.

Horseshoes, as has been already observed, are made by machinery, and so also are the horseshoe nails. In England the greatest prejudice exists against both, and with customary English prejudice they are not likely to be in large use for a long time. The spirit of Toryism in its worst type descends deep into the constitution of the English mechanic, however liberal his creed may be. Were this not the case, there would be few English workmen's homes without a sewing-machine and a clothes-washing machine. As has often been observed, the very necessities of the American people compel them to invent methods of labour-saving. The labour question is the question of the present day, and no trade has larger interest in it than the iron trade.

There is a machine called a squeezer, requiring no manual labour, in every ironwork in America, doing the work of our steam-hammer, which requires the attention of two men. There is only one of these machines used in England. A steam-hammer is not seen in one work out of ten in America. To England belongs the honour of every great discovery connected with iron; but we need not despise or disparage the ingenious inventions which as naturally belong to America.

The languid state of the iron trade in the States is greatly due to the aspect of political affairs, and not a little to the continual fluctuations in the price of gold.

These are elements of so much uncertainty that it is needless to enter into considerations respecting them. It can only be hoped that the Southern States may speedily resume their commercial importance under a system of free labour, and that free trade may be the outcome of the present struggle.

Both in England and America the iron trade is overborne by excess of production. With the labour question so unsettled, capital is not likely to be attracted to it, and when confidence revives there may be a better chance for the large capital invested in it.

Your obedient Servant,

J. S.

THE ANGLO-INDIAN TELEGRAPH COMPANY.—A memorial in favour of a Government guarantee of 5 per cent. on a capital of 1,000,000l., to enable the proposed Anglo-Indian Telegraph Company to establish an independent line to India by way of Egypt, has been signed by the leading houses connected with our Eastern trade, and was transmitted on Thursday to Sir S. Northcote by the Lord Mayor. The route in question was favourably noticed by the Committee of the House of Commons appointed in 1866 to consider the postal and telegraphic communication with India.

SINGLE ENGINES ON STEAMSHIPS.

A CORRESPONDENT of the *Scientific American* (Mr. J. W. Cole) writes to that journal as follows, with reference to some remarks of ours upon an invention patented in England by two American engineers:

"In your issue of October 5th, I noticed a quotation from *ENGINEERING*, criticising 'American Beam' or single-cylinder marine engines, with reference to their liability to being caught on their centres; also editorial remarks, closing as follows:—'The invention alluded to is intended only for infrequent contingencies.'

"Being acquainted with the performance of the engines of the Pacific Mail Steamship Company—the finest of this class—as also with the object of the invention alluded to, a few words of explanation may not be out of place.

"While the valves of these engines are worked by the eccentrics, or, in technical terms, 'hooked on,' no assistance is ever required in passing the centres; this is shown by the steamers' logs. But while moving in port, or working at the dock, with the eccentrics unhooked, and the valves worked by hand—so as to stop or reverse on the instant—they are liable to be caught. This danger increases with the size of the engine, or lack of skill on the part of the engineer working the valves. Occasionally there are causes over which the engineer has no control, as in working our ferry-boats through ice which obstructs the wheel-floate, stopping the engine at the point of least power.

"While this invention of Messrs. Vanderbilt and Sims is at hand in any case of emergency, it is more especially designed for use in port, and to push the engine off the centre after it has been placed there for adjustment, that being the only point at which the engine can be properly adjusted and 'keyed up.'

"The use of these hydraulic jacks will prevent such serious accidents as caused a man to have both legs broken on the steamer *Rising Star*, in the latter part of the summer; and another, more recently, to lose his life on the steamboat *Providence*. Both these accidents occurred while in port by prying the engines off the centres with levers in the wheel, as has been the usual custom."

HOW TO DRAIN A WELL.

TO THE EDITOR OF *ENGINEERING*.

SIR,—The first perusal of such a delightfully innocent effusion as the one subscribed "Economic Utilitarian" in your last must surely be esteemed by you as one of your greatest editorial privileges. Apart from the "fun" such a letter contains, it affords most conclusive evidence of the circulation of your journal beyond the limits of the profession, even into the trackless space peopled by Britons with a grievance generally.

As our disinterested friend, the E. U., evidently glorifies himself upon having hit upon an idea, it is almost a pity he did not permit it to "blush unseen," and so continue to enjoy it. If the "few seconds" dodging of the "vulgar Cerberus" (I hope he didn't call the navy that to his face) had been supplemented by a few seconds' consideration, it might have occurred to the E. U. that possibly the whole area of the Victoria Station of the Metropolitan District Railway and the adjacent portions of the line might be below the limits of natural drainage (it is some 10 ft., I believe), and that such a great gravel basin must in that case be saturated with water below that limit—not locally, but uniformly over the whole area.

For the more easy understanding of the E. U., we may compare the condition of the excavation for the station, with its retaining walls all round, to that of a tube with a perforated bottom, or with, say, a sieve fitted on to its open end, plunged sieve downwards into 10 ft. of water. Now if it were required to keep such a pipe empty, a poor ignorant engineer or contractor would pump away till he threw out the water at the top as fast as it came in at the bottom. A brilliant light, however, is flashed upon the subject by the E. U. In future we have only to fix a pipe in one of the meshes of the sieve, and the water will run out at the top, and may be employed for any of the ordinary purposes to which that indispensable fluid is applied!

Mutatis mutandis, that is exactly how he [proposes to deal with the station.

It is evident that, to keep the water permanently out of the pipe, or out of the station, it would merely be necessary to put in a water-tight bottom as well as water-tight sides; and that, doubtless, will be effected in the instance of the station by laying a bed of concrete of the requisite thickness over the whole area of the works extending below the limits of natural drainage.

Wishing the E. U. another grievance immediately to restore him to his normal condition,

I am, Sir, your obedient Servant,

T. SQUARE.

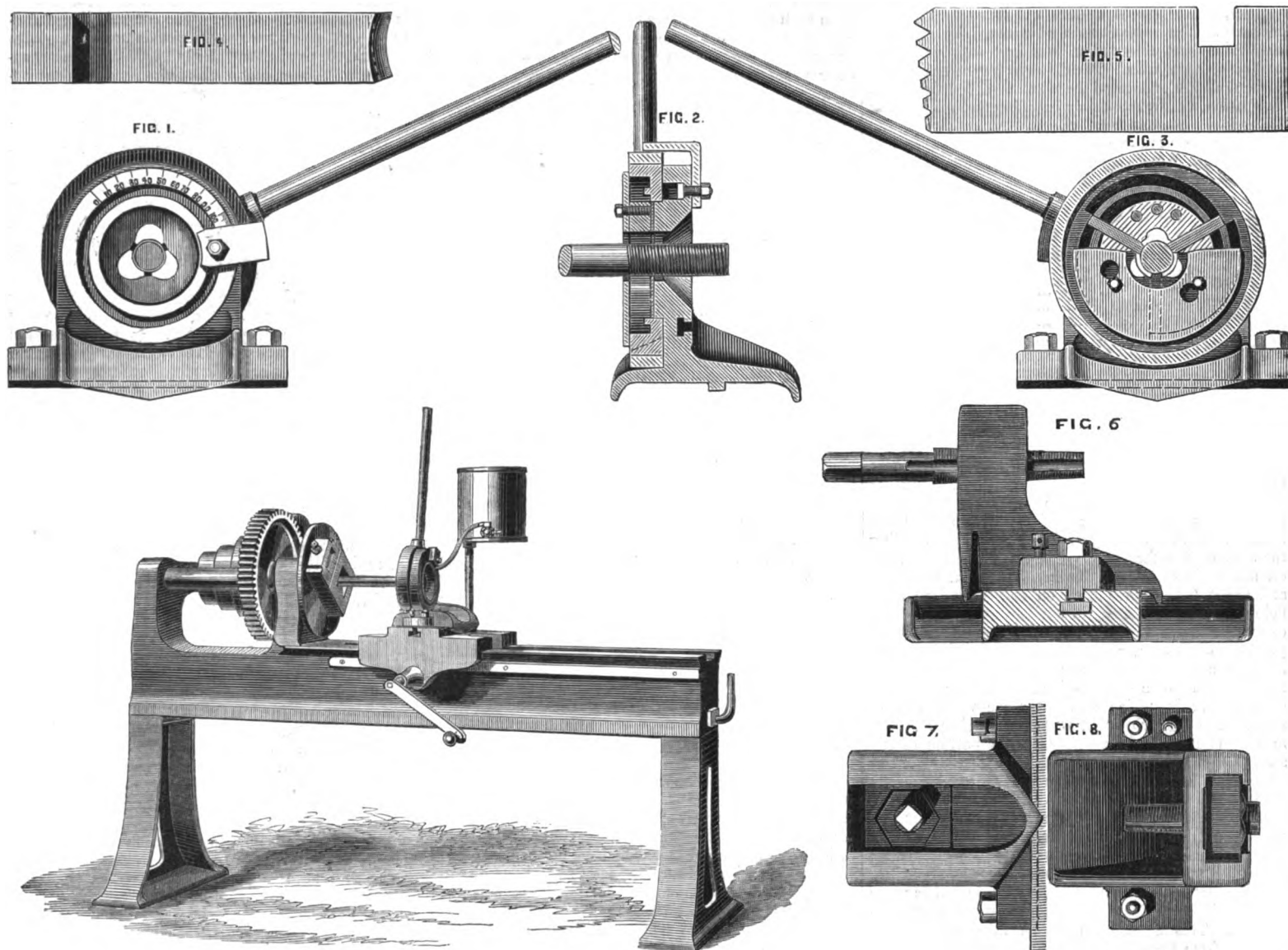
Westminster, November 19, 1867.

THE MONT CENIS TUNNEL.—The Italian papers report that in the month of October the Mont Cenis tunnel was advanced 131.85 metres, or upwards of 140 yards, and that up to the 31st of October last 7664 metres had been excavated, leaving 4555 metres to be done to complete the work. The progress during the first ten months of the present year was 1329 metres against 1094 metres excavated during the whole of 1866. If the rate attained during the last month can be kept up, the tunnel would be completed in 1870.

PRUSSIAN RAILWAYS.—Since 1838, when the first railway was completed in Prussia, the average annual length of railway opened in that kingdom has been 180 miles. At the commencement of this year Prussia had 5762 miles of line, but this total would not have been so considerable but for recent annexations of territory. The capital expended upon the 5762 miles of Prussian railway was estimated at the commencement of 1867 at about 90,000,000l. In 1866 there were, altogether, 1831 locomotives at work upon Prussian railways.

BOLT-SCREWING AND NUT-TAPPING MACHINE.

CONSTRUCTED BY MESSRS. SMITH AND COVENTRY, ENGINEERS, MANCHESTER.



We give, above, engravings of a form of screwing-machine, of which a large number have been constructed by Messrs. Smith and Coventry, of Manchester. The general arrangement of this machine will be readily understood from the perspective view. It consists of a bed, somewhat similar to that of a lathe, having the fixed head, by which the main spindle is carried, cast in one piece with it. The main spindle, which is driven by gearing, as shown, carries at its end a face-plate provided with a kind of vice for holding the bolts to be screwed, these latter revolving whilst the screwing dies are stationary. The main spindle is made hollow, so that long bolts can be passed through it.

The arrangement and form of the cutting dies will be seen from Figs. 1, 2, 3, 4, and 5. The dies, which are three in number, are carried by a casting fixed to a saddle which slides along the bed of the machine, this slide being capable of being traversed by a pinion gearing into a rack. The three dies are placed radially in grooves in the casting, as shown in Fig. 3, and their outer ends abut against spiral cams, formed on a cam-plate which can be rotated by the radial handle shown. Each die or cutter has a notch formed in it, as shown in Fig. 5, this notch fitting on a corresponding spiral rib on the cam-plate, and enabling the rotation of the latter in one direction to effect the withdrawal of the dies. The cutting ends of the dies are not shaped to the arc of a circle struck from the centre of the bolt to be screwed, but are formed so that the cutting edge is nearer that centre than the following edge, this form enabling the dies to cut much more cleanly.

The cam-ring, which is shown in section in Fig. 2, can, as we have said, be moved round by the radial handle, and the extent to which it can be so turned, and, consequently, the amount to which the dies can be closed, is regulated by an adjustable stop shown in Figs. 1 and 2. The casting in which the cam-plate turns is graduated so as to enable the stop to be readily set to any desired position. In using the machine the stop is fixed in the position corresponding to the size of bolt to be screwed, and the sliding saddle being run back from the face-plate, the cam-plate is turned round by means of its radial handle until the latter rests against the stop. A bolt being then placed in the machine, the dies are pressed up against its end by means of the rack and pinion movement with which the saddle is provided; and on the bolts having been screwed for the requisite length, the dies are withdrawn by turning the cam-plate, and the slide run back, leaving the bolt clear for removal. The man or boy

working the machine has thus but a few very simple movements to perform, and the machine is therefore capable of turning out work very rapidly. With the stop once properly adjusted also, it is scarcely possible to turn out inaccurate work, as it is merely necessary to bring the radial handle against the stop to ensure that the bolts shall be screwed to the size required.

The arrangement of the die and cam plates affords great facilities for inspection and cleaning. The dies are held in their grooves by a plate secured by three screws, as shown in Figs. 2 and 3; and by slackening back these, and turning the plate partly round, it can be readily removed, leaving the dies, &c., fully exposed. The cam-plate also can be very easily removed, when necessary. The dies are kept well lubricated by oil, supplied from a can, and delivered between the dies, right on the top of the bolt which is being screwed. The casting carrying the dies and the saddle are so formed that the waste oil is delivered into the hollow bed of the machine, and from this it is drawn off as required by the neat arrangement of oil-cock shown on the right of the perspective view. Of course, the waste oil is mixed with the cuttings removed by the dies, and an ordinary cock, if used for drawing it off, would be likely to become choked. To avoid this Messrs. Smith and Coventry have adopted the neat little contrivance alluded to. It consists merely of a bent pipe jointed to the end of the bed of the machine, so that the end of the pipe can be directed either upwards or downwards. When the pipe is turned downwards, any oil which may be in the bed of course flows out through it; whilst when the pipe is turned upwards, its end is above the level of the oil. The bottom of the bed is made with a downwards inclination towards the pipe.

When the machine is to be used for tapping, the casting carrying the dies, cam-plate, &c., is removed, and the bracket shown by Figs. 6, 7, and 8 substituted. This bracket serves to hold the nuts to be tapped, the tap being carried by the main spindle. The arrangement will be readily understood without further explanation.

In the machine which we have described, the arrangement for carrying and adjusting the dies is particularly simple, and, indeed, the whole of the details are exceedingly well designed. The machine is made in several sizes, the largest being capable of screwing bolts up to 3 in. in diameter. Our engravings of it have been prepared from tracings with which we have been supplied by Messrs. Smith and Coventry.

STEERING-ENGINE FOR THE NORTHUMBERLAND.

THE Lords of the Admiralty have ordered Messrs. G. Forester and Co., Liverpool, to fit the Northumberland with automatic steam steering-gear on Mr. McFarlane Gray's patent similar to that applied by them so successfully to the Great Eastern. This was illustrated in *ENGINEERING* of June 7th this year. In our description the word *hydraulic* should have been *automatic*. The hydraulic modifications of the invention, for which we have the drawings, had to be omitted from the illustrations for want of space; and as the Great Eastern's is alone represented, the letters R, S, and T should be omitted in the reference index. A further description of this steering-gear was given in this journal, in the third volume, page 448.

The steering-gear of the Great Eastern is not a hydraulic apparatus; it is steering entirely by steam, and the distinguishing feature is the introduction of a simple differential apparatus, which controls the engine automatically. Our illustrations showed winding gear and telegraph apparatus attached to the steering-engine, as they were actually constructed for the Great Eastern; but that for the Northumberland will be only a steering-engine, and would be represented by omitting from our illustrations the parts lettered E, F, G, H, and O, which will greatly simplify the machine.

BREECH-LOADERS.—In reply to a question by Lord Elcho, Sir John Pakington stated in the House, the other evening, that the prizes awarded by the committee, nominated last year at Lord Elcho's instance, were not to be considered as determining the arm to be adopted into the service. Of one hundred breech-loading rifles sent in for competition, seventy did not comply with the terms of the advertisement. Sir John was disposed, if it could be arranged, to have some or all of these seventy tried also, and thus to obtain further elements for a final decision as to which is really the best arm for the British soldier.

THE FRENCH-AMERICAN ATLANTIC TELEGRAPH.—M. Pinard, the new French Minister of the Interior, has granted to MM. Delessert, Frederick C. G. Ritsa, and others, promoters of the Franco-American Telegraph Company, the exclusive right for a term of years to do all telegraph business between France and the United States of America, and no other concession exists.

YOUNG'S PARAFFINE WORKS.

(Continued from page 479.)

THE crude shale oil is a mixture of the different kinds of hydrocarbon and of a great number of impurities, which give it a dark colour and a dirty appearance. The impurities are removed by repeated distillation and alternative washing with sulphuric acid and caustic soda. The different ingredients of the purified oil are separated by what is called fractional distillation, *i.e.*, by separately catching and condensing the vapours coming from the still in succession, the more volatile products coming first, and the heavier portions at a later stage. The proportion in which the different kinds of oil exist in the crude shale oil was shown by Mr. Young in one of his illustrative groups of samples at the Paris Exhibition. The quantity of crude oil from 6 kilogrammes of shale being ≈ 1.065 litres; the contents are given by the following figures, *viz.*:

Burning oil	...	...	0.468 litre
Lubricating oil	...	...	0.092 "
Naphtha	...	...	0.016 "
Paraffine	...	...	76.2 grammes.

The machinery and apparatus for refining the shale oil at the Addiewell Works we understand to have been made by Messrs. Norman and Co., of Glasgow; but there is a very complete boiler-maker's workshop belonging to the paraffine works, where a great number of the wrought-iron stills and boilers have been made, and where all the repairs are executed. The crude oil is pumped from the reservoir, where it first collects and settles into tanks elevated to a height of about 20 ft., and it is run from these tanks into the refining stills simply by opening the cock of the feed-pipe. The stills for the crude oil are plain cylindrical boilers, 7 ft. 6 in. diameter and about 9 ft. long, placed on end, and fired from below. They are sixteen in number, and each is filled once in forty-eight hours, on an average. The volatile products distil over, and are condensed in long pipes running zigzag through a shallow water-tank, each still having its own cooling-pipe immersed in the same great reservoir, which serves for the whole row of stills. The lighter portion of the oil being removed in this manner, there remains at the bottom of the still a thick heavy liquid, which, when accumulated to a sufficient height, about once every week, is drawn off to another set of similar stills for extraction of the solid paraffine. Below this heavy liquid another product of the first oil-still collects, and this is a solid, pure, and uniform coke of very superior quality, which is much in request by copper-smiths, brass-founders, &c. The products of first distillation are conducted in pipes to the building which contains the apparatus for purification. This building is placed at a considerable distance from those parts of the works where fires are maintained; it is divided by a central partition, forming the engine-room, into two tracts of about 150 ft. each in length, and it is covered by a roof in two spans of about 30 ft. each, supported on the outer walls and on a row of cast-iron columns. The machines throughout this entire building are exact repetitions of one type—*viz.*, a cylindrical cast-iron tank placed about 6 ft. above the floor level, and carrying a vertical spindle in its centre, on which a set of agitators is made to revolve so as to mix the liquid contents of the tank. The motive power is obtained from a central shaft running all along the building, and twelve such machines are placed in each wing of the building in two parallel rows of six. Below each mixing tank are three settling reservoirs of similar size and appearance to the former, only without any agitators. The same kinds of machines serve for the mixing with sulphuric acid and for the caustic soda, and only the filling cisterns, or "measures," from which the chemicals are discharged into the tanks are different, those for holding sulphuric acid having a lead coating, while the others are of plain cast iron. The action of sulphuric acid in contact with crude paraffine oil is to destroy the colouring organic substances mixed or contained in it. The acid does not attack the paraffine itself, and it separates from the oil when allowed to settle by the difference of gravitation. The caustic soda is wanted for removing any remaining traces of sulphuric acid, and also for taking out the carbolic acid contained in the oil. It separates from the oil, the same as the acid in the settling tanks. The process of distilling and washing with sulphuric acid and soda is repeated three times in succession, and for this purpose the oil is carried through pipes to a series of large stills or boilers, 8 ft. 6 in. diameter and 22 ft. in length each, and after each distillation, pumped back into another mixing apparatus of the purifying-house, the arrangement being such as to make

the oil take its course through machines and stills placed behind each other in straight lines, as it enters its different successive stages of refining. Each distillation shows the same results, and affords the same facilities for separating the lighter and heavier materials from each other, and for collecting those of a similar character. The ultimate products and their relative proportionate quantities we have already named, and their properties are too generally known to require further description.

The separation of the solid paraffine from the heavy oil containing it, and the subsequent purification of the former, is another important branch of Mr. Young's great invention. The machinery and plant for this process, although in course of construction at Addiewell Works, is not yet completed, and we refer, therefore, to the establishment at Bathgate for the details connected with this branch. According to the different melting-points of the different varieties of solid paraffine, to which we have already alluded, the temperature of solidification varies within a very wide range. Some kinds of heavy oil produce crystalline flakes of solid paraffine at the atmospheric temperature; others at a slightly lower temperature; while some oils require refrigeration to 10° or 15° Fahr. below the freezing-point of water, *i.e.* to 20° or 15° Fahr., before they will allow the dissolved paraffine to crystallise. Some oil, having parted with part of its paraffine at a higher temperature, may be made to yield a further quantity by refrigeration, and consequently the means for cooling the oil artificially have become of primary importance for the manufacture of paraffine. The most successful refrigerating-machine is that invented and patented by Mr. Kirk, who formerly was the chief engineer of Mr. Young's Paraffine Works. We, in one of our earliest numbers (see vol. i. of *ENGINEERING*, pages 62 and 124), described and illustrated Mr. Kirk's refrigerating machine, and we now refer to that description for all the details connected with this machine. The machine at Bathgate works with eminent success, and a new and much larger machine of the same type is about to be fitted up at the Addiewell Works. The cold-transmitting agent which circulates between the refrigerating machine and the paraffine oil is salt brine, and the solid paraffine is collected upon a large revolving table or disc, cooled by this brine from below. In its crude state, the paraffine forms yellow crystalline scales of somewhat dirty appearance, and mixed with a quantity of heavy oil adhering to the crystals. The separation from the liquid is effected by mechanical pressure, the mass being first filled in bags and exposed to a moderate pressure, and afterwards piled between flannel sheets and subjected to the action of a hydraulic press, which effectually removes all liquid matter from the solid paraffine. At Addiewell upwards of thirty hydraulic presses, some made by Messrs. A. and O. Steven, of Stirling-road, Glasgow, others by Messrs. A. Moore and Son, are in course of erection for the extraction of paraffine. The colouring matter contained in the crystals is removed by repeated dissolution in naphtha, and subsequent removal of the latter by pressure. This process is repeated three times, each successive stage producing a finer solid mass, which ultimately has a perfectly white colour. A final treatment is required for removing any traces of naphtha, which would give an unpleasant smell to the paraffine. This removal is effected by melting the paraffine, and passing steam through it. The mechanical action of the steam carries the volatile naphtha with it out of the liquid mass, and when allowed to cool the refined paraffine presents the aspect of one of the finest, clearest, and most homogeneous substances at present known. The principal application of solid paraffine is the manufacture of candles, and this last stage of the succession of processes is in full operation at the Addiewell Works. The machines for forming or casting candles are of American origin, and of a very simple and ingenious construction. The paraffine is run into the candle-moulds in the liquid state, and removed after solidification by a simple mechanical movement. The candles are occasionally coloured, care being taken to select combustible colouring substances, such as aniline dyes, in order to prevent the formation of ashes due to the incombustible mineral colours. Some of the oil squeezed out of the solid crystals of paraffine has for a long time past been considered as a refuse, it being too thick to be used as lubricating oil, and still incapable of yielding any more crystallised paraffine. Mr. James Young, jun., the son of the founder of the paraffine industry, has succeeded in utilising the material by a process patented some two years ago. It consists in distilling the heavy oil under pressure, and the result is the conversion of this material into lubricating

or burning oil or naphtha, according to the temperature and degree of pressure maintained. The pressures now in use vary from 1 to 1½ atmospheres.

Paraffine industry has, since 1850, become one of the most important sources of wealth and prosperity in this country and elsewhere. The mineral oil manufacture of this country amounts at this present moment to an annual production of 10,000,000*l.* in value, exceeding, we believe, that of all other chemical manufactures put together. There are many great works in Scotland, Wales, and in some parts of England making mineral oils from coal, bituminous shales, and from natural petroleum; and large engineering establishments, like the Kinning Park Foundry, in Glasgow, and some others, are exclusively employed in making the plant and machinery required for oil-manufacture. Manufacturing districts have come into existence on formerly uninhabited land, and whole populations have grown up dependent upon this new industry, and maintained by it. This whole great accomplished fact, due to the talents, the perseverance, and industry of one man, is a magnificent creation in itself—a new world of labour and prosperity. It will form the great monument of James Young in time to come, and it will carry his name down to future generations.

PROPOSED RAILWAY BETWEEN RANGOON AND CHINA.

ALTHOUGH the English Government has now, for many years past, consolidated its power in the East Indies, it is a subject of no small amount of astonishment that up to the present time there is no direct commerce between the British possessions in the East and the western provinces of China, although their borders lie within two hundred and fifty miles of each other. In order to reach those provinces, a detour of several thousand miles, by sea and river, is needful; and this, by a direct land communication, would be reduced to a few hundred miles. Not only would a railway communication between the British possessions and China secure immense advantages to both England and India, but it would give to the Chinese visible working proofs of the advantages of railways and telegraphs, without which they are never likely to adopt these inventions. Various routes have from time to time been proposed for effecting such a communication with China, and, amongst others, one from Upper Assam, which would prove peculiarly advantageous to the tea-speculators in that district; but the subject of our present notice is the project for a line from British Burmah. Should the hopes of the friends of this enterprise ever become realised, there can be no doubt that Rangoon would then become the most important and thriving port in the whole of our eastern possessions. It cannot be denied that some substantial support, in the shape, probably, of a guarantee of interest on the required capital, would be looked for from Government, by any parties who might wish to undertake the construction of such a railway. What the cost would probably be it is impossible to estimate in the absence of even any experimental survey of the entire line. The only objections raised to the undertaking, so far as we are aware, have been on the grounds of a fear lest it should lead to political complications with the King of Burmah; but these, we feel assured, will not bear much scrutiny, and that they must fade away into insignificance before the highly important results, political as well as commercial, that the construction of such a line would be sure to secure us.

The construction of a line of railway between Rangoon and the district of Yunau, in China, was, we believe, first proposed by Captain Sprye, a retired officer of the Indian army, some ten or twelve years ago, soon after the annexation of Pegu and Martaban. The object of the line then proposed was to open up a commercial communication with the friendly Shan States lying to the north-east, and through them to reach the western districts of China. The railway was to start from the port of Rangoon, and to run across eastern Pegu and the Burman Shan State of Kiang Tang, to Kiang Hung, on the right bank of the Meikong, or Upper Kambaja river, near to where it issues from the Chinese western province of Yunan, a navigable stream for deep-laden boats; and it is considered that both India and England could not fail to benefit very largely from the realisation of this design. Without taking into account the rich and well-peopled Shan States, the six most western pro-

* Some very well written accounts of the modern state of paraffine industry in Scotland, by Mr. John Mayer, F.C.S., have appeared in the *Glasgow Morning Journal*, and have, we are informed, been transferred to the columns of other publications without acknowledgment of the source.

vinces of China, which it is proposed to open, contain an area of 551,773 square miles, with a population of 93,651,778, and 428 cities. The two most western of these provinces, and consequently those nearest to British Burmah, viz., Yunan and Szechuen, alone contain more than 38,000,000 of people, and are known to yield, with numerous other valuable products, gold, silver, mercury, cinnaabar, vermillion, copper, iron, and coal; tea and silk; wool and goats' hair; sables and other furs; wheat, rice, and millet; rhubarb and other valuable drugs; indigo and other dyes; insect-wax, bees'-wax, the tallow and oil trees, and petroleum; honey, cinnamon, lemons, oranges, and pomegranates; variegated marbles of great beauty; horses and mules; skins and hides; the grass-cloth, or rhea plant, jute, and other textile fibres: products which it would be but natural to consider would be provided in any quantities necessary to pay for British and Indian goods, suited both to the people of the north and the south, to whom the Chinese traders would actively convey them. With regard to the disposition of the people to deal with us, it appears from the report made by Captain McLeod, assistant commissioner, at Moulmein, to the Government of India, of his mission in 1836-37, to the Burman Shan States of Kian Tung and Kian Hung and the west of China, that the ruling princes of the two Shan States, their ministers, chiefs, and people, received him with the most marked cordiality and rejoicing, gave their ready concurrence to the opening of a commercial way from the British Burman frontier to China across their states, and even through their capitals, proffered every facility and assistance that they and their people could render to the work, promised that British merchants should pass to and fro through their territories free of transit duty, and declared that everything their countries produced should be at the disposal of our merchants—excepting only women and children for sale into slavery, for which purpose they are sometimes carried off by Siamese marauders. Subsequent inquiries have further shown that the rulers of these Burmese Shan States are fully alive to the importance of a dependence on the British Indian Government, which they would greatly prefer to their present subjection to the king of Ava.

For more than ten years the proposition has been urged by Captain Sprye, and his son, now deceased, upon the Indian and home Governments, and the subject has since been ably taken up by Captain J. M. Williams, of the Bengal Staff Corps. From 1861 to 1865 no less than twenty-six memorials in favour of the proposition, and praying for a survey of the country, were addressed by the principal chambers of commerce in this country to the ministers of the day. But Sir Charles Wood, at that time Secretary of State for India, co-operating with the Foreign Office, always discouraged the enterprise, and the replies received were all of an unsatisfactory character. Upon the accession of Lord Derby to power, the Chambers of Commerce of Yorkshire and Lancashire addressed a fresh series of memorials to the new premier on the subject. These were eleven in number, making thirty-seven in all. Upon receipt of the earliest of them, the Cabinet took the question into consideration, and the result was a despatch from Lord Cranborne to the Viceroy of India, dated 29th September, 1866, directing that a survey of the line should be effected. On the 8th December following, Sir John Lawrence answered the despatch, objecting to the survey; whereupon Lord Cranborne, on the 7th February last, addressed a rejoinder to the viceroy, disposing of his excellency's opinions, and repeating the order that the survey should be made; and Sir John Lawrence had, accordingly, no alternative but to order a surveying party to be formed, and its direction was given to Captain J. M. Williams, A.I.C.E., and Captain C. H. Luard, R.E. By this time a good part of the dry season had been lost, and even then the surveying party were not adequately equipped. Their operations, however, up to the setting in of the rains in July, when the party had to return to Burmah, were highly favourable, the first two hundred and fifty miles having been surveyed with most satisfactory results.

The country from Rangoon to the Sittang river is practically level, and is drained by numerous small creeks which fall into the Pegu and Sittang rivers. East of the Sittang, hills, which are extensions of the Himalaya range, reach southwards, almost as far as the town of Beeling; what level ground there is being confined to the immediate neighbourhood of rivers and the larger streams. The hills, running north and south, form the watersheds of the Sittang, Beeling, Youzaleen, and Salween rivers, the three rivers first mentioned, and their watersheds must be crossed by any route taking a direct line to the British frontier

on the north-east. Two routes were examined by the surveying party—one by Shoaygyeen, crossing the watershed on the Thekay-doung range to the east of Shoaygyeen; the other passing south through Kyketo, and entering the Beeling valley a little to the north of the town of that name, but instead of crossing the hills of the Sittang watershed, passing round their base. These two routes coincide from Rangoon to Pegu, and also from the 166th mile on the Beeling river northwards to the Pah Choung.

After leaving Pegu, the first obstacle to be encountered is the Pegu river, 300 ft. broad, which might be bridged without difficulty. The passage thence across the Pegu plains is easy, and an embankment of from 2 ft. to 3 ft. is all that would be required. From Pegu the Shoaygyeen route takes the direction of Shoaygyeen, and near that place crosses the Sittang river, which is about 1040 ft. broad. From the east of this river the route passes through a fairly easy country for twenty miles, when it nears the Thekay-doung range, which is the watershed of the Sittang. This offers a difficult obstacle; but, having crossed the range, the route descends into the Beeling valley, where it joins the alternative or Beeling route.

The Beeling route, after leaving Pegu, takes the direction of Sittang, crosses the river, at that point 1520 ft. broad, near that town, and thence passes by Kyketo into the Beeling valley a little north of the town. By following this course, the Beeling route, though about ten miles longer than that by Shoaygyeen, avoids the high watershed on the Thekay-doung. From Beeling the route passes alongside the river, finally joining the Shoaygyeen route, as before mentioned. To reach that point with the fewest engineering difficulties the river must be crossed twice in order to avoid spurs which come down to its edge; but as in this neighbourhood it is only about 300 ft. broad, bridges would not be a serious expense.

From the point of junction, the common route passes through an easy country to the Beeling watershed, crosses this and passes up the Youzaleen valley on the right bank of the river; at a point about 12 miles above Paphoon, the route crosses it and approaches the Youzaleen watershed. This, with the country between it and the Pah Choung (the British frontier), are the serious difficulties which have to be encountered, necessitating under favourable circumstances an ascent by a gradient of about 1 in 30; but unless the eastern spur of the mountain range were made use of, it would be little less steep than 1 in 17.

The Shoaygyeen route, though the shorter, is more difficult than that by Beeling, which is 245 instead of 235 miles in length. Either route has to encounter 40 miles of difficult country between the upper portion of the Youzaleen valley and the Pah Choung, but until that is reached the Beeling route meets with no serious obstacles.

It was recently stated in one of the home Indian papers, that orders had been sent out for a suspension of the survey; but, since that statement appeared, a telegram from India, in the *Times* newspaper, announced that orders had been given for its continuance. Whichever may be the correct representation of the present state of affairs with reference to this highly interesting survey, it is to be hoped that no short-sighted policy or mistaken political views may arise to put a stop to a work, scarcely yet commenced, which met with such continued opposition before it was permitted to be undertaken.

MUSEUM OF FIREARMS.

A MUSEUM for the permanent exhibition of all varieties of firearms and their accessories has just been established adjoining the Rye-lane Railway-station, Peckham. The museum has been established for the purpose of showing, free of charge, specimens of every known principle and system applied to guns, rifles, carbines, pistols, and all other small arms; also samples of all explosive compounds, projectiles, cartridges, cartridge-cases, cartridge-machines, wadding, &c., &c., with the accessories, implements, and tackle used therewith; also models and illustrations of the various contrivances for the successful breeding and rearing of game, vermin-traps, and poaching preventives; in short, nothing will be omitted that can possibly interest the shooter. A shooting range is attached to the museum, for the trial of small-arms, new or improved explosives, projectiles, &c., &c., provided with instruments and appliances for correctly and scientifically ascertaining their relative and comparative merit as regards velocity, penetration, pattern, recoil, and other important elements necessary to the perfection of really useful and efficient weapons. The library will contain the principal standard works on firearms, explosives, projectiles, the game laws, the theory, science, and practice of shooting; dog-breaking; the breeding and rearing of game; also the specifications of patents for firearms, and copies of those journals which more especially devote their pages to these subjects. Books are kept in which are recorded full particulars of all estates and shooting-quarters to sell or let; dogs, game, and

other shooting property for sale; gamekeepers and watchers wanting situations; also the pedigree of celebrated shooting-dogs. The institution will further collect, for the use of subscribers, information on all new and improved principles, processes, and inventions which have reference to firearms; on the bearing and influence of the game laws; the prospects of the shooting season, and all kindred matters.

It is further intended, so soon as the opinion of the supporters of the museum shall have been obtained, to form and develop an association for the more effectual suppression of poaching, illicit traffic in game, and similar evils. It is felt that a united and powerful association, under the management of a central and permanent institution—whose special business it is to watch the interests of its subscribers, to receive and circulate information, undertake prosecutions, and endeavour to improve, as well as apply, existing laws—will be much more likely to secure the objects proposed than any local or temporary society.

The subscription is one guinea per annum, which will entitle the subscriber, 1st, to have free admission at all times, when open, to the museum, shooting range, and library; 2nd, to be entitled to the advice and assistance of the institution on matters compatible with the objects for which it is established; 3rd, to have the opportunity of using the registers as a medium for the obtaining and transfer of all descriptions of shooting property, free of charge; 4th, to have their small-arms tested and certified, free of charge; 5th, to be informed of all important improvements and other matters interesting to the sportsman. We believe that this museum is likely to meet with extensive support.

LECTURES UPON CIVIL ENGINEERING.

We observe that Professor Fleeming Jenkin is about to begin his second course of lectures at University College, Gower-street, on the 4th of December.

During the past two years, at University College, Gower-street, Professor Pole, who occupied the chair of Civil Engineering, had formed no class, and there seemed some danger of the total extinction of one of the attempts made to give a public technical education to engineering students. We therefore observe with pleasure that Mr. Fleeming Jenkin, who lately accepted the chair vacated by Professor Pole, has delivered one course of lectures, and now announces a second course (on "locomotives"), having, we understand, met with some encouragement by a fair attendance at his first course of lectures on "bridges."

Lectures on general engineering can hardly be made very instructive unless they are either extremely numerous or are supplemented by very hard reading on the part of the students. It is difficult to say where engineering, as a study, begins and ends. The duty of the engineer is to apply to practical problems the theoretical information which he gains by the study of mathematics, physics, chemistry, and geology. To do this he requires a partial acquaintance with the properties of materials which can only be gained by experience, such as a very lucky pupil may sometimes get in an engineer's office or in a workshop. Most men begin to gain this experience when first put in charge of work. No instruction can ever supersede the necessity for this experience; but lectures may at least show how the various principles and results of the science are applied by the practical engineer. They can show the student what he has to learn, and can draw his attention to the works already executed in which the application of those principles is best exemplified. This, in the prospectus issued by Professor Jenkin, is the programme which he puts forward.

His plan of subdividing his whole course will probably be found convenient. Instead of a connected course of fifty or sixty lectures, in which a large number of subjects are handled in a somewhat cursory manner, he takes some limited subject, such as "bridges," for civil engineering, or "locomotives" for mechanical engineering. On each subject he proposes to deliver about ten lectures, in the course of which he will be able to treat the various subdivisions of his subject with some completeness; for instance, any student, who had really understood and could apply the printed notes given him with the ten lectures on bridges, would have a fair knowledge of how calculation was applied to bridge work, and of the kind of experience it would be necessary for him to acquire by observation.

The prospectus for "locomotives" promises equally complete treatment in the lectures, which will begin on the 4th of December. The subdivision of the lectures into short sets will also be convenient for engineers' pupils from outside the university, who may choose those subjects which specially interest them without paying high fees for a long course.

If, however, University College is to educate engineers, it must add considerably to its yearly programme. We understand that the governing body has sanctioned the establishment of a drawing class, in which mechanical draughting may be taught.

A good workshop, such as King's College possesses, and perhaps a class of applied mechanics, are required in addition to the teaching now given. The class of surveying and levelling must also become a reality. Professor Jenkin is, no doubt, aware of these deficiencies, and we hope may be able to remove them.

Further information as to Professor Jenkin's course will be found in our advertising columns.

ANCIENT ORDNANCE.—The Army and Navy Supply lately took two large Armstrong guns to be sent thence to the Dardanelles to be exchanged for ancient and very large gun of great historical interest at the Dardanelles, which will be taken home by the *Terrible* as a curiosity. This monster gun weighs from 12 to 15 tons, is 12 ft. long, and 30 in. to 36 in. in exterior diameter. It was one of the pieces of ordnance used in the memorable siege of Constantinople by Mahomet II. in 1463, and has been presented to the British Government by the Sultan.

ANVIL BLOCK (WEIGHT, 210 TONS) AT THE BOLTON IRON AND

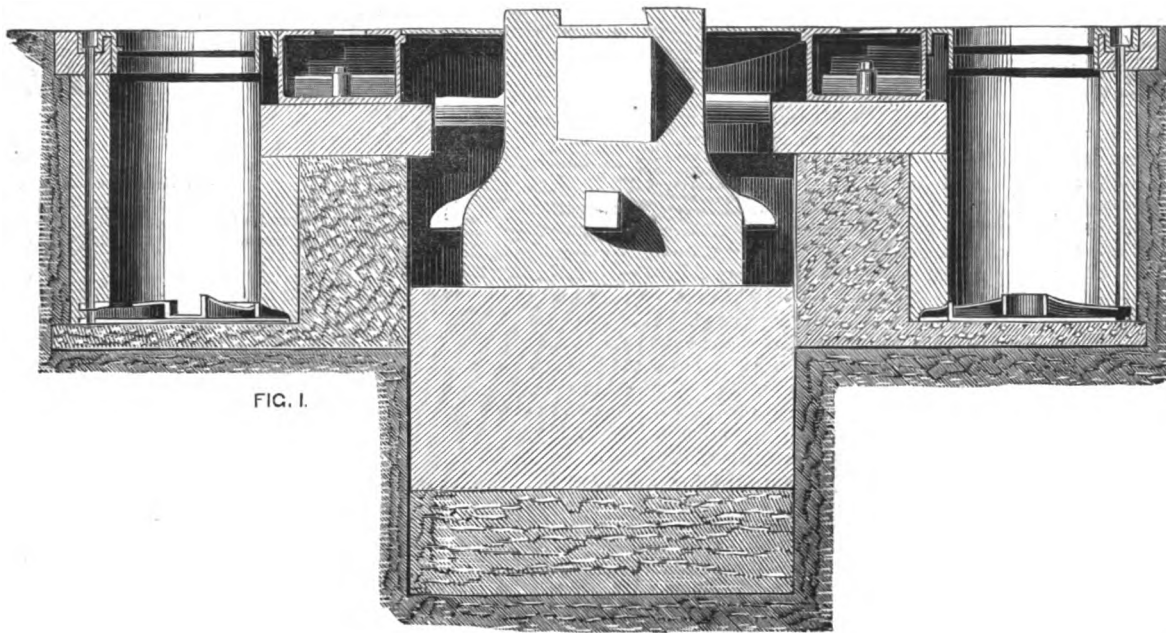


FIG. 1.

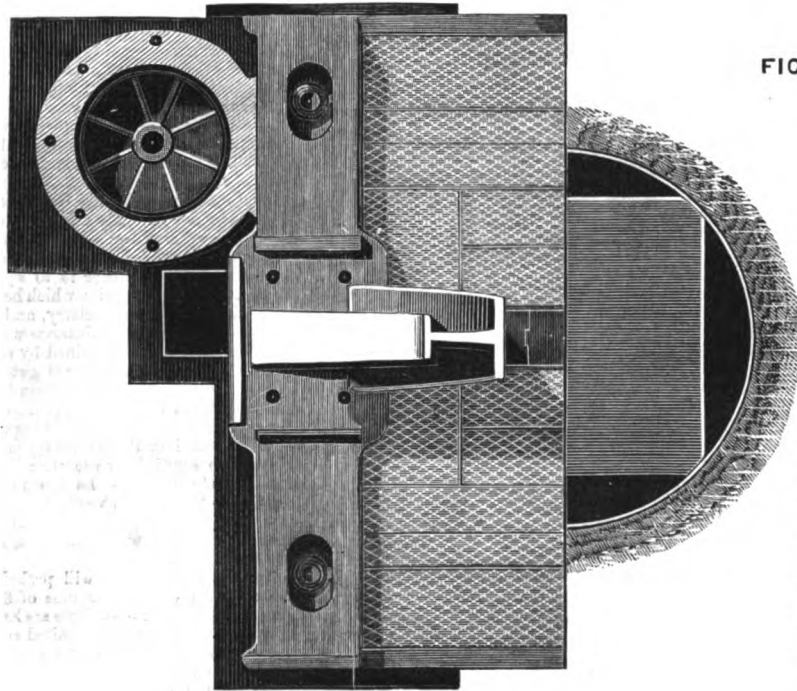


FIG. 2.

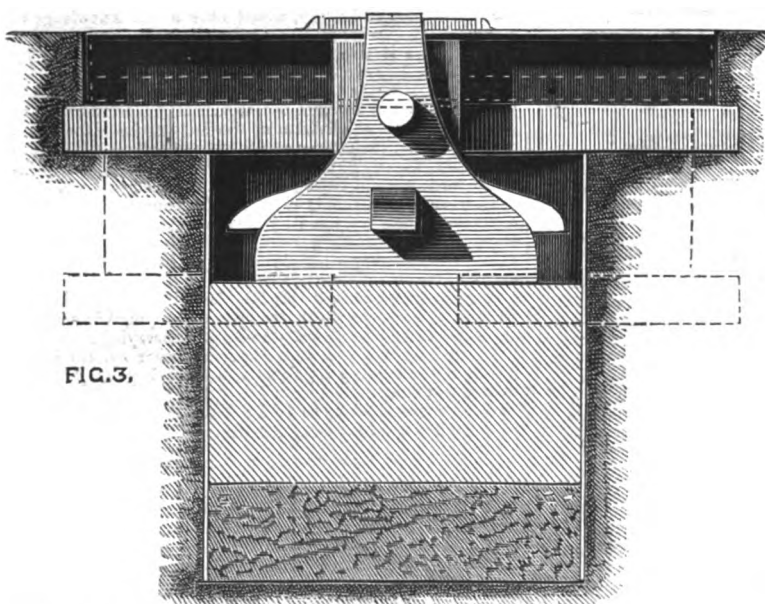


FIG. 3.

SCALE 1/96 FULL SIZE.

The weight and the size of that weight in the annular engravings, is the largest single casting which has ever been made. This block belongs to a steam hammer used at the Bolton Iron and Steel Company's works at Bolton, for hammering steel ingots, the hammer, which was made by Messrs. Nasmyth, Wilson, and Co., having a 25-ton head, falling 9 ft. The foundations for the hammer standards are shown in our engravings, which comprise a longitudinal section, transverse section, and plan. The block, the shape of which is shown by the figures, is a casting 12 ft. square on the base by 11 ft. 6 in. high, and it was cast at a horizontal distance of 16 ft. from its present site, in an inverted position. The casting was made by the aid of two of Ireland's patent cupolas, and the operation was conducted under the direction of Mr. J. Ireland, who has great experience in this class of work.

The two cupolas used at Bolton had wrought-iron casings 7 ft. in diameter and 22 ft. high; and the charging doors were 16 ft. above the ground level. The furnaces, when bricked up, were 3 ft. 8 in. in diameter across the tuyeres, widened out below to 5 ft. 6 in., and above to 5 ft. There were twelve tuyeres in each furnace—four at the bottom, each 8 in. in diameter, and eight upper ones, each 3 in. in diameter. The blast was supplied from the blowing-engines used for the Bessemer process, and it was conducted to the furnaces through cast-iron pipes 15 in. in diameter. The pressure at the furnaces was equal to a water column 14 in. high.

In commencing operations, the charges consisted of 50 cwt. of metal to 8 cwt. of coke; and for the first fifty charges, from 3 cwt. to 4 cwt. of scrap Bessemer steel were put in along with each charge, in addition to the above-mentioned weight of iron. In the afternoon the proportion of coke in the charges was reduced to 2½ cwt. for the same weight of metal. The two furnaces were each filled with melted iron up to the level of tuyeres before the first tap was made, and throughout the operations the iron was allowed to accumulate in the same manner before being let out. There were runners from the furnaces to the side of the mould, where a perpendicular gate was formed down to one of the two trunnions, which were cast on the block, as shown in the engravings. The use of these trunnions will be explained presently. The metal thus ran into the mould through the trunnion; and all the metal was run in in this way, and none over the top. The effect of this method of proceeding was that each fresh lot of metal that was run in after the mould had been filled up to the level of the trunnions welled up through that previously poured, and the whole mass was thus kept in a molten state until the mould was full. The casting was a perfectly successful one.

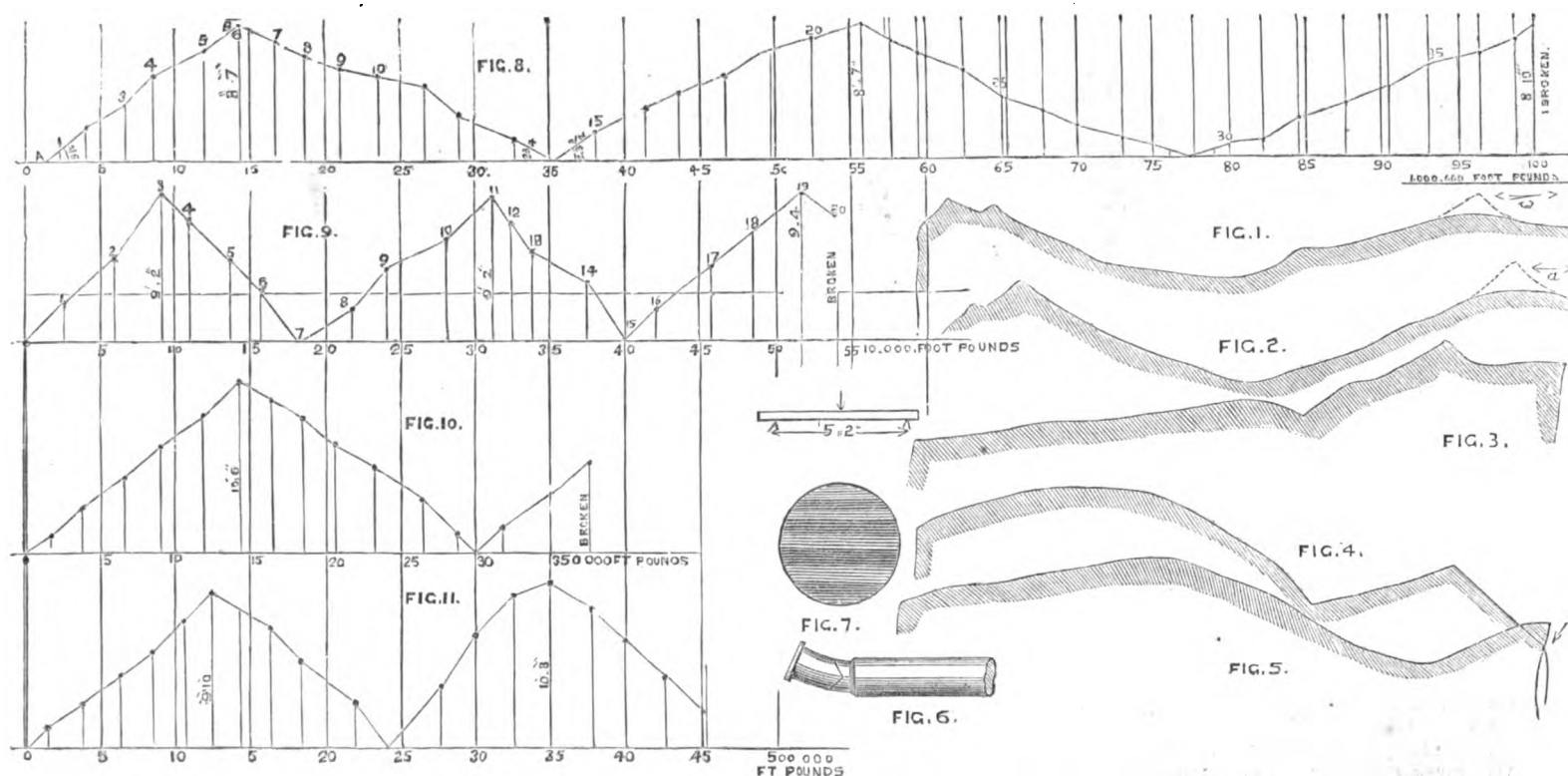
The total time occupied in melting was 10½ hours, but from this time must be deducted two hours during which the men employed in charging the furnaces were taking refreshments, and during which the blast was shut off. The time actually occupied in melting the required quantity of iron was thus but 8½ hours. The mould was built up of brickwork, lined with loam, and we believe that nothing was placed at the bottom of the mould to break the force of the falling iron, as from the latter being led in at the trunnion, it only fell about 4 ft. A large quantity of charcoal was, however, put into the mould before pouring the metal, and this floated on the latter, and kept it from chilling. The brickwork of the mould was not removed for a month after the casting was made, although the sand was dug from around it the week after the metal had been run.

As we have said, the block was cast bottom upwards; and after the mould had been removed, and the necessary space cleared, brick walls and bearers were built up under the trunnions already mentioned, and the casting was then turned over on these trunnions, so that it hung bottom downwards. The trunnions are each 1 ft. 6 in. in diameter by 3 ft. long, and they are situated at a distance of 7 ft. 4 in. (measured to their centres) from the base of the block, so that when the latter was in the inverted position in which it was cast, there was a great preponderating weight above them. After being turned the right way up, powerful jacks were brought to bear on the block, and it was moved horizontally 16 ft. into its present position, where it is bedded in a thick layer of concrete and a cement made of iron borings and sal ammoniac. The arrangement of the foundations will be seen by our engravings, which have been prepared from a working tracing, for which we are indebted to the Bolton Iron and Steel Company.

ENGINEERS FOR INDIA.—In addition to the forty young engineers lately sent out by the Indian Government, thirty more are to be sent out for temporary service. This is substantially what we announced, upon authority, would be done, in an article "Work to be Done," in *ENGINEERING*, of October 11th last. There is no part of the world where the demand for properly qualified engineers is just now as great as in India.

UNDERGROUND RAILWAY IN NEW YORK.—Much attention has for a long time been given to the subject of an underground railway under Broadway, New York. Mr. T. Marr Johnson, who lately went to America for the benefit of his health, is now in that city, and we shall not be surprised to learn that his large experience in the construction of such works is being utilised there.

EXPERIMENTS ON THE "FATIGUE" OF BESSEMER STEEL.



WHILE a very few professional men and men "in the trade" in this country are trying to discuss the relative merits of Bessemer steel and of wrought iron in the spirit of a party contest, and while a so-called scientific paper is advising the profession to wait for a quarter of a century or a little longer in order to see whether the hundreds of miles of new steel rails now laid down will not be subject to spontaneous internal diseases, or attacks of worms, brought about by age, for "no one can exactly say what changes may be wrought in the nature of a rail," our neighbours on the Continent are patiently and steadily pushing on their careful experiments and truly scientific investigations of the properties of metals with that earnest spirit of abstract and precise inquiry which we have so recently learnt to respect and now find somewhat difficult to imitate.

The fatigue of metals, or the destruction of their cohesive power by a repetition of applied strains, is one of the subjects which have received attention only at a comparatively recent date. Mr. Fairbairn, we believe, was the first authority who drew attention to the difference between the power of resistance of an iron girder or beam to a simple strain and to the repeated application and removal of a load. Since then, numerous experiments upon the fatigue of iron, and most particularly of steel, have been made on the Continent, and have shown some unexpected yet remarkably uniform results capable of being reduced to very simple and concordant laws. We have given accounts of some of these experiments made by M. Wöhler, the chief engineer of the railway works of the Silesian State Railway in Prussia, on page 160 of the present volume. We have recorded that M. Wöhler has alternately bent and released bars of steel under loads closely approaching their elastic limits up to some twenty million times, and that fractures of such bars were exhibited at Paris showing no trace of an alteration of the grain from the original. Similar results have been obtained in the laboratory of M. Krupp's works at Essen, and we expect at some future time to record some of them. M. Knut Styffe, the celebrated director of the School of Mines in Stockholm, has also made and published experimental researches on the behaviour of cast steel and iron within their elastic limits, and under strains producing permanent sets. And last, but not least, M. Josef v. Stummer-Traunfels, the intelligent engineer of the Northern Railway of Austria, has made some very extensive trials with Bessemer steel axles, the results of which he has communicated to the Society of Engineers in Vienna, and of which we now give an account from the author's own manuscript and sketches.

M. Stummer was called upon to test the qualities of Bessemer steel axles with a view to their introduction

into the rolling stock of his railway, instead of iron. His experiments were all made with full-size carriage axles of equal form and dimensions, but of different kinds and qualities of materials; each axle was 6 ft. 8½ in. Austrian total length, and 4½ in. Austrian (1 Austrian inch = 1.037 in. English) in diameter; the bearings at each end were 6½ in. long, and turned down to 3½ in. in diameter. The mode of testing was the same as in general practice, viz., a weight falling from a measured height upon the centre of the axle, the latter being supported on cast-iron blocks at a measured distance from each other. But M. Stummer did not confine himself to record the weight and number of blows by which each axle was fractured, as is most frequently done; he proceeded cautiously, commenced with lighter blows, and measured the effect produced by each in succession. He succeeded in bending most of the axles to a considerable extent, and afterwards straightening them again by blows in the opposite direction; and the results he obtained by recording the effect of each single blow give a very clear insight into the character and behaviour of steel under different and repeated strains which exceed its elastic limits. The weights of rams used by M. Stummer were 653 lb. (German Zollfund = 1.0312 lbs. English) and 612 lb.; the distance between the supports was 3 ft. 3 in., and occasionally 5 ft. 2 in. Each axle was tested in the finished state, with its bearings properly turned in the lathe. The blows were first applied to the centre of the axle, and after complete fracture each bearing was tested separately, so that every axle was ultimately fractured at three points. The axles having been supplied by numerous manufacturers as samples for testing with a view to obtain contracts from the railway company, the number of tests made was very large, and the results are therefore all the more instructive. As a general result, M. Stummer found Bessemer steel axles to show, as nearly as possible, double the cohesive strength, in every sense, as compared with the best Styrian and British wrought iron; viz., the same weight falling from the same height produced only one-half of the deflection on the steel-axle; and to obtain the same deflection as with iron, the number of foot-pounds exerted by the falling weight had to be doubled. The effect of blows previously sustained was not, as expected, a reduction of resisting power, but, on the contrary, an increase. This latter took place at the expense of ductility, but within very narrow limits. A blow of about 30,000 foot-pounds applied to a new axle at once caused immediate fracture, while repeated blows, gradually increasing in force, could be applied up to a higher limit without producing the same effect. The form of the fractures, although apparently irregular, proved, upon closer comparison, to be of a remarkably uniform character.

M. Stummer was thereby led to the construction of diagrams recording the outline of each fractured piece from careful measurements of all characteristic projections and cavities. We reproduce, in Figs. 1, 2, 3, 4, and 5, some of the most instructive diagrams, showing fractures of Bessemer steel axles of different degrees of hardness, the arrows indicating the direction of the blows. Fig. 1 is the softest steel made from Carinthian charcoal iron at the Bessemer Steel Works at Heft, in a Swedish converter; Fig. 2, a harder specimen from the same works; Fig. 3, Bessemer steel, of a medium degree of hardness, made at Baron Rothschild's Iron Works at Witkowitz, in Austria; Fig. 4, a hard, and Fig. 5, an excessively hard and brittle Bessemer steel axle from the last-named works. The diagrams represent vertical sections through the centre line of the bearings broken through, as shown in Fig. 6; but the figure of the irregular line of fracture remains the same all across the width of cross section, so that each point in reality represents a straight line all across the fractured surface, as indicated in Fig. 7. The carbon contents were not ascertained by analysis; but from what we have seen of fractured specimens of Bessemer steel, we are almost tempted to put them down as somewhere about .2, .3, .6, .7, and 1.1 per cent. respectively.

A remarkable difference will be observed between the lines of fracture of the softer and harder kinds of steel. The point marked in each figure appears to separate the fibres in tension from those in compression, and represents, therefore, the neutral fibre. The position of this point lies nearest to the upper surface, or "top flange"—if we keep to the nomenclature adopted for the elements of a girder—in the hardest specimen of steel, and it descends gradually towards the lower line, or "bottom flange," the softer the steel is made. This indicates a varying rate or proportion between tensile and compressive strength of steel of different degrees of hardness, an important point, to which attention has been already called in one of the papers read at the recent meeting of the British Association in Dundee (*vide* ENGINEERING, present volume, page 238). The more or less irregular parts of the line of fracture at the upper end, marked *a*, in Figs. 1 and 2, is due to a primary crack or fracture ensuing at the compressed side before the final rupture of the whole takes place. These cracks are generally more prominent in the softer specimens, since the great ductility of the material affords a wide range for the elongation of the fibres in tension, exceeding the compressibility of the opposite fibres; but the harder specimens also show clear indications of the existence of such primary cracks. On the opposite side, *i.e.*, through the fibres under extreme tension, similar cracks are visible only

occasionally, and only with the softest kinds of steel; the harder specimens generally break right across, without a previous warning by primary cracks. There is another peculiarity about these lines of fracture, viz., the soft specimens show the opposite curves towards the point α , or neutral fibre. Taking this point as the deepest, the two more or less irregular curves which meet there are concave towards it in the soft steel axles, and convex in the hard specimens. This may be very clearly seen by comparing Fig. 2 with Fig. 4. M. Stummer has confined himself to recording this observation, which he has made in very numerous instances, and he has not ventured upon an attempt to explain this certainly not accidental coincidence. M. Stummer has also noticed the fact more fully brought to light by M. Wöhler's experiments, that the sudden changes of section or, in fact, all sharp corners in the outer form of the articles produce points of weakness: he has even observed the effects of the impression of trade-marks or names, which were stamped into the axles to a somewhat greater depth than usual, and which caused fracture of the axles at that particular spot. A somewhat similar observation, with regard to steel stay-bolts, induced M. Stummer to cut the threads off the projecting ends of steel stay-bolts used in the construction of Bessemer steel boilers for the locomotives of the Northern Railway, in order to avoid their cracking when rivetted over. We gave an account of this eminently successful expedient on page 66 of vol. iii. In order to compare the relative value of steel and iron axles with regard to their capability of resisting fatigue, M. Stummer had recourse to a graphical record of all those data which have a direct connexion with the work of extension and contraction within the elastic limits of the different materials. For this purpose he started with the hypothesis that the permanent set observed under strains not very much exceeding the elastic limit would be very nearly in proportion to the number of foot-pounds or the mechanical work expended in producing the permanent set. This assumption has been since then proved to be correct by the experiments of M. Styffe, at Stockholm, and has therefore ceased to be merely hypothetical. M. Stummer has furnished us with some of his graphical records, which we have reproduced in Figs. 8, 9, 10, and 11. The work of 10,000 foot-pounds is represented as the unit of the scale according to which the datum line is divided; the work of each blow, having been taken singly, is added to the work previously done, and the corresponding total deflexion is marked as the height of the vertical in Austrian inches and twelfths of an inch. Fig. 8 represents the behaviour of a Bessemer steel axle of very soft character, struck in the middle, and supported at a distance of 5 ft. 2 in. between the blocks. It was bent to a total deflexion of $8\frac{1}{2}$ in. by six successive blows, after which it was turned and bent straight by eight further blows of gradually increasing power. It arrived at the straight shape after having had 350,000 foot-pounds of work expended upon changes of its molecular arrangement. The axle was bent a second time to the same total deflexion of $8\frac{1}{2}$ in., taking seven blows for this and seven more for being bent straight a second time. The third deflexion went to $8\frac{1}{2}$ in., again requiring an increased force of blows, nine in number, and it broke upon being bent back the third time, having stood the effect of more than 1,000,000 foot-pounds, applied to the alteration of its molecular arrangement. The lines which connect the tops of the verticals in this diagram are straight, or nearly so, proving the proportionality of the deflection to the work expended; and the first line, A B, does not pass through zero, or X on the datum line, but crosses the latter at the point, A, the distance, X A, represents the elastic limit, or rather the work required for arriving at the first trace of a permanent set. The angle between the line, A B, and the vertical is a direct measure of what we call hardness of steel, or if we take its counterpart, i.e., the angle between the line A B and the datum line, we may call that a measure of softness. The greater this angle, the softer is the material. Comparing Fig. 8 with Figs. 11 and 12, the diagrams of the behaviour of iron axles from Wittkowitz Works, we find the angles much greater in the iron; still this softer material has not withstood one-half the amount of work before fracture ensued, in one case with 500,000 foot-pounds, in the other with 350,000. Fig. 11 is a hollow axle, obtained in the year 1856 from the Patent Axletree Company, of Wednesbury: it gave similar, only less regular, results than the solid iron axles. To return to the diagram, Fig. 8, it will be seen that the angle of softness is decreasing at every successive operation: it is 31° at the outset, falls to $25\frac{1}{2}^\circ$ after the first bending and straightening, falls to $24\frac{1}{2}^\circ$ and to $23\frac{1}{2}^\circ$ after the second

and third deflections. At the same time the work required to produce the first deflection up to $8\frac{1}{2}$ in. is not quite 150,000 foot-pounds; for effecting the second deflection of the same extent the axle required more than 200,000; and when bent the third time this axle took somewhere about 250,000 foot-pounds for a deflection of $8\frac{1}{2}$ in. This shows very clearly that, by repeated strains, *exceeding the elastic limits*, the strength of Bessemer steel is gradually increasing at the expense of its softness or malleability, but the changes are extremely gradual and within very narrow limits. Similar changes take place in the softest iron, as may be seen from the Figs. 9, 10, and 11, only the decrease of malleability is quicker and less regular than in the case of Bessemer steel. The inferior material, iron, independent of its smaller power of endurance, is for this reason of a more treacherous character, since its changes are always quicker, and very frequently more irregular, than those of Bessemer steel. We consider M. Stummer's experiments, and his ingenious mode of recording them, worthy of the most general attention and of imitation in this country. Let those who know no better boast of their ignorance, and make a barefaced acknowledgment of their own want of scientific knowledge a point of argument in professional matters. They cannot arrest the progress of the truly scientific and well-educated men in our profession, and their prejudiced protestations serve only as marks to show how far they are already behind.

ENTRANCES TO ABYSSINIA.

We have recently seen a *précis* of all available information regarding the several entrances to and routes in Abyssinia, drawn up by Captain R. G. Kennedy, from information on the subject obtained by Mr. Wynne, Colonel Merewether, and the further details contained in the works of Beke, Bruce, and Salt.

From this memorandum it would appear that there are in all five routes from the coast to Debra Tabor, viz., from Mussowah, Annesley Bay, Amphilla Bay, Edd, and Tajoura, which are as follows:

Route 1.—Mussowah, a part about 460 miles from Aden, possesses a good harbour and anchorage, and there would appear to be no difficulty about water or forage. Almost immediately after leaving Mussowah, the steep ascent of the range of mountains which forms the water-shed of the Mediterranean commences, but directly the summit of this range has been attained the whole country gradually slopes away towards Debra Tabor. A route suggested by Colonel Merewether, *via* Keaquor, is considerably easier than any other hitherto tried, and thence to Goota Felassee, Adowa, Antalo, and Sokota the road is comparatively easy, and through countries whose inhabitants might possibly side with us. Mussowah to Sokota may be reckoned from twelve to fourteen days' march. After crossing the Takazzay, the route rises to the surface of the water-shed between that stream and Lake Tzana, then crosses and recrosses the Tekken until Eburat is reached, when it takes a turn due south and reaches Debra Tabor. From Sokota to Debra Tabor may be counted as twelve or fourteen days. There are numerous ascents and descents along this part of the route, and water is not plentiful. The numerous reasons for preferring this route to all others are thus stated in Mr. Wynne's memorandum:

1. It is the route adopted by the commerce of the country.
2. It is known throughout to one European; in parts, to several.
3. As far as Antalo, the inhabitants might be counted on as allies.
4. By this route the ultimate destination of the force need not be determined upon until its arrival at Sokota.

Route 2.—The head of Annesley Bay, where the town of Zulla is situated, is distant from Aden by sea about 460 miles, or the same distance as Mussowah. The anchorage is good, and the expedition might be pushed to the very head of the bay. The road at the commencement of the route is very steep, but after reaching Halai it becomes much better. There are but few villages of any importance until close to Dixon, at the end of the sixth days' march. From Dixon to Adowa the route is simpler and more open; thence to Debra Tabor as in Route 1.

Route 3.—Amphilla Bay is distant from Aden by sea 340 miles. The harbour and anchorage are good, there is but little pasturage, and the wells for water are situated at a considerable distance (6 miles) from the landing-place. The thermometer averaged in December 78° . The road to Antalo is described as hilly for the first two days; on the third day came upon wells, and in five hours crossed the salt plain. On the fifth

reached Mount Senafe, which is exceedingly steep; sixth, passed through a beautiful country, and on the eighth arrived at Antalo; thence to Debra Tabor as in Route 1.

Route 4.—Edd is distant from Aden by sea 260 miles. The anchorage is bad, and the roadstead open and dangerous, especially when there is a southerly wind. The village is small, and grain and supplies of all kinds are scarce, as is also water. Colonel Merewether, in his reports, mentions Edd as one of the points from which an expedition might start, and draws attention to the possibility of its proceeding direct to Antalo, *en route* for Debra Tabor, crossing the salt desert in its line. Were this possible, it would be one of the shortest routes to the capital, and, once arrived at Antalo, the march to Debra Tabor would be identical with Route No. 1 from that point. But Salt, in his work, speaks of the road from Edd to Antalo as impracticable, and appears to have considered the only practicable route to have been *via* Madir, at the head of Amphilla Bay. This, of course, would at once condemn this route. On the whole, it appears that little is known regarding this route, except that the landing-place and harbour are bad, and supplies of all kinds scarce, which in themselves would be almost sufficient grounds for its abandonment.

Route 5.—Tajoura, a town situated on the northern shore of a bay of the same name, is distant from Aden 160 miles, and lies outside the Straits of Babel Mandel. The distance from Tajoura to Debra Tabor is about 350 miles; but were an expedition landed at the head of the bay, instead of at the town of Tajoura, 30 miles or more would be saved in the land journey. The road passes through or near the towns of Auradowe and Magdala, at which latter place the captives are confined. Dowe is distant from Tajoura sixteen days' quick or thirty days' slow (caravan) travelling, or, as it appears from measurement on the map, about 200 miles, and lies 50 miles east of Magdala, which place would therefore be 250 miles from Tajoura. Dowe lies on the edge of the highlands. Although this route has certainly been travelled, but little is known about it, save that, as its course lies through the lowlands, it is intensely hot; water is very scarce, and what there is is brackish. From Magdala to Debra Tabor is about 100 miles. Theodore is making a military road, and halfway, in an extensive plain, has founded a large camp or capital, at a place called Zebit. Between Zebit and Debra Tabor this road crosses the pass "Infat-Mawatsi," or "Gate of the Winds," at an elevation of 10,000 or 11,000 ft. above the level of the sea.

A WEST INDIA HURRICANE.—An eye-witness of the havoc caused by the late hurricane at St. Thomas says: "The wharfs which used to line the shore were gone, and every street blocked up with broken rafters, zinc roofs, bricks, boughs of coconut palms, household furniture, and debris of every conceivable kind. Houses even were to be seen standing erect which had been lifted from their foundations many yards distant and dropped down into some of the lanes running seaward out of the main street. A dining-room, forming the upper story of a wing of the house belonging to Mr. J. B. Cameron, Superintendent of the Royal Mail Packet Company at St. Thomas, had been in a similar manner whisked through the air and carried into a neighbouring garden; singular to say, on effecting an entrance, the lamps and decanters in the room were found to be unbroken. In one lane were to be seen, among tons of broken wood, an anchor, several cart-wheels, a pianoforte, and slabs of marble, which, when the storm was at its height, had been seen whirling round in the air like sheets of paper. Windows, though protected by bolts and hurricane bars, stout pieces of wood several inches square, had been dashed in, and not a wall but showed marks of the hail of stones and bricks which had battered it. A bombarded town could never have presented a worse picture of ruin and desolation."

ARTIFICIAL GRINDSTONES.—The evidence upon which the following statement is based appeared not long since, and for the first time, in *ENGINEERING*, and we now find it in the City article of the *Times*: "A correspondent announces as an 'important discovery' that it has lately been ascertained that a grindstone manufactured by the Patent Concrete Stone Company, Limited, at their works at Greenwich, is capable of performing the same amount of work in *sixteen minutes* that it takes a grindstone made from the hardest Yorkshire stone *eleven hours* to accomplish."

ABYSSINIA.—On the 29th of October, Colonel Merewether and his party, returned to Massowah, from reconnoitring the country to the southward, after a severe march of 130 miles. In the country they traversed—now for the first time visited by Europeans—they found but little water, and that in wells. In parts the thermometer ranged at 110° . The passes were through beds of torrents, with huge masses of rock on every side. The landing-pier at Zulla, 350 yards long, was finished, and a great portion of tramway had already been laid down. We may expect, therefore, to hear of it having been completed to the foot of the mountains very shortly.

THE EAST LONDON MUSEUM.—Lord R. Montagu has obtained leave, in the House of Commons, to bring in a bill for the acquisition of a site for this institution, to which 5000*l.* were voted last session.

ENGINEERS FOR INDIA.

It is now upwards of twelve months since the more vigorous prosecution of irrigation works was determined on by the Government of India, but as yet we are not aware that any very prominent steps have been taken towards actually carrying that resolution into effect. An explanation for this undoubtedly may be sought for in the present numerical inefficiency of the public works establishments throughout India, which are, we believe, in each presidency, below even their former established strength. It will be remembered that the number of appointments offered for competition in July last was altered, after the issue of the usual advertisement, from twelve to twenty-five; and instead of an interval of twelve months being permitted to intervene before the next examination, we find that the Secretary of State has offered twenty-five more appointments to be competed for next month. That examination will commence at the India Office on Monday week, and we observe from the printed particulars issued respecting it that testimonials of intending candidates will not be received after the expiration of the present week. Should the full number of twenty-five qualified candidates be obtained on that occasion, there can be little doubt that the pressing exigencies of the service will scarcely be adequately met by such an augmentation to its strength. Irrigation works, if they are to be carried on with anything like vigour, will require the exclusive services of a complete and distinct establishment to itself, quite irrespective of the existing Public Works Department; and we hear it stated that, with a view to meet this extra demand, an advertisement will shortly be issued from the India Office for the services of not less than thirty more experienced engineers, to be temporarily engaged at somewhat higher rates of salary than those given to successful candidates at the usual competitive examinations.

IMPROVED GABIONS.

By direction of the Secretary of State for War, a committee of officers of the Royal Engineers has been sitting for some time past at the Royal Engineer establishment, Chatham, for the purpose of investigating and reporting upon the merits of various descriptions of gabions submitted to the Government for general use in the service for field-fortification. During the competitive trials, which were made with the various descriptions of gabions, the committee examined and reported upon gabions invented by Capt. Tyler, Royal Engineers; Capt. P. Smith, Royal Engineers; Quartermaster Jones, Royal Engineers; and Mr. Newton, C.E. The chief points of comparison to which the committee were required to direct their attention were cost, weight, arrangement for transport, stability, and durability, with any special merits possessed by either of the gabions invented. The merits of the sheet-iron gabion invented by Captain Tyler consist in its being light and durable, while each gabion can be made by two men in ten minutes, while the disadvantages attending its use are that it makes a great noise when being carried and when filled, with a want of stiffness, the report stating that it is "unfitted for sapping." The wire netting gabions invented by Captain Smith and Mr. Newton were both found to be very light, durable, and portable, and each could be put together in a few minutes, the defects of each being their unsteadiness and loss of shape while being filled, the report describing them as "totally unfit for flying and other saps." In the gabion of Mr. Newton the wire netting was lined with felt. The iron band gabion, the invention of Quartermaster Jones, was found to be light, portable, durable, and very stiff, while each could be made by a couple of men in five minutes, an additional merit of this description of gabion being that the galvanized iron bands can be utilised for the formation of flying bridges and for numerous other purposes. The chief desideratum in a good gabion, in addition to the ordinary advantages of durability, portability, and cheapness, is that it should possess rigidity of form when put together, or when being filled it becomes distorted, gives way to slight pressure, and becomes useless as a support to large masses of earth. All the above conditions were found to be fulfilled in the gabion invented by Quartermaster Jones, and the committee accordingly unanimously reported that it was in all respects the best for siege works and for general purposes. The hoop-iron gabion, known in the service as the "Sebastopol gabion," was also reported upon by the committee, its only merits being that it was "strong and durable," while its defects consisted in its being "very heavy, and taking three men an hour and a half to make one." The only other gabion brought under the notice of the committee was the ordinary service one of brushwood, which, although possessing great strength, has the fatal defects of being heavy and requiring three men three hours to make one.

STEEL RAILS.—Messrs. William Bird and Co.'s Monthly Circular states that for railway purposes there has been more doing, and increased orders for Bessemer steel rails are said to be expected from more than one important line. The small Belgian state railway contract for Bessemer steel rails was taken by a Belgian maker about 17s. 6d. per ton under the lowest English tender, and about 50s. per ton under last year's price. The Lyons Railway has ordered its requirements in France, something under 127. 10s. per ton at works. In tyres there is now so little difference between the price of best crucible cast steel and Bessemer steel that the former seem likely to retain the preference of engineers.

CHINESE IRON AND COAL.

THE *Times*' correspondent in China gives the following interesting information:

"A new ambition has arisen among the foreign residents in China. Hitherto trade, in the sense of tea, silk, opium, and grey shirtings, has been the main object of existence, and 'opening up the country' meant the possibility of tendering the two last-named articles to its inhabitants on more favourable terms. But now we want to 'develop the resources' of China. A great deal has lately been said and written here about the mineral wealth contained in its hills, and every one is intent on mining. There are two difficulties in the way, but neither is insurmountable. In the first place, mining requires capital, and there is none in China just at present—none, at least, in foreign hands. But that might be obtained from England, where, judging from the rate of discount, there seems to be a plethora. In the second, the Chinese Government will not give its consent to any measure which involves the establishment of foreigners in the interior, as this would do. But it may be found possible to avoid this difficulty by refraining from asking permission. To go directly to Peking with a request for permission to mine for iron in the Shantung hills would be to invite refusal; but it may not be impossible to come to a verbal understanding with the local officials that any proceedings with that object shall be winked at, and a royalty on the proceeds accepted as though forthcoming from a legitimate undertaking.

"But before saying more regarding the possibility of getting at the mineral resources of the country, it may be well to allude to their nature and situation. The north-east part of Shantung first claims attention, both on account of its wealth and accessibility. The Rev. Mr. Williamson has lately published an account of some researches made by him in this neighbourhood, which disclosed the existence of coal, iron, gold, lead, and sulphur—in districts, too, from which water communication exists with the treaty port of Chefoo. In reference to the first of these products Mr. Williamson says, 'There are three great coal-producing districts in this province in active operation, several minor ones, and other places where coal is known to exist, but where mining is interdicted.' The first is the valley of the Lan-fei-ho, situate in longitude 117° 36' E., and stretching from latitude 36° 30' to 36° 50' N. Here several varieties are produced, 'some fine bituminous coal, some partly bituminous and partly anthracite, and other kinds difficult to class. This district is famous all over the country.' In the neighbourhood is a large manufactory of coke, where it is stored in yards and largely exported. It is used for smelting silver and other purposes where great heat is required. Next in importance to this valley ranks a plain situated near Yi-chow, in longitude 118° 24' E. and latitude 25° 15' N.; but though coal is found here in great abundance, it is inferior in quality to that found at Lan-fei-ho. The third district is situate in longitude 119° 12' E. and 36° 40' N. latitude, and here excellent coal is exhumed, which might be brought to Chefoo in junks. With reference to the fact that I speak of these fields as already being worked, it may be asked what particular advantage we anticipate from the interference of foreigners in the process, and why we do not supply ourselves thence now, instead of paying ruinous prices for English and Australian coal. The application of foreign skill is necessary to exhume the lower and better strata. The Chinese merely work at the surface. A pit is dug down, and they work on until the water rises. They then leave that to go to another pit—missing, of course, in nine cases out of ten, the finest quality, and leaving vast quantities untouched. The inferior quality of the coal they obtain, combined with the difficulty attending its transport, renders it hardly worth the attention of foreigners. Thus it is that the question of mining is intimately connected with that of railways. In some cases good water carriage exists from the neighbourhood of the mineral districts to the sea coast; but they can never be properly worked until the advantages of steam carriage are actively recognised by the Chinese Government. It has been aptly remarked that the difficulty of getting at coal in China consists less in digging it from the earth than in sinking a mine in the Chinese intellect.

"Turning to iron, Mr. Williamson tells us that very fine iron ore has been procured at a hill called Pan-shan, about fifteen miles south of Tanchow, a large city on the southern shore of the Gulf of Pecheli, which is mentioned in the treaty as an open port; but for which Chefoo was afterwards substituted, on account of its more convenient harbour. This ore lies near the surface, and there is plenty of it; it is magnetic, drawing a needle after it like the strongest loadstone. The hills at the back of Tsi-nan, the capital city of Shantung, contain similar ore, and an inferior quality is reported to exist in the hills near Chefoo itself, which certainly have the appearance of being highly ferruginous. All these localities, it will be observed, are in the same province, so that coal for smelting purposes is available in the neighbourhood of the iron. A different conception must be formed of the extent of a province from that which attaches to the same term in Europe. The province of Shantung, for example, covers probably nearly as great an area as England. But in most cases water communication will enable fuel to be transported to the neighbourhood of the iron.

"Gold is collected by washing the sands of mountain streams. Marvellous stories are told by the natives concerning the richness of the quartz, which of course must be accepted with caution; but of the existence of the precious metal in these hills there is not the slightest question. Little is done towards extracting it from them, because the Government 'squeeze' the projectors so outrageously that the profits hardly repay the risk and expense attendant on regular mining operations. Less interference is exercised with the 'washers,' so many natives earn a livelihood by this employment. It would be a wonderfully efficacious mode of opening up the country if a few hundred adventurers were to determine on testing the value of these districts, with or without permission. I do not believe the military skill of all the generals in China would drive them out again, unless by cutting off supplies.

"Lead ore is said to be widely distributed over the eastern portions of the province, and the Chinese speak even of an interdicted mine in the hills at the back of Chefoo. I believe I have in previous letters spoken of the 'Feng-shui,' or 'in-

fluences,' which are so much respected by the Chinese people. The erection of a line of telegraph posts between Shanghai and Woosung interferes with the Feng-shui. A man happened to die in one of the villages along the line of route the day after they had been erected, and the villagers pulled them all down, and accused the projector of murder. By erecting the posts he had interfered with the Feng-shui, and caused the death of the man. These Feng-shui, too, are the great obstacles to the introduction of railways, and in deference to the Feng-shui mines have been closed in several parts of the country which had once been in full work. The interdicted lead mine, to which I have referred above, was closed for this reason. The elders of the surrounding villages represented that it annoyed the Feng-shui, and it was ordered to be closed accordingly. In other parts of the province, however, this restriction has not been exercised. A specimen of ore brought from Kihwo-shan, a hill in which iron is found, is said to have contained 80 per cent. of lead, and nearly equally rich specimens have come from the neighbourhood of Ninghai.

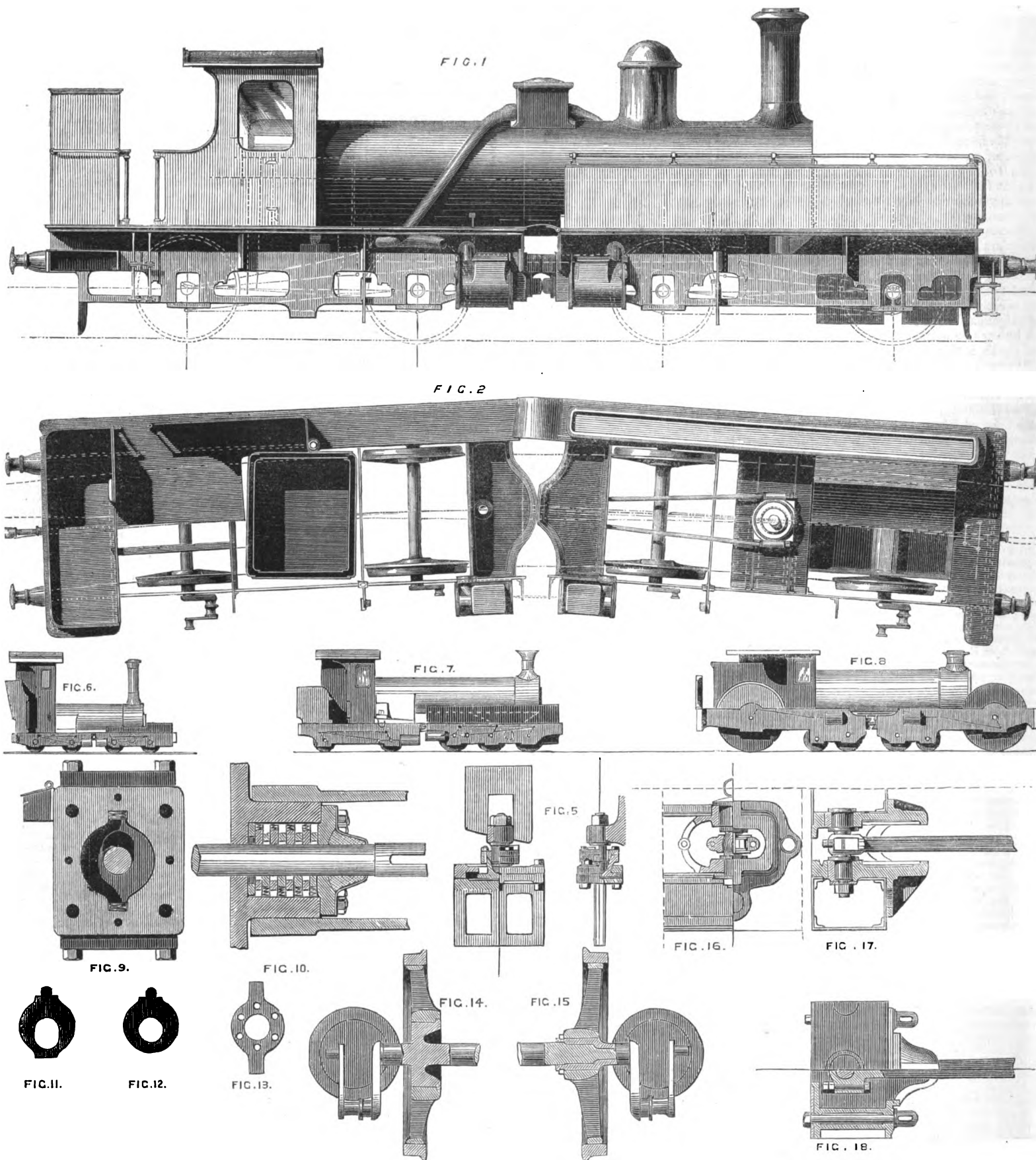
"I have said enough, I think, to show that Shantung is rich in mineral wealth. It is possible the estimates made of the quality and profusion of its products may be exaggerated. Too glowing impressions are frequently conceived of imperfectly explored districts, but there is no doubt that the minerals I have referred to do exist in the neighbourhoods indicated, and a glance at the map will show their easy accessibility. They are not locked up a thousand miles in the interior; they are in a seaboard province, and within approachable distance of a treaty port—Chefoo."

ENGINEERING IN AMERICA.—Mr. Kennard, the engineer in chief to the Atlantic and Great Western Railway, in a recent communication to the bondholders, observes as follows:—"I shall proceed to state why I did not construct the embankments and cuttings some 2 ft. wider, and why in several places I put up trestle work in place of solid banks. Almost as soon as I put the first shovel into the ground, the civil war was upon me, and, with 500 miles of railway to build before me, I saw the price of labour run up to an alarming extent. I therefore decided to adhere strictly to all my gradients and curves, but to economise on earthworks as much as possible, leaving the trestles to be filled up by steam excavators, and the banks to be widened from the cuts where needed, when the track should be completed, and thus vast sums saved. In this way I did succeed in constructing the whole line at the rate of one mile per day of working days. I did also provide the steam excavators, and what is now being done would have been done more than a year ago but for the panic in England, which, as all know, stopped these works, and depreciated the value of the securities of the road to an extent ten times as much as the value of the works in question. When I state that to execute the earthworks I had to import 90 per cent. of all the labour, and that a legion of army recruiting agents were hovering round me all the time, offering from \$500 to \$1000 per man bounty to join the army, the difficulty of the situation will be apparent to all. Nor must it be supposed that the line when opened was not substantial. I have only to call attention to our time-tables of the speed made by our trains almost immediately after the line was opened. There the fact stands for all time, that we did run express trains at express speed in successful competition with other long-established lines; and it is also a fact that extremely few accidents occurred, and that up to the present time only one passenger had lost his life on the line."

THE FRENCH NAVY.—By the last official returns the total of the fleet comprises 343 vessels, with an aggregate steam power of 77,643 horses and 110 sailing ships in serviceable condition. There are besides afloat, in process of completion, four steamships of a force of 1215 horses, and on the stocks 39 vessels, also steamers, of 14,730, and one sailing transport. This total effective is divided into two categories, comprising—first, the new fleet, and, secondly, the fleet of transition. The effective of the vessels completed and classed in the first category amounts to 316 steam and 70 sailing ships, and consists of 16 ironclads, ships of the line, and frigates of 14,000 horse power; 12 fast steamships of the line, of 8900 horse power; one ironclad corvette of 450 horse power; 17 fast steam frigates, not ironclad, of 9070 horse power; and 270 smaller vessels, including the transports, of 40,372 horse power, making a total of 316 steamers, worked by 72,852 horse power. The 70 sailing vessels are 20 transports and 50 small fishery guard boats. On the 31st of December next (the date on which the situation of the naval material has been reported in previous years) there is reason to expect that the French will possess, in addition, two ironclad corvettes and one screw despatch boat, which will bring the total of the effective of the first category to 319 steamers and 70 sailing ships. The second category, comprising old ships and others not fully effective, comprises 27 steam and 46 sailing vessels—that is, there are two screw liners of 1010 horse power; six frigates, screw, of 1050; two special steamers of 12; 17 corvettes and despatch boats, paddle, of 2610; of sailing vessels, two of the line; frigates, 11; and ships of inferior force, 33. Altogether, 73 ships, with an aggregate of 4082 horse power. There are besides forty vessels on the stocks, and four afloat and in preparation. Of the former, four armoured frigates of 3800 horse power; five armoured corvettes of 3150; four plated coastguard vessels of 212; one floating battery, ironclad, of 120; one screw frigate, not plated, of 380; seven screw corvettes, not plated, of 3150; eight screw despatch boats, of 2180; eight screw gunboats, of 400; one screw transport of 430; and one sailing transport; the total horse power of these vessels being 15,730. The four ships afloat and not yet finished are—two armour-plated corvettes, of 900, and two screw despatch boats, of 315. Since the 31st of December, 1866, the total number of vessels completed or purchased is 26, of which two are of American origin; four have been condemned as past service, and three have been lost at sea, the effective augmentation being 19 ships. The fleet of transition comprises 25 vessels, and one lost at sea, making a total diminution of the effective of 26 ships.

TANK LOCOMOTIVE ENGINE.

DESIGNED BY MM. JEAN JACQUES AND ADOLPHE MEYER, ENGINEERS, MULHOUSE.



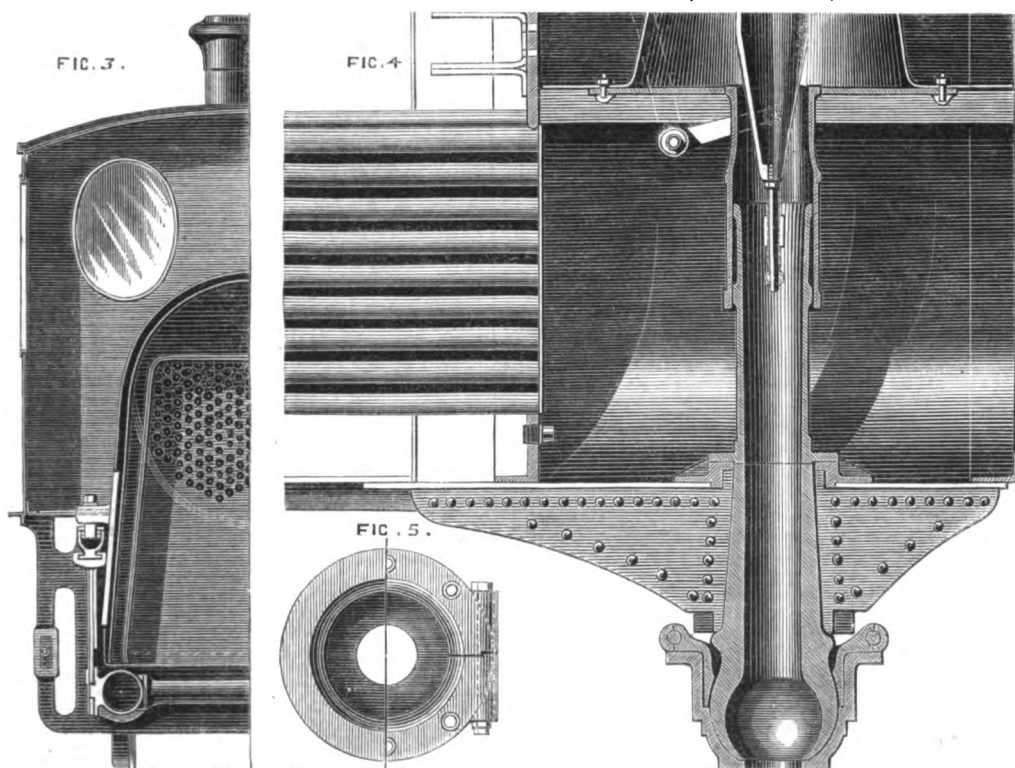
AMONGST the most recent designs for locomotive engines intended for working on heavy gradients are those lately patented by MM. Jean Jacques and Adolphe Meyer, of Mulhouse, which form the subject of our engravings on the present and next page. In many respects the designs of MM. Meyer resemble Mr. Fairlie's well-known plans. Like Mr. Fairlie, MM. Meyer propose an engine with two steam bogies, these bogies carrying the boiler together with the feed-water tanks and coal-bunkers. Each bogie has four or more coupled wheels, driven by an independent pair of steam cylinders, the steam being supplied to these cylinders by pipes of sufficient length to give them the required flexibility. So far Mr. Fairlie's and MM. Meyer's plans are alike; but in the methods adopted for carrying the boiler and connecting the two bogies several differences occur. In

Mr. Fairlie's first engines the two bogies were connected by a frame which encircled the central firebox with which the boiler was provided, and the boiler itself, resting upon the centre of each bogie, to some extent formed a connexion between them, although it was not allowed to transmit any tractive strain. In Mr. Fairlie's more recent plans the boiler is carried by an independent frame, or kind of cradle, which forms a direct connexion between the centre pins of the two bogies, and this frame, although itself strong enough to resist any tensile or compressive strain which is likely to be brought to bear upon it, is in some cases assisted by a connecting frame placed between the bogies. The effect of both these systems of construction is, that the "pull" of the leading or the thrust of the trailing bogie, as the case may be, is transmitted direct from the centre of one bogie

to the centre of the other, and each bogie is thus perfectly free to adjust itself to the curvature of the road. In MM. Meyer's plans the case is different. In their engines the centre of the leading bogie is connected by a bar with a point near the front end of the following bogie, and the movement of the latter is thus to some extent tramelled. The arrangement to which we allude will be understood by reference to Fig. 2, and the manner in which the connecting-bar is coupled to the forward bogie is shown, to an enlarged scale, in Figs. 16, 17, and 18. In MM. Meyer's engine the boiler is carried on three points, namely, the centre pin of the leading bogie, and two points at the trailing end, one on each side of the firebox. The support at the leading end comes under the smokebox, and one method of constructing it is shown to an enlarged scale in Fig. 4. From

TANK LOCOMOTIVE ENGINE.

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this it will be seen that the pin is of a spherical form where it bears upon socket on the bogie-frame, and that it is cast hollow so as to form a passage for the exhaust steam. In the arrangement, illustrated in Fig. 4, the chimney is made with a central core, the pointed lower end of which enters the exhaust nozzle. The exhaust steam is thus made to escape in an annular jet, and an annular passage is left around the core for the escape of the waste gases. The object aimed at in this arrangement is to get an increased jet surface; but this is obtained in any

nozzle fitted with the ordinary central cone for regulating the amount of opening, and we much doubt if the central core in the chimney, as applied by MM. Meyer, would increase the efficiency of such a jet.

The construction of the supports on either side of the firebox casing is shown by Fig. 5. From this it will be seen that the brackets on each side of the firebox each carry a spherical-ended pin, which bears upon a kind of shoe working in suitable guides fixed to the engine-frame. The arrangement is such that the

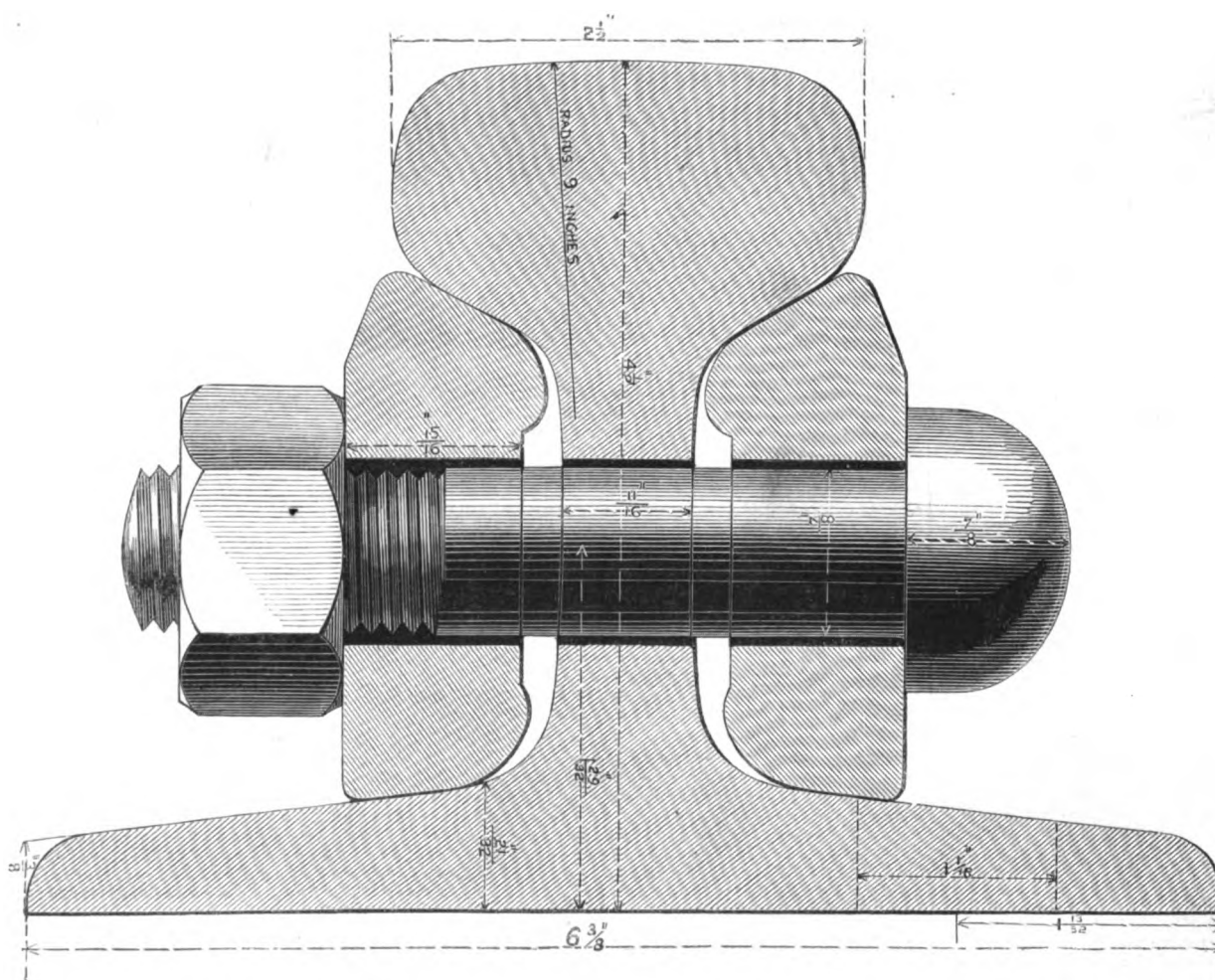
pins cannot lift from their bearings. When the engine is on a curve, one of the shoes just mentioned is shifted forward and the other backward in its guides. The positions assumed by the various parts in such a case are shown in the plan, Fig. 2.

MM. Meyer's engine has outside frames, and both the connecting and coupling rods are connected to cranks outside the bearings, as shown in Fig. 2. This arrangement has been much used on the Continent, but is one which would meet with but little favour from locomotive engineers in this country. To lessen the objectionable overhang of the cranks, and enable the cylinders to be kept as close together as possible, MM. Meyer adopt the plan of forging the cranks in one piece with the axle, as shown in Fig. 14, or in one piece with a kind of socket into which the axle enters, as shown in Fig. 15. The plan of lengthening the boss of the crank so as to form the bearing has been in several cases adopted by Continental makers; but MM. Meyer have gone further than this, and have continued the boss of the crank inwards to within the boss of the wheel. When the cranks are forged on the axle, as shown in Fig. 14, the hole in each wheel boss has to be made large enough to allow the corresponding crank to pass through it, when properly tilted.

Figs. 9, 10, 11, 12, and 13 represent a form of metallic packing which MM. Meyer propose to apply to the piston-rods and valve-spindles of their engines. Figs. 9 and 10 are respectively an end elevation and longitudinal section of a stuffing-box with this packing applied. The steam enters the stuffing-box through a space left around the piston-rod at the bottom of the box; and the cover, C, is fitted steam-tight, and is in close contact with the last ring of the packing, but does not touch the rod. The bottom ring, d, has helical springs lodged within its thickness, which bear against the other packings, e¹, e², e³, &c., and force them against the cover, C. The ring, d, does not touch the rod, but is in close contact with the first ring, e¹, of the packing; it does not touch either the bottom or the inner sides of the packing-box; the first ring, e¹, is pushed against the rod in a direction at a right angle with the latter by a spring, r; the second ring, e², is pushed in an opposite direction; the third one, e³, in the direction of e¹; the fourth ring, e⁴, in the direction of e²; and so on. A greater number of packing-rings may be used, if required; the said rings may be made either of cast iron, steel, brass, or any other suitable metal or alloy. ff is a reservoir, fed by any suitable means with lubricating fluid of any kind. The remaining figures of our engravings, Figs. 6, 7, and 8, are outline diagrams showing modified arrangement of tank-engines proposed by MM. Meyer. These will require no special explanation.

"ERIE" RAILS.—Rails of the inferior pattern and quality, made many years ago in Wales for the Erie (American) Railway Company, have been lately sold at 6 $\frac{1}{2}$ ¢ per ton. The Erie Company have long ago repented of their former speculation in this class of rails, whose name has stuck to them so long, and commenced, three years ago, to buy steel at 25¢ per ton (gold) duty paid, in New York.

RAIL OF THE METROPOLITAN EXTENSION RAILWAY.



The Metropolitan Railway was originally laid, by Mr. Fowler, with iron rails having their tops "converted," by Dodds's process, into steel, as in case-hardening. Under the great weights, however, of the engines on this line, which weigh 42 tons in working order, with 30 tons on the four coupled wheels, and under the constant traffic these rails were soon in a great measure destroyed, and the manner of their failure proved that no combination of steel and iron could be fully depended upon. It was not long before the engineer of the line determined to relay it, as fast as became necessary, in steel, and steel rails have been rolled for it at various works, particularly at Messrs. Brown's and Messrs. Cammell's.

The Metropolitan Extension rail, of which we give a full-size section herewith, and which is held by fang bolts to cross sleepers, is remarkable for its width of base, the section being that of the 84 lb. Bessemer rail, now being rolled by the Dowlais Iron Company for the Metropolitan Extension Railway. These rails are rolled under careful inspection, and we are able to state that the very broad and thin flanges come out of the rolls perfect in their edges, thus proving the good quality of the steel. The steel rails already in use are wearing extremely well, although in some places, where the brakes are put on in descending inclines of 1 in 100, the steel is being slowly but surely planed away by the action of the wheels. Iron, in the same situation, would hardly stand a month.

EAST INDIA IRRIGATION AND CANAL COMPANY.

THE report of the directors states that the progress made by the company's staff upon the main line and on the distributary channels during the last six months had been very satisfactory, although, in consequence of the effects of the late famine in Orissa, the supply of labour had been more limited than was anticipated. The expectation of an early extension of irrigation and of traffic returns had lately received confirmation, and it appeared that the native cultivators were now really beginning to use freely the water offered to them from the company's works. The works that had been commenced in December, 1863, and completed on the 31st of May last, consisted of four anicuts, 6600 ft., 8600 ft., 1980 ft., and 1500 ft. in length, and 12 ft., 11 ft., 8 ft., and 7½ ft. high respectively, with aprons in front and rear, involving the quarrying, carriage, and placing of 12,000,000 cubic feet of stone, weighing about 800,000 tons; the completion of nearly 100 miles of main canal; the construction in part of 60 miles more in course of excavation, which would most probably be ready by the end of this year; the completion of 100 miles of distributaries, with 60 more miles in progress. The area irrigable in July was about 140,000 acres, and after the completion of the distributaries now in hand 200,000 acres. According to the statements of the provisional chief engineer and those of the several executive engineers in charge, all the masonry works and embankments have passed through the season just ended without a single accident or mishap of any kind; and generally there were, at the date of that report, fifty-three miles of main canal so far completed as to afford irrigation and accommodate traffic to a limited extent, 39 miles of main canal capable of being used for transit purposes during high tides, requiring but little expenditure to render them navigable at all times; that 49 miles more of main irrigating and navigable canals were in a forward state, the greater portion being almost ready for opening; and that 134 miles of distribution channels, some of which would also become navigable, had been excavated, and water admitted therein sufficient to irrigate 153,400 acres of land, while several others were being proceeded with. With reference to the intended line of canal connecting Midnapore with Calcutta, 48½ miles in length, the three reaches proceeding from the Hooghly towards Midnapore, and ending at Panuchkorah, 24 miles in all, were now open for navigation, but not being yet supplied with all the necessary locks, could only be used during high tides. The value of those three reaches, even when furnished with locks, must necessarily depend in a great measure upon the completion of the entire line to Midnapore, of which 4½ miles at the Midnapore end were opened already, 10 more miles were all but finished, leaving 10 miles only to construct, and the masonry works to add. The gross amount of the 12 half-years' interest which had been paid to shareholders, amounting to 112,477½, had by the tolls received in respect of navigation, and by income derived from other sources, such as freight earned by their boats, &c., been reduced to 67,000½, while no payment had yet been made to the company by the Government for the irrigation hitherto supplied. The total amount of capital received up to the 1st inst. was 841,532½, and there had been received advices of the receipt on account of the loan from the Secretary of State of 102,000½, and that the expenditure up to the 30th of June last in India was 611,141½, and in England to the 1st inst. 192,157½, making together 803,298½.

CHIMNEYS.—A friend writes: "I can send you a tracing of a chimney-shaft, 108 ft. high, with a flue 5 ft. square, and parallel all the way up. It is supported, however, by external buttresses which give the chimney a tapering appearance. Speaking from memory, the cost was 540½." Can no one of our readers give us some precise details of the chimneys in a single ring of brickwork, bonded with hoop iron, of which Mr. Scrivenor, of Hanley, has erected so many in the Potteries during the last twenty years? We believe their cost is but 1½ per foot of height up to 100 ft. high.

RAILWAY ACCIDENTS.—The fifth of a series of reports on certain railway accidents that have occurred in the United Kingdom has just appeared, and contains detailed particulars concerning thirteen accidents during the months of June, July, August, September, and October, all of which were investigated by the inspecting officers of the Board of Trade. Three of these accidents happened on the North-Eastern Railway, two on the Midland, and the others severally on the Metropolitan, Bristol and Exeter, Dublin, Wicklow, and Wexford, Lancashire and Yorkshire, London and North-Western, Brighton, Preston and Longridge, and Salisbury and Yeovil Railways. Seven were caused by collisions, three from the engine or carriages leaving the rails, one by a train breaking into two parts, one by a train coming into collision with a bullock, and one by the ignition of luggage on a carriage roof. A long report is made by Colonel Yolland, R.E., on a very destructive accident that occurred on the Dublin, Wicklow, and Wexford Railway, on the 9th of August, when the engine, tender, and three third-class carriages left the rails near the Bray station, broke through the handrail of a viaduct, and fell from a height of about 33 ft. into the ravine below. This accident caused the death of two persons, and twenty-three others were more or less injured. From the evidence recorded in the inspector's report, it appears that the accident was entirely due to the defective condition of the permanent way; that an accident occurred near the same spot in April, 1865, and was inquired into by Colonel Rich, R.E. A defective carriage wheel and an imperfect permanent way were then reported as causes of the accident, since which time a change recommended by the inspector has been only partially adopted, and had not been made at that part of the line where the recent accident occurred. This latter circumstance emphasises the remarks of Colonel Yolland in the fourth series of these reports, in which he reminds the Board of Trade that they have no control whatever over railways after they are once open for traffic, and questions the utility of these unauthorised inquiries, inasmuch as the Board have no power to enforce the recommendations recorded by their inspectors.

THE SOCIETY OF ENGINEERS.

We observe that, in addition to the names of other members of long standing in the Society of Engineers, those of Messrs. William Wilson (the engineer, with Mr. Fowler, of the Millwall Docks), Mr. Daniel Kinnear Clark, and Mr. William Naylor, of the Great Indian Peninsula Railway, are nominated for election on the Council for 1868. This is an evidence of increasing strength, and will be most gratifying to all the members of the Society. The Council has greatly improved, within the last two or three years, in respect of the professional status of its members, all of whom, with perhaps a single exception, are now engineers, and nearly all of them gentlemen in extensive and responsible practice.

The annual general meeting of the Society will be held on Monday week, December 9, in the Lower Hall, Exeter Hall, at 7½ P.M., when the election of officers for the ensuing year will take place.

The annual dinner of the Society will take place on Friday, December 20, at the Bridge House Hotel, London-bridge, the hour being 6½.

A handsome sum has been subscribed by many of the members with the object of presenting a suitable testimonial to the Honorary Secretary, Mr. Alfred Williams, who has laboured so unceasingly for the Society for the last twelve years, and to whose exertions, indeed, the success of the Society is really due. Mr. Nursey, of the *Mechanics' Magazine*, and Mr. Olrick, of 27, Lead-nhall-street, are the honorary secretaries of the testimonial fund.

NAVIGATION OF THE THAMES.

In the House of Commons, on Friday evening last, Mr. Crawford asked the Vice-President of the Board of Trade whether it was true that the navigation of the river Thames is in danger of being obstructed by the formation of mud banks near the outfall of the main drainage sewers at Crossness and Barking-reach.

Mr. Cave replied that early in the summer a vessel grounded in Barking-reach at a time of the tide when there ought to have been sufficient water. A survey was ordered by the Conservancy Board, the report of which, presented on the 10th of June, states that there were large accumulations of mud, in some places to the depth of 6 ft., off the Main Drainage outfall. Some of this mud was sent to Dr. Letheby; and an analysis made by him, the report of which is dated the 24th of June, left no doubt in his mind of its being composed in a great degree of sewage in a state of decomposition. On the 25th of June a communication was made by the Conservancy Board to the Metropolitan Board of Works, to which a reply was sent on the 11th of November, stating that the Board had acted in obedience to Acts of Parliament, and that it was the duty of the Conservators to remove the shoal. The Conservators will have before them a report from their engineer on the best mode of doing this on Monday 25th, and will proceed at once to act upon it. There is, therefore, no danger of the navigation of the Thames being obstructed. Mr. Cave had received copies of a minute of the Metropolitan Board of Works questioning the alleged origin of the shoal and their liability to remove it, also of a report from their engineer admitting that the question is a complicated one, and recommending a conference with the Conservancy Board for the purpose of discussing the whole subject.

Mr. Crawford asked whether there would be any objection to produce the papers to which the right honourable gentleman had referred.

Mr. Cave replied that there would be no objection whatever to produce them.

It thus appears that it took four months and a half for the Metropolitan Board of Works to consider whether the solid portion of the sewage discharged by them at Crossness was actually forming, as of course it must form, shoals in the river. Let us see how long it takes to remove the shoal.

THE FORTS IN THE MEDWAY.

On Monday last Major-General Freeman Murray, commanding the division at Chatham, made a tour of inspection of the batteries and other defences under construction for the better protection of Chatham harbour and dockyard. The principal works, on which, including the cost of the land, a sum of little less than 100,000, has been expended up to the present time, are two powerful batteries erected on the projecting points on either shore near the harbour entrance, at Folly Point and Darnet Ness; but although commenced several years since, their completion seems more hopelessly distant than ever. From the commencement of the works there has been one continued series of mishaps. Under the principle of construction adopted, the forts are gradually settling down, and at one time it would appear to have been a serious question whether the superincumbent weight placed on the substructure would not cause them to disappear altogether before a gun was mounted on them. For several months past all work on the forts has been abandoned; but hopes are now entertained that with the means adopted by the engineers and contractors to arrest any further settlement of the foundations, the massive structures have at length been made to stand. Already two separate firms have been employed on the undertaking, and it would now appear that the Government has entered into a contract with Messrs. Mansfield and Co. for the completion of the forts at Darnet Ness, and with Messrs. Lee and Co. for furnishing the defences at Hoo Ness and Folly Point.

LOWMOOR AND BOWLING IRON.—A reduction of the list price of iron tyres and axles has at length been forced upon Lowmoor, Coopers, Taylors, and other best Yorkshire makers by the growing rivalry of Bessemer and crucible steel manufacturers, and they are quoted now as follows, according to make: 19s. to 19s. 6d. per cwt. for tyres, 18s. to 19s. 6d. per cwt. for axles, or 3½ per ton less than heretofore.

BELGIUM.—Official returns from Belgium give the exports of that country to September 30, as 73,450 tons rails, and 9600 tons plates and sheets in 1867, against 55,800 tons rails and 12,851 tons plates and sheets in 1866. Of their imports of pig iron (44,000 tons) 40,500 tons were from British ports.

THE INSTITUTION OF CIVIL ENGINEERS.

At the third ordinary general meeting, session 1867-68, on Tuesday, the 26th inst., Mr. Charles Hutton Gregory, Vice-President, in the chair, a report was brought up from the council, stating that, under Section IV. of the Bye Laws, the following candidates had been admitted as Students of the Institution:

Name of Candidate.	Recommended by
John Simeon Berghem ...	John Fowler.
Edward Pearce Brown ...	James Simpson, jun.
Walter Chapman Burder ...	James Easton.
Charles Clowes ...	James Easton.
John Thomas Denniston ...	John Fowler.
The Hon. Alan de Tatton Egerton	Walter Marr Brydone.
Thomas Charles Ellis ...	J. R. McLean.
Tristie James Ellis ...	John Fowler.
David Gravell ...	John Fowler.
John William Drinkwater Harrison	W. H. Bidder.
Frank Livesey ...	Joseph Fогerty.
Arthur Robert Lungley ...	Henry Carr.
William George Moore ...	John Fowler.
Arthur Neame ...	Joseph Cubitt.
Thomas Farmer Parkes ...	John Taylor.
Howard Devenish Pearsall ...	Henry Shield.
The Hon. Philip James Stanhope ...	John Fowler.
Clarence Edward Trotter ...	Nathaniel Beardmore.
Arthur Joseph Waring ...	James Abernethy.
Charles Stroud Williams ...	James Easton.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—The trade in pig iron during the last week has been at an unusually low ebb. On only one day was the market in any way firm, when the prices were from 53s. 7½d. to 53s. 9d. cash, and 53s. 10½d. a month. Flatness has been the order of the day. Yesterday 500 tons were reported at 53s. 6d. a month, and sellers remained at 53s. 4½d. cash. The small amount of business done may be judged of by noting the large decrease in the shipments indicated in the following table of pig iron shipments from all Scotch ports:

For the week ending 23rd November, 1867.			
			tons.
This year ...	...	...	7,961
Last year ...	...	...	12,225
			Decrease ... 4,264
Total since 25th December, 1866 ...			564,604
For corresponding period in 1865-66 ...			541,508
			Increase ... 23,096

Appointment of Messrs. John Hawkshaw and D. K. Clark by the Caledonian Investigation Committee.—The investigation committee of the Caledonian shareholders, consisting of Messrs. Thos. Richardson, Charles Cowan, George Smith, and William Spens, feel that such report as they may make will neither be satisfactory to themselves, nor carry such weight with the shareholders as ought to be its aim, without consideration of, and unaccompanied by, the views of eminent professional men. They are therefore glad to intimate that they have secured the services of the following gentlemen: John Hawkshaw, C.E., F.R.S., to report on the permanent way and works; D. K. Clark, C.E., London, to report on the rolling stock; Alfred Allott, accountant, Sheffield; and Robert Fletcher, accountant, Moorgate-street, London.

It is not expected that the committee's report will be forthcoming in less than a month, so that there is still plenty of time for the "bears" to carry on their merciless dealings with the shareholders' stock. Yesterday the stock was again lower than at any time during the present crisis, 71½ 5s. being taken, and to-day it has been as low as 70½.

Water-supply of Leven, Thornhill, Paisley, and Alloa.—Hitherto the inhabitants of Leven, in Fifeshire, have depended for their water-supply on numerous wells scattered up and down the town, the supply being frequently deficient, and the quality of a very detrimental character. This was seen to be notably the case during the cholera visitation towards the end of the summer of 1866. The town was found on inspection to be without sewerage, and the well-water to be strongly impregnated with decayed animal matter, which percolated through the soft gravelly soil from the numerous cesspools. The surrounding district was surveyed by Mr. Sang, of Kirkcaldy, and the Durie estate was chosen as the source of a supply which was thought to be suitable for the town. Dr. Stevenson Macadam examined the water, and reported favourably of it. Plans were forthwith matured by Mr. Sang for bringing an adequate supply of water into the town.

The works are now completed, and were formally opened on Saturday last, by Captain Christie, the lord of the manor. They are of a very simple nature compared with many similar undertakings, and the expense connected with them will not be very great. The water is collected principally on the estate of Durie, the chief source being a spring on Wester Durie farm. A metal cistern, 31 ft. in diameter by 4 ft. deep, capable of containing about 40,000 gallons of water, has been constructed in a hollow about a mile from the town, and at an elevation of about 50 ft. from the level of the principal street. Into this cistern the water is led from the large drain by which it was formerly carried off the ground into a settling box, some 20 ft. long by 10 ft. broad. The object of this box is to retain any impurities which may exist in the water; and, should it be found feasible, it may yet be used as a filter. A 5 in. pipe has been laid between this cistern and the town. A 4 in. pipe conveys the water through the principal streets, while smaller pipes supply the outlying localities. The main pipe is capable of conveying to the town about 120,000 gallons per day, which allows 40 gallons to each inhabitant, estimating the population at 3000. At present, the cistern yields a full supply; and about one-third waste is conveyed away by the overflow pipe. By the provisions of the Lindsay Police Act, the residents are bound to introduce the water into their houses, and many of them have already done so; but, for the convenience of others, wells have been erected throughout the streets. The total expenditure of the works to

this date will be about 1200L, but it is estimated that about 200L additional will be required to complete them. An abundant supply of good water being now obtained for the town, the commissioners are proceeding vigorously to carry out a complete system of drainage. When the work of improvement is completed, Leven will be one of the tidiest, as it is already one of the most pleasantly situated, watering-places on the Fifeshire coast.

The new waterworks of Thornhill, Dumfriesshire, were opened on Friday last, by his Grace the Duke of Buccleuch, on whose estate the town itself is situated. The water is brought from Hawgill Springs, about three miles from the town, in accordance with the plans of Mr. R. C. Reid, C.E., Edinburgh, under the direction of Mr. James Leslie. The water is collected from three springs at Hawgill, and conveyed by 7515 ft. of 5 in. clay pipes, at a gradient of 1 in 500, from thence to a distributing reservoir constructed between Mansfield and the railway station. The reservoir is a massive piece of masonry, 16 ft. by 25 ft., by 10 ft. in depth, and is constructed to hold 25,000 gallons of water. The walls are 3 ft. 6 in. thick, with 2 ft. of clay outside; the grooves being filled with cement concrete up through the walls, making them perfectly water-tight. From the reservoir to the Cross the water is conveyed by 5460 ft. of 4 in. cast-iron pipes, and distributed through the town in the usual manner by means of service pipes. The quantity of water supplied will be about 60 gallons per minute, or nearly 60 gallons for each inhabitant every day. The quality of the water is very excellent. From an analysis made by Dr. Penny, of Glasgow, it appears that it contains five grains of foreign matter to one gallon of water, or one in every 14,000 parts. Of this there are somewhere about three grains of salt and chalk. The hardness of the water is 2½ degrees, which is very soft as compared with that of many other towns. The contractors, Mr. Clennell, brick-manufacturer, Sanquhar, and Mr. Drummond, plumber, Thornhill, commenced operations in the beginning of August last. Since that time the works have gone on vigorously, and have been finished three months before the specified time at an estimated cost of 2000L.

For the present, the Water Commissioners of Paisley have abandoned the high-level scheme of water-supply which was projected some time since, owing, it is said, to the great expense which it would entail upon them without anything but a very small return. The new dams at Rowbank are being pushed forward with all possible speed. The pipes and conduits leading from Rowbank to Stanley are so far forward that it may reasonably be expected that before the end of next year the water will be in the new reservoir.

The Water Commissioners of the town of Alloa, on the banks of the Forth, have just incurred an expense of 3000L in the construction of new waterworks. The table of rates has been readjusted in consequence. Manufactories will be supplied by meter, and small establishments will be charged partly according to the number of operatives employed, or the numerical horse power of any steam-engine that may be in operation. Trial of the new rate is to be given for one year.

Association of Assistant Engineers.—This association met last week; and on the chair being taken by the president, Mr. Charles Smith, the discussion on the miners' Davy lamp was resumed, and ultimately concluded; Mr. Mortimer Evans, C.E., by some interesting experiments with the lamp, assisting greatly to elucidate the conditions that ensure perfect safety. The attention of the meeting was then directed to the consideration of screw propellers, more particularly in connexion with the paradoxical question of "negative slip," regarding which various theories were advanced by several members. A carefully prepared model of a mould for casting screw propellers was brought forward by Mr. John Neilson, this being designed to show how, by careless or ignorant setting of the sweeping gable, an unintentional and unknown pitch might be given which might eventually lead to a supposed case of "negative slip," even when there actually was considerable "positive slip." This model was also happily suggestive of a very simple method of obtaining a propeller with an increasing pitch, a mere alteration in position of the ordinary gable obtaining the desired increase with great accuracy.

The Abyssinian War and Export of Coals from the Clyde.—During the last two months and a half the export of coals from the Clyde to Bombay and other Eastern ports at which the steamers engaged in the transport service in connexion with the Abyssinian war touch for coaling, has been unusually large. During the last few days in August, three ships—the *Gerant*, *Impulse*, and *Hope*—sailed from Greenock with 3040 tons of coals for Bombay; and the *Orissa*, with 974 tons for Calcutta. In September the *Robert Buak*, Moonbeam, Cardross, and *Isabella Kerr* sailed for Bombay, with 4410; the *Janet Cowan* and *Kurrachee* with 1420 tons for Calcutta; *Indux* and *Three Bells*, for Kurrachee, with 1440 tons; *Mauritius* and *Trochirugue*, with 1930 tons for Mauritius; and four ships for other ports with 3000 tons; in all, during the month, over 12,000 tons of coals. In October the ships *Otago*, *Martaban*, *Derwent*, *Ardgowan*, *Inglewood*, and *Undaunted* sailed for Bombay with 5250 tons of coal; the *Madras* and *Glencoe*, for Point de Galle, with 1620 tons; and four ships with 1930 tons for other parts; in all, during October, 8800 tons. During the present month the *Galloway* and *Clutha* have sailed for Bombay with 3350 tons; the *Lake Constance*, for Calcutta, with 670 tons; the *Barbadian*, with 1010 tons, for Point de Galle.

State of Trade in the Coatbridge, Kilmarnock, and Johnstone Districts.—During the last fortnight a considerable improvement has taken place in a number of the principal malleable iron works throughout the Coatbridge district. Orders are coming in more freely from the shipbuilding yards on the Clyde, Yorkshire, and other places. Some extensive orders have also been received for railway material at Coatbridge, Mossend, and Motherwell. The rolling-mills have been in full operation night and day for some time back—a state of matters which could not be reported previous to this date since the beginning of the year. It is rumoured that a reduction of wages will, however, be necessary to allow of the ironmasters competing successfully with the English manufacturers. In the coal trade there is as yet no improvement. The blast furnaces are pretty well employed in the district, those at Calder being all in blast. Dundyvan

malleable iron works are entirely stopped, and the workers have all left the district.

Trade in Kilmarnock joins in the dullness which prevails too generally throughout the country. A good many workmen are out of employment, whilst the wages of those in employment are, in most cases, being reduced. The hammermen at the Glasgow and South-Western Railway Company's works have received notice of a reduction from 16s. to 15s. a week.

The factories and engineering establishments in Johnstone, near Paisley, are also suffering from dull trade, and a number of the hands have been paid off.

Miners' Affairs.—In the Motherwell and Wishaw districts discontent prevails more or less generally among the coal miners. Dull trade is interfering seriously with the compact made several months since regarding the rate of wages which should prevail. Just now the rate should have been 5s. per day, and this amount is being obtained in some of the Lanarkshire collieries, but in a number of instances the coalmasters have not given more than 4s. 6d. per day, which is the rate that was agreed upon for the three autumn months. Strikes are, therefore, existing in the districts named above. At the Braidhurst collieries, the property of Mr. Gavin Addie, a conference between the employer and the employed prevented a strike a few days ago, the majority of the men accepting a reduction to 4s. 3d. per day, rather than a rise, on being assured that the depressed state of trade fully warranted the reduction. In another instance the coalmaster has come to terms with his men, and has agreed to continue to give 4s. 6d. per day. On the Coltness estate the men seem determined to resist the reduction.

Glasgow Sewerage—Appointment of Messrs. J. F. Bateman and J. W. Bazalgette to report on the same.—In conjunction with Dr. Anderson, Professor of Chemistry in Glasgow University, these two eminent civil engineers have been appointed by a joint committee of the Town Council, Clyde Trust, and Police Board, to examine the various plans which have been proposed for dealing with the sewage of this city, and to report on them. Indeed, the question in all its entirety has been remitted to the three gentlemen named, with a view to such a definite report and plan being obtained from them—with an estimate of the probable cost—as to enable the local authorities to take a defined and practical issue on a subject on which the community feel a deep interest, and which has long engaged their anxious attention and consideration. In order that they may carry on the necessary local investigations, Messrs. Bateman and Bazalgette will visit Glasgow in the first week of the ensuing month. I shall keep your readers duly apprised of any plan or plans that may result from the execution of the commission with which these gentlemen are charged.

Shipbuilding News.—A few days ago a beautifully modelled paddle-wheel steam-yacht, of 750 tons, B.M., was launched by Messrs. Caird and Co. for the Trinity House, London, to be used in the lighthouse inspection over the English, Irish, and Scotch coasts. The vessel was named the *Irene* by Miss Lydia Caird, daughter of the builder. Her dimensions are: length of keel and fore-rake, 212 ft.; breadth of beam, 26 ft.; and depth of hold, 13 ft. 10 in. The *Irene* will be supplied with oscillating engines, of 220 horse power, by Messrs. Caird and Co. The blocks for a new screw-steamer, of 3000 tons, sister to the *Helvetia*, at present building for the Hamburg-American Steam Packet Company, will be laid on the ground vacated by the *Irene*.

The new twin-screw steamer *Gova* passed down the river this week, on a trial trip, which proved highly satisfactory. This steamer was built by Messrs. Aitken and Mansel for the Panama Steam Navigation Company, and is a sister to the *Taragay*, built by them a month ago for the same firm. They are each of 550 tons, and have been supplied with engines of 90 horse power by Messrs. James Aitken and Co., Glasgow.

Mr. Fife, the famous yacht-builder of Fairlie, has received orders from Mr. G. H. Dundas, the owner of the schooner yacht *Oriana*, to build him a schooner yacht of 60 tons.

NEW LOCOMOTIVE FOR COMMON ROADS.

MR. R. W. THOMSON, C.E., Edinburgh, has invented and patented a new locomotive for common roads, which was tried for the first time publicly, on Monday last, in the neighbourhood of Edinburgh.

Mr. Thomson's patent road steamer has wheels made of a material which at first sight does not look a very likely substance to stand the heavy work they are subjected to. The tyres are made of bands of vulcanised india-rubber, about 12 in. wide and 5 in. thick. Incredible as it may appear, this soft and elastic substance not only carries the great weight of the road steamer without injury, but it passes over newly broken road metal, broken flints, and all kinds of sharp things without leaving even a mark on the india-rubber. The tyres do not sink into the road in the least degree. They pass over stones lying on the surface without crushing them.

The india-rubber tyres require scarcely any more power to propel them over soft bad roads or over loose gravel roads than on the best paved streets. The reason of this is quite obvious: they do not sink into roads, and do not grind down the stones in the least degree.

On Monday, the trials commenced by running the road steamer across a soft grass field, and it was afterwards taken across a part of the field which had just been covered with loose earth to the depth of one or two feet, and run straight across, and then back through the deep soft soil. The weight of the road steamer is between four and five tons; and yet the wheels, in passing over the loose earth, compressed it so little that a walking-stick could easily be pushed down in the track of the wheels without any exertion. After various evolutions, showing the ability of the road steamer to run about where there were no roads, it passed out into the street, and, taking a large omnibus full of passengers in tow, it proceeded up the Bonnington-road to Messrs. Gibson and Walker's mills, where it took a large wagon, weighing, with its load of flour, about 10 tons, up a steep lane full of holes and ruts, and rising with a gradient of 1 in 20. It was obvious that the road steamer was able to do a great deal more than it had to do in this trial. The bite on the road is something marvellous, and

the easy way in which it floated along on its soft and elastic tyres was very curious. When riding on the road steamer, the feeling is like what would be experienced in driving over a smooth soft grass lawn. There is absolutely no jarring at all. There was no appearance of wear on the india-rubber tyres. The original surface which the rubber had when it left the manufactory is still visible. The engine is destined for Java, where it will be employed in drawing trains of wagons between two ports. The steamer, which was the subject of the experiments, had another speciality besides the wheels, it being fitted with one of Mr. Thomson's patent vertical boilers.

TUMBLING-BEAM ENGINE.

WE give, on the next page, engravings of a very peculiarly arranged engine, designed by Mr. Norman Wheeler, of New York, for the Norwalk Iron Works, Norwalk, U.S. In this "tumbling-beam" engine, as it is called, the two cylinders are placed in a vertical position, one on each side of the crank-shaft, and the pistons, which have small trunks on their upper sides, are connected by rods to a sort of triangular beam by which motion is communicated to the crank. The form of the beam just mentioned is a right-angle triangle, placed with the hypotenuse uppermost, and the crank is coupled at the right angle of the triangle. From this point transverse bars extend to the centre of the hypotenuse, which is connected to a parallel motion, so that it moves up and down in a straight line. The pistons are connected to the ends of the hypotenuse of the triangular frame, and as one of the pistons is always half a stroke in advance of the other, the beam has a compound motion imparted to it, due to the oscillation on the centre at the middle of the length of the hypotenuse, and to the rise and fall of that centre in a straight line.

The peculiar motion of the beam will be best understood by referring to the series of outline diagrams included in our illustrations. These diagrams show the relative positions of the beam, pistons, crank, &c., at five successive points in the revolution of the crank-shaft, these points being separated from each other by an eighth of a revolution. Thus, in the first figure both pistons are near the tops of their respective cylinders, and the crank is pointing directly upwards. In this figure, the left piston is performing its downward and the right-hand piston its upward stroke. In the second figure, the crank has made an eighth of a revolution towards the right, and the right-hand piston has arrived at the top of its stroke, the left-hand piston being at the same time at the middle of its downward course. In the third figure, both pistons are moving downwards, and the crank is horizontal. In the fourth figure, the relative positions of the two pistons are the reverse of those shown in the second figure; and in the last figure of the series, the crank is shown after it has completed half a revolution, the two pistons being equidistant from the bottoms of their respective cylinders, the right-hand one being on its downward and the left-hand one on its upward stroke.

The diagrams show very clearly two of the peculiarities of the motion. The first of these is, that the pistons arrive successively at the ends of their strokes at the times that the crank is inclined at an angle of 45°; and the second is, that, notwithstanding that the point of the beam at which the crank is attached to the centre of the hypotenuse is of course equal to half the length of the hypotenuse, the stroke of each piston is more than double the throw of the crank. Thus, in the particular engine illustrated, the pistons, which are 14 in. in diameter, have a stroke of 20 in., whilst the throw of the crank is 7 in. only. The reason of this will be readily understood by reference to the outline diagrams.

Of the remaining points in the arrangement of the engine it is unnecessary that we should say much, as most of them will be understood by reference to the engravings. That the whole design of the engine is one of great ingenuity there can be no doubt, and its complexity is, to a great extent, more apparent than real. The arrangement certainly gives great compactness, a point which is of value in many situations.

THE SUZ CANAL.—A tug belonging to our own Government has actually been floated through the Suez Canal. This was the *Prompt*, recently despatched from England to assist in the embarkation of the Indian troops at Suez, and was conveyed through the new Suez Canal, to the Red Sea. After having been lightened as much as possible, even to the removal of the paddle-wheels, a number of empty casks were placed under her, and in this manner she reached Suez.

LEEDS.—We understand that the Kirkstall Forge Company has received a large order for railway wheels. Messrs. Kitson have also obtained an order for ten locomotive engines. Many of the Leeds works are, however, on short time.

MONSTER BLAST FURNACES.—The Rosedale and Ferryhill Iron Company has completed two blast furnaces of great size, their dimensions being, height, 105 ft.; diameter, 28 ft. Each furnace will contain, when in full charge, about 1300 tons of raw material.

REDUCTION OF WAGES.—There is every prospect that the ironworkers on the Tyne will submit to the proposed reduction of wages—about 10 per cent.—which will come into force in a fortnight; a reduction is also taking place in the wages of the men employed in the chemical trade on the Tyne; the reduction at the principal works will be about ten per cent. also.

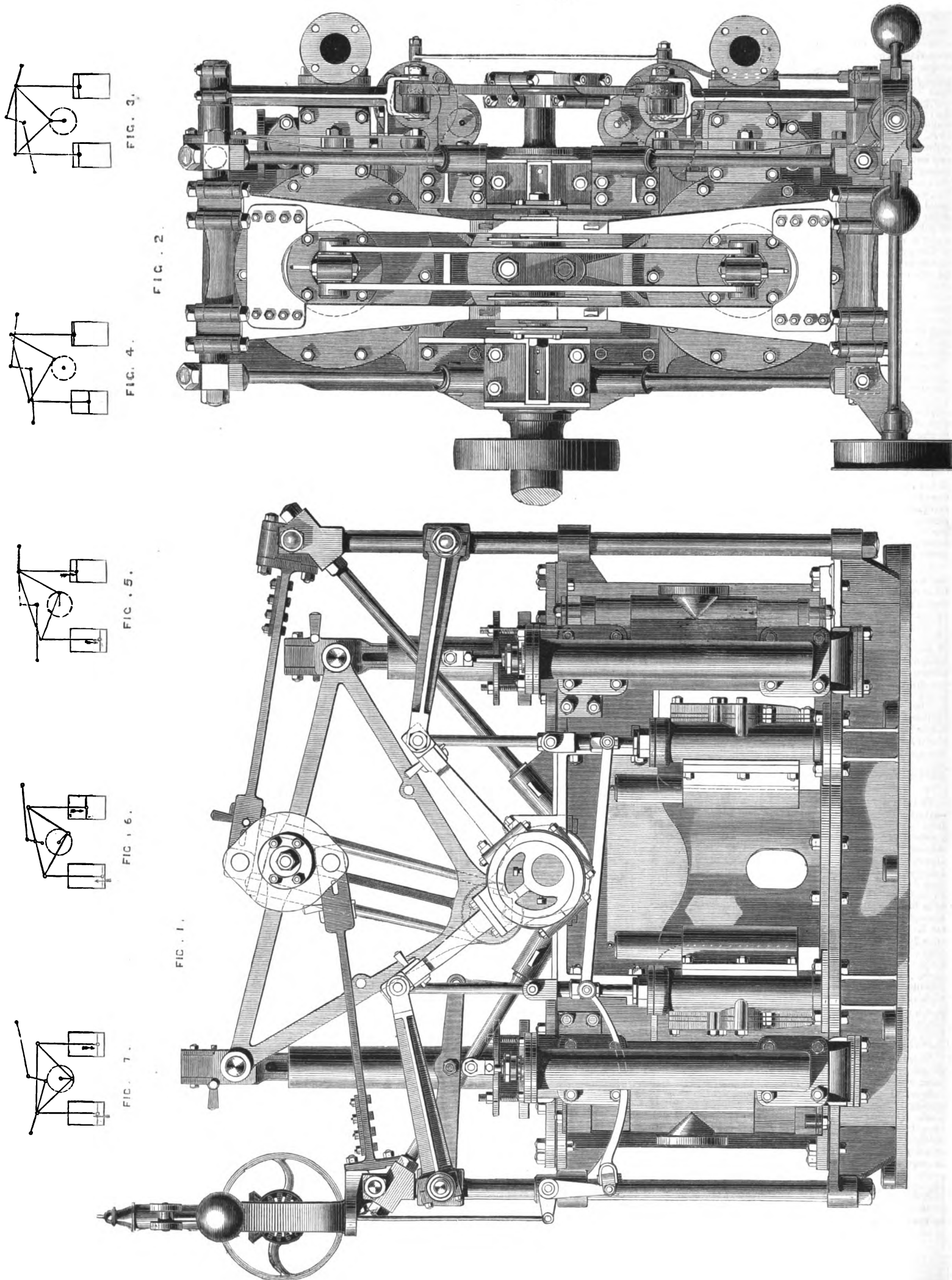
ISLINGTON RAILWAY.—Notice has been given of an intended application to Parliament to construct a railway from Islington-green to the Moorgate Station of the Metropolitan Railway.

RAILWAY GUARDS' AND PASSENGERS' COMMUNICATION.—Mr. Sheridan has obtained leave to re-introduce before the House of Commons his Bill of last year to compel railway companies to establish some means of communication between guards and passengers.

TUMBLING BEAM ENGINE.

DESIGNED BY MR. NORMAN WHEELER, NEW YORK, FOR THE NORWALK IRONWORKS, NORWALK, U.S.

(For Description, see preceding Page.)



PUBLISHER'S ANNOUNCEMENT.

Advertisements cannot be received for insertion in the current week later than 5 p.m. on Thursday. The charge for advertisements is three shillings for the first four lines or under and eightpence for each additional line.

The price of ENGINEERING to annual subscribers, receiving stamped copies at places three miles away from the General Post Office, is 11. 1s. 8d. If credit be given, the charge is 2s. 6d. extra, subscriptions being payable in advance.

Cheques and money orders to be made payable only to Mr. Charles Gilbert.

Office for Publication and Advertisements, No. 37, Bedford-street, Strand, W.C.

ENGINEERING is registered for transmission abroad.

D. Van Nostrand, 192, Broadway, New York, is the sole American agent for ENGINEERING, and is authorised to receive all Subscriptions and Advertisements from America for this paper.

Le bureau d'ENGINEERING pour la France est 15 Quai Malaquais, Paris, chez E. Lacroix, Directeur des Annales du Génie Civil.

Subscriptions for the ANNALES DU GENIE CIVIL are received by Mr. Charles Gilbert, the Publisher of ENGINEERING, of whom also the NOUVEAU PORTEFEUILLE DE L'INGENIEUR DES CHEMINS DE FER may be obtained, price 9l.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 3rd, at 8 p.m. 1. "Description of the Victoria Bridge, on the line of the Victoria Station and Pimlico Railway." By William Wilson, M.Inst.C.E. 2. "On New Railways at Battersea; with the Widening of the Victoria Bridge, and Approaches to the Victoria Station." By Charles Douglas Fox, M.Inst.C.E.

SOCIETY OF ENGINEERS.—Monday evening, December 2, 1867, at 7½ o'clock. Adjourned discussion on paper read on November 18, "On the Connexion between the Shape of Heavy Guns and their Durability." By Arthur Rigg, Jun., C.E.

ENGINEERING.

FRIDAY, NOVEMBER 29, 1867.

PORTRAITS OF THE ENGINEERS.

As has been already announced, we shall soon commence—possibly in our next number—the publication of a unique and exclusive series of portraits of the leading English and foreign engineers, large manufacturers, and inventors. Each portrait will occupy a full page of this paper, and will be in the best style of wood engraving. The portraits of Mr. Fowler (President of the Institution of Civil Engineers), M. Flachet (Président de la Société des Ingénieurs Civils, Paris), Mr. Robert Napier, and Sir John Brown are already in the engraver's hands; and Sir Daniel Gooch, Mr. Hawkshaw, Mr. Fairbairn, Mr. Penn, Mr. Whitworth, Mr. W. H. Barlow, Mr. Bazalgette, Mr. Harrison, Mr. Hutton-Gregory, Mr. Bessemer, and Mr. James Young have already kindly consented to sit for exclusive photographs to be copied for the series.

PROPOSED CANADIAN SHIP CANAL.

WITH so little work in progress at home, it is a pleasure to learn of any large undertaking which is to occupy a considerable amount of English engineering talent in our dependencies. A ship canal is to be made through Canada West (formerly known as Upper Canada) to connect the waters of Lake Ontario and the Georgian Bay. Lake Ontario is 234 ft. above the level of the sea, while the Georgian Bay, communicating freely with Lakes Huron, Superior, Michigan, St. Clair, and Erie, is at an elevation of 574 ft. The ascent from Lake Ontario to Lake Erie is now made by means of the Welland Canal, which runs nearly parallel with and to the west of the river Niagara, and which has thirty-four locks, large enough only for vessels of small size. The new canal, which will be about 100 miles long, 100 ft. wide, and 15 ft. deep, and of which the estimated cost is about \$8,000,000, will overcome a summit of moderate height in addition to the rise of 340 ft. from Lake Ontario to the Georgian Bay. The canal will be fed from the summit from the inexhaustible waters of Lake Simcoe, 30 miles long, 18 miles wide, and 470 ft. above Lake Ontario, or 130 ft. higher than the Georgian Bay and Lake Huron. This lake (Simcoe) will be utilised for navigation for a distance of 24 miles. The locks are to be of great size, 560 ft. by 36 ft., and of 8 to 15 ft. lift, which would require, say, forty-two locks for the whole lockage of about 600 ft. The great summit cutting, south of Lake Simcoe, will be 8½ miles long and 187 ft. deep at the deepest part. The project of this canal

is, we believe, due to Mr. Sykes, an engineer of Toronto; but Mr. Hawkshaw and Mr. Rendel have assumed the engineering charge of the undertaking.

This canal, which will follow the general course of the Northern Railway of Canada, will save to vessels sailing from the St. Lawrence to Chicago the long *détour* of about 300 miles *via* Lake Erie, and it might, in the possible event of war, prove of the greatest service in opening a way for gunboats to the upper lakes.

There is still, however, the descent of 234 ft. from Lake Ontario to the Atlantic, 180 ft. of this being in that part of the river St. Lawrence above Montreal, and of this 80 ft. are at the Long Sault, or rapids. Ten years ago it was considered that no vessels more than 130 ft. long, 26 ft. beam, and 10 ft. draught could navigate the whole length of the St. Lawrence, and at present all vessels going above Montreal must pass under the great tubular railway bridge there.

The proposed undertaking will be known as the Huron and Ontario Ship Canal. We expect, shortly, to give a plan of it, with much fuller particulars than are contained in the present brief notice.

FRENCH AND ENGLISH ENGINES.

AT one of the recent meetings of the French Institution of Civil Engineers, M. Normand, son of the eminent shipbuilder of Havre, and who is himself a constructor of marine engines, made a detailed comparison of the French and English marine engines in the late Exhibition. Our countrymen cannot fail to respect, and even to admire, the frankness with which M. Normand, upon perfectly dispassionate and nicely discriminating arguments, awarded the palm to the Englishmen; more especially, perhaps, to Mr. Penn. "When," said M. Normand, "we examine the English screw-engines shown at the Exhibition, we are struck by the contrast presented by the simplicity and the rational lightness of their framing when compared with the heavy, complicated, and cumbrous edifices which characterise the French types; we feel that a wholly different order of ideas presided at the creation of the two species, although both are made to accomplish very simple and perfectly identical functions, viz., turning a shaft. In the English construction, the great crank-shaft is the base and true foundation of the system; towards that all the movements converge, and all the parts which contain them gravitate. The cylinders are generally united '*en bloc*,' perfectly rigid, or isolated as in Maudslay's engine, and their *point d'appui* or main support is upon the bearings of the shaft through small isolated frames, distributing the action of the motive force upon four points spaced equidistantly upon the circumference of the cylinders—an excellent point with respect to the strength and security of the parts. The condensers and slide-bars form a separate group, placed upon the other side of the shaft, and connected with the bed-plate by a light and flexible framing, leaving full liberty to the movements always observed in the structure of a ship. The work of the air-pumps being at most but the twentieth part of the effort upon the pistons, this arrangement involves no objections.

"During twenty years of experience these principles of construction have been found to furnish every desirable guarantee. They are accepted without question, not only in England but everywhere, in the construction of screw-engines, with the exception of France alone.

"The French engines intended for the imperial navy have been designed with the idea of making all their parts rigorously solid; and it has been thought that this result could be best secured by throwing all the strains upon a foundation-plate embracing the whole extent of the engine. It should be observed that at first, because of the large dimensions—about 23 ft. by 26 ft. 6 in. in the engines of 950 horse power—this plate has been put together in six pieces, a fact which, when its slight depth is considered, deprives it of almost all value in the very contestable point of view which could have led to its employment. The cylinders are almost wholly held by means of external horizontal lugs, and the reaction of the motive force (about 80 tons in the engines of 950 horse power) is thus sustained upon two points only in the perimeter of the cylinders. May we not here find the reason for the occasional fractures of cylinders, which happen in the larger engines? In this system the connexion between the cylinders must of necessity be slight. Finally, the inequality of dilatation of the cylinder with respect to the foundation, introduces into the system strains which should not be neglected. For the temperatures being about 250° and 125° respectively, the difference of dilatation in the whole group of cylinders is not less than ¼ in.

It should be said here that at Le Creusot they do not, properly speaking, employ foundation plates but in a very restricted manner; but they do not, because of thus suppressing them, avail themselves of hardly any advantage, for all parts suppressed as the foundations are maintained as dependencies of the cylinders and condensers.

"In conclusion, it is at least doubtful whether the system practised in France possesses more solidity, and at the same time useful rigidity, than the mode followed by the English constructors. It certainly causes a notable increase in the total weight and of the cost of construction. It uselessly augments the volume of the engines, especially in height, at the expense of the space so necessary for the strengthening of the hull. The designs exhibited by the Imperial Marine show that in our vessels the longitudinal stringers, of such capital importance in respect of strength, are completely wanting. This arrangement has the further disadvantage of increasing the distance between the cylinders to afford room for their external fastenings. In the three-cylinder engines of 950 horse power, the increase of distance between each pair of adjoining cylinders is about 16 in., being 4 ft. for the whole machine. A still graver objection is that of the increase of distance between the bearings of the main shaft. In the 950 horse power engines, of which the stroke is 4 ft. 3 in., this distance is increased from 8 ft. to 9 ft. 4 in. The strains tending to bend and break this principal member of the machine, and of which the conservation is so delicate, is thus increased in the same proportion, or about 17 per cent.

"M. Normand would not go to the bottom of this special question, until now too much neglected—the measure of the *real* fatigue of the shafts of marine engines. It should be recollected that these parts are subjected to two distinct kinds of strains—a strain of *torsion*, the *net* result of the work of the pistons, and a strain of *flexion*, which in all engines of short stroke so much exceeds the first kind of fatigue, that it alone remains to be considered. The mode of construction of the large engines of the French section aggravates still more, then, the situation already so unfavourable."

At an earlier period in his remarks, M. Normand paid a high compliment to Messrs. Penn's engines, not only in respect of their fine workmanship, but also of their arrangement. By the employment of the trunk, the connecting-rod is kept on the cylinder side of the shaft, leaving no moving parts on the other side but the air, bilge, and feed pumps, and it is thus that Mr. Penn finds room, with perfect accessibility to all the parts, for the very large surface-condensers which form so prominent and valuable a feature of his later designs.

OMNIBUS SUBWAYS.

MR. PETER BARLOW has published the prospectus of a scheme which, if we could take his word for it, would revolutionise railway engineering—dispensing with steam, and, indeed, nearly all other power, and reducing wear and tear to almost next to nothing. He proposes to drive a system of tubular subways under London—first of all under the Thames, near the Tower, and to work carriages through them, each weighing two tons, loaded, and containing 12 passengers, the motive power to be that of *one man*! Mr. Barlow estimates the friction of his omnibus, running on a very accurately laid railway, as 4 lb. only per ton, and the resistance of the air at 2 lb. more, or 6 lb. per ton in all, or 12 lb. only for the loaded carriage! He proposes to make the quarter-mile run of the Tower subway in 2½ minutes, or at the rate of six miles only an hour. With "two and a half men," however, which means, we suppose, two men and a boy, the run can, he says, be made in one minute, or at the rate of fifteen miles an hour, which is more like what the public would require.

Of course, if safe railway carriages can be made to weigh no more than the weight of the passengers carried—the present ratio being as from three to five tons of carriage to one ton of passengers, and if the resistance to motion may be diminished to but from 4 lb. to 6 lb. per ton, Mr. Barlow's scheme may answer; but so, of course, a reform could be made in all our ordinary railways, which would save something like eight millions yearly in their working expenses, equal to 2 per cent. additional dividend upon the 400,000,000l. invested in British railways.

Mr. Barlow proposes to drive his cast-iron tubes horizontally through the soil by means of powerful hydraulic pressure; and between stopping-places (for he dispenses with stations) he proposes to let the line descend for halfway and then rise again,

so as to help the carriage off on starting, and help also to bring it up without brakes in stopping. The passengers are to be lowered to and lifted from the tubes by hydraulic lifts.

The plan reminds us somewhat of the proposition printed a few years ago by a shareholder in the Great Western Company, who insisted that the trains on the branches of the company's lines might be worked each by a horse, mounted on an endless railway in the guard's van, and who would thus work the train at 10 miles an hour, while, "if whipped up," the poor brute would "easily" do twenty!

RAILWAY FOUNDRY AT MADRAS.

THE 600 miles of the Madras Railway, with the exception of the Bangalore branch, were originally laid with wooden sleepers and ordinary chairs. The sleepers, however, did not last much more than twelve months under the energetic attacks of the white ants, and it was found, too, that the native workmen would not take proper care in packing them. Since Greaves's pot sleepers have been put down the maintenance of way has been lessened to from 65% to 70% per mile per annum, where before it had cost at least twice as much. The natives, too, attend properly to the packing of the pots, which is an easy matter in which they can hardly go wrong.

The Madras Railway Company have lately made a contract with Messrs. Hopkins, Gilkes and Co., of Middlesboro'-on-Tees for 10,000 tons of Greaves's sleepers, and these are about to be cast, in Madras, using the old railway chairs, of which there are many thousands of tons, and melting with native coal. Messrs. Hopkins, Gilkes, and Co. are sending out two of Woodward's steam-jet cupolas, an invention which appears to have now established itself beyond question in the favour of ironfounders. Mr. Thomas W. Bayes, the engineer in charge of this work, left London for Madras on Sunday evening last, and it is anticipated that he will soon have the foundry erected and at work.

COMPOUND RAILS.

AN experiment is being tried upon a mile of the South-Eastern Railway, the details of which were privately communicated to us, a few weeks since, by the engineer of the line, Mr. Peter Ashcroft. As the result of the experiment was to some extent uncertain, and could only be determined after a considerable lapse of time, we were naturally requested not to make it at once public, and as naturally saw the propriety of delay. The subject of the experiment, however, a compound steel and iron rail, made in three parts, has since been published, without sanction, in one of the mechanical newspapers, and we may now therefore describe and comment upon it.

The compound rail consists of a T-shaped steel bar, weighing 45 lb. per yard, bolted by steel bolts between a pair of L-shaped angles, weighing together 64 lb. per yard, the whole thus weighing 109 lb. per yard. The separate lengths break joint equally with each other. The Lancashire Steel Company are making 200 tons of this way, at a cost, for steel and iron, of 9 guineas per ton, equal for each mile of way to a 73 lb. steel rail at 13 guineas per ton.

This compound structure, the cost of which is thus practically the same as that of steel way, would be expected to have the usual durability of steel, in so far as the wear of the head of the rail is concerned, and it will probably have about the same vertical strength as a steel rail, possibly, however, rather more. If it were the fact that steel, when made by makers of repute, and under due inspection, was brittle, the compound rail would have the advantage of the toughness of its iron angles, supposing, of course, that these were tough. Engineers can now, however, so easily satisfy themselves of the extraordinary toughness of steel rails, of good makes, and can so certainly secure the same toughness by enforcing the test of trying one rail taken at random from every fifty, by dropping upon it a ton weight from a height of from 20 ft. to 30 ft., the rail being supported on 3 ft. bearings, that no apprehension can be felt upon this point.

The slight difference in the expansion of the steel and iron is of course provided for by making the holes, for the bolts which bind the separate lengths together, a little oblong.

But the main consideration with respect to all compound rails is, will not the separate parts wear upon each other, slightly at first, and more rapidly afterwards? Almost the identical form of rail under notice, except that it was all in iron, was held together by rivets instead of bolts, and was hardly heavier than the ordinary single rail which it replaced, was used,

for some years, but not, we believe, since 1856, on the Baltimore and Ohio Railway, in America. It was designed by Mr. Benjamin H. Latrobe, the chief engineer of that line, and was known as "Latrobe's three-part rail." Many sections of compound rail in which the rail is divided, in various forms, into two parts, have been extensively tested in the States, but not, we believe, with permanently satisfactory results. None, we believe, are in use there now. Holley's *Railway Practice*, an important work, insufficiently known in this country, gives (page 179) what little information is to be had, and the author there speaks with some degree of favour of the compound system. The general fact is that compound rails have commonly failed, after a comparatively short period of use, by the separate parts knocking against each other under the action of continued traffic. Mr. Ashcroft's plan is better than that of the American compound rail, inasmuch as it is much heavier (and, of course, more costly), its wearing part is of steel, it has a broad base, and its separate parts are held together by bolts, which may be tightened when necessary. We shall await the results of experience with this new line, and hope sometime to give our readers the results.

THE RICHARDSON PROCESS.

It is only a very short time since we regretted the absence of a sufficient number of facts and practical data concerning the Richardson process and its practical results, and now such facts are crowding in as fast as we can recount them. The Richardson process has been taken up by Mr. Beardmore, of the Parkhead Forge, Glasgow, and a number of puddling-furnaces have been fitted with the simple apparatus required for this mode of puddling. The first charges were made about three weeks ago, and since then two of the furnaces have been kept constantly and regularly working, each furnace making six heats per day from grey pig iron of the same mixtures which are used in the common puddling-furnaces at the Parkhead Forge. The blast is provided by a small horizontal blowing-engine of a peculiar construction, designed by Mr. A. Kirk, of the firm of James Aitken and Co., Glasgow. The steam cylinder is apparently about 14 in. in diameter, and about 2 ft. stroke, the blowing cylinder has a trunk, or large hollow piston-rod, which contains the suction-valves, the outlet-valves being at the upper part of the cylinder on the outside. The pressure of air in the receiver is 8 lb. per square inch, but the blast is considerably reduced in its pressure by being conducted to a considerable distance in narrow pipes with sharp corners and varying sections, so that the actual blast pressure may be estimated at 4 lb. or 5 lb. at the utmost. The furnaces have not been altered in any way for the application of this process, and the mode of working up to the introduction of the blast is exactly the same as usual. The blast-pipe, or tubular rabble, has been altered from its original form, the numerous small holes through which the blast used to be subdivided having been supplanted by one broad slit or rectangular opening about $\frac{1}{4}$ in. wide and 3 or 4 in. long. This is more easily kept in order and clean from slag. Two or three rabbles of this kind are fitted to each puddling-furnace for being used alternately, in order to prevent overheating and destruction of the rabbles; each rabble is connected to the blast-pipe by a long flexible tube of india-rubber. The blast is turned on before the rabble is introduced into the furnace, and continued for a short time after extraction, so as to prevent the mouth from being choked up by the cinders.

The manipulation is identical with common puddling, the tubular rabble being stirred and moved about in the furnace instead of the common rabble; but the time, from the melting of the iron to the "boil," is reduced to ten minutes with a quality of iron which usually took from twenty-five to forty minutes to undergo the same change. At the beginning of the process the sparks, characteristic of the period of desilicatisation, are thrown out of the furnace through the small hole in the door, through which the rabble passes. At a later time the furnace fills with a voluminous bright flame. The tubular rabble is withdrawn when the iron begins to boil, to prevent loss of iron by its being thrown out of the furnace. The plain rabble is then inserted, and the charge completed by common puddler's work. The total saving of time under the circumstances now existing at the Parkhead Forge may be estimated at an average of twenty-five minutes per heat, the loss of iron is diminished, and the quality most decidedly improved. We have seen bars at the Parkhead Forge made from the same mixtures of pigs, in the same kinds of furnaces, and by the same set of men, with and without the assistance of the Richardson apparatus, and

the difference in the quality of the mill-bars produced is so marked and so much in favour of the Richardson process as to be quite conclusive. The mill-bars produced are of a very good quality in both cases; but those made by the new process bend cold round a sharp corner to a right angle, while the others crack after being bent to less than half that amount. The fracture of the new material has also a much finer and more uniform grain of iron, and under the microscope shows an effect much more resembling the softest kinds of steel than the common kinds of puddled bars. There has not being a single spoiled charge or bad bar produced throughout the entire time of working at the Parkhead Forge, and the products of the Richardson process are used for the best qualities of articles, each mill-bar undergoing a test for its quality before its being employed. The puddlers find no difficulty in managing the apparatus, since virtually the character and method of their work has not been changed in any respect, and is only reduced in quality or duration in one particular stage of the process. It is very probable and, in fact, also visible that the iron is raised to a higher temperature by the action of the blast than it attains by the old puddling process, and this may cause the iron to take a somewhat longer time in balling, as it has to cool down to its point of solidification from a higher heat. There is, however, a tendency amongst the workmen to protract this period purposely beyond its necessary limits, as they seem to fear an interference with their present rates of wages in case of their power of production being "unduly" increased. The balls made are very large, there being only three taken out of one heat of 4 cwt.; and they are hammered into blooms, two balls by preference taken from different furnaces being piled together to form each bloom. We have seen several charges in succession made by the Richardson process at the Parkhead Forge; we have timed one charge, the furnace having been settled fresh before its introduction, and its total time from charging to the removal of the third and last ball was 1 hour 17 minutes. The rabbles remain in good working order for a very long time; they are cleared of all adhering matter immediately after their being withdrawn from the furnace, and they can be dipped into cold water without injury, same as the common puddler's tools. Further experiments and an immediate extension of operations are about to take place at the Parkhead Forge, where the success hitherto attained gives every reason to expect the most important advantages from the improved mode of working.

WOODWARD'S STEAM-JET CUPOLA.

THE use of the steam jet to create a draught in a narrow chimney has been understood ever since Trevithick thus employed it in 1803, or, at least, since Nicholson fully described its action, and patented certain applications of it, in 1806. A steam jet was tried many years ago at Caerphilly, in the wide throat of a blast-furnace; but Mr. Edmunds, who made the experiment, soon found that it would not answer merely because the throat of the furnace was so wide that the jet drew its air, not through the charge below, but from the large space immediately about it.

In the small chimney of the locomotive, as used by Trevithick and by Hedley, long before George Stephenson could bring himself to see its advantage, the steam-jet, whether of waste steam or live steam, is effective, and is found not to be greatly more costly, even with live steam, than would the working of mechanical blowers delivering the same volume of blast, at least where the blast is to be delivered under the slight pressure required for cupola furnaces.

Messrs. Woodward Brothers, of the Queen's Foundry, Ancoats, Manchester, have now erected upwards of sixty cupolas having closed tops and charging-hoppers, and having a narrow sheet-iron chimney-flue, taken off at the side, through which a jet of live steam is discharged as the only means of producing a draught. Engines, fans, or other blowing machinery are thus completely dispensed with.

Some of these cupolas have been at work since April, 1865, and among those who have been supplied with them are Messrs. Robert Stephenson and Co., Messrs. Galloways, of Manchester, Messrs. Beyer, Peacock and Co., Messrs. Dobson and Barlow (Bolton), the Manchester Steel and Plant Company, Messrs. Jack and Co. (Liverpool), and many other well-known firms. The Norton Iron Company, whose furnaces are near Stockton-on-Tees, state that they are melting in these cupolas at the rate of one ton of iron to one cwt. of coke, and in general practice we are informed, upon good authority, that $1\frac{1}{4}$ cwt. of coke to the ton of iron suffices, except with very small castings, when the coke rises to $1\frac{1}{2}$ and even $1\frac{3}{4}$ cwt.

The consumption of coal under the boiler to supply steam for the draught is 1 cwt. for each ton of iron melted, and often the cheapest slack, worth less than one-fourth or even one-sixth as much as coke, is used for this purpose.

The rate of melting is about 15 cwt. per hour, per foot of diameter of outside casing, although, with more steam, a greater cast may be made. It has been alleged, too, that the iron cast from the jet-blown cupola is somewhat stronger than that cast from fan-blown furnaces, but we have no positive information on this point.

Messrs. Hopkins, Gilkes and Co. have sent two of Woodward's cupolas to Madras, to melt down the iron for their contract with the Madras Railway Company, for 10,000 tons of cast-iron chair-sleepers.

THE HONDURAS RAILWAY.

BEFORE English investors are taken in with the delightful prospectus of the Honduras Railway Company, proposing to make a railway through a trackless tropical forest for 8000*l.* per mile, they should remember that the comparatively easy works of the Panama Railway, 49 miles long, cost 32,000*l.* per mile, and occupied eight years in their execution, during which the loss of life among the labourers, including thousands of Chinese coolies, was frightful.

Those who wish to know what the Honduras route really is should read the account published in 1853-54 in the *Journal of the Franklin Institute*, by Mr. John C. Trautwine, an able American engineer, who carefully surveyed the proposed line of railway. In 1860 the present writer had occasion to pen the following observations:

"Mr. E. G. Squier surveyed his Honduras grant, 'employing, we believe, as an instrument of measurement a mule which travelled so many miles an hour.' The result was a report that the railroad would be 150 miles long, and cost 8,000,000 dols. (1,600,000*l.*). When Mr. Trautwine made his report, as the result of the closest investigation, that the length would be '250 miles, and the cost 30,000,000 dols. (6,000,000*l.*), he was repudiated, his report suppressed, and a tremendous effort made to muddle Lord Palmerston and Clarendon, and the French Emperor, in regard to the whole affair. These tactics, however, did not answer, and the Honduras grant, originally held at 600,000 dols., could now be had, doubtless, at a much 'lower figure.'"

BREECH-LOADING REVOLVERS.

THE *Pall Mall Gazette* has done good service by its clear, well-reasoned, and dispassionate statements of the advantages of breech-loading as compared with capping revolvers. The objections to central-fire, copper-cased cartridges have, happily, been well-nigh silenced. They are not liable to explosion from any cause, except, of course, they are smartly struck upon the igniting point, nor, with a dozen or more cartridges placed together, is the explosion of one communicated to another. Nor does the powder deteriorate. The copper-cased cartridge shoots as "hard" as will the same weight of powder in any other form of casing, and it of course shoots just as accurately, simply because the breech-loading action of a firearm has nothing to do with accuracy of shooting, this being wholly a question of weight of charge, form and weight of bullet, of the bore, length, rifling and truth of the barrel, and of the accuracy of aim. Breech-loading ammunition, too, has actually become more readily procurable than any other, both in England and abroad.

The Government, it appears, have determined upon abandoning capping revolvers in favour of a breech-loader submitted by Messrs. Adams, and the subject of converting the muzzle-loading revolvers is under consideration.

STEEL-TOPPED IRON RAILS.

NONE who have any faith in the future of invention and discovery would pretend to fix limits to the degree of improvement that may yet be attained in processes which, although already carried out with some success, are not yet satisfactory. It may yet be found practicable to make a perfect weld between a steel top and an iron stem of a railway bar; but this has not been thoroughly done yet. Many trials have been made, and it was for a long time believed, by a number of engineers, that the plan pursued at Crewe, of welding steel tops to iron stems, with an intervening layer of puddled iron, would secure perfect soundness. Unfortunately, this is not the case. The steel-topped rails in use on the London and North-Western Railway have been found to show, after a time (and that oftener in warm weather), a slight crack between the steel and

the iron at one point in their length. Once opened, each successive train extends this crack until the whole of the steel top comes off as if it had been fastened by some kind of cement rather than by welding. We have been shown large numbers of the tops which have so peeled off, and no doubt any gentleman really interested in knowing the facts will be shown the same dis severed *caputs*, on application in the proper quarter.

INDIA AND HER RESOURCES.

THE Indian correspondent of the *Times* observes, with reference to our Indian empire: "It may be safely asserted that next to England itself there is no country financially so sound. Her debt is not twice her revenue; for political reasons her population are so lightly taxed as 8*s.* a head; and she spends on public works, including guaranteed railways, close on twelve millions a year, or one-fourth of her whole revenue, and that not out of loans. It is not too much to say that if the necessity of paying some two millions sterling a year as interest on guaranteed railway capital, and of occasionally advancing such capital, had not occurred at the very time when the mutiny involved the expenditure with which Messrs. Wilson and Laing had to deal, India would have had a permanent surplus, like England. That interest is now being paid back, and the guarantee does not now involve so much as half a million a year. But there are two reasons why, in spite of this, a surplus will never be realised without new sources of taxation. Railway extension involves new guarantees, and there are four or five lines which for imperial and local purposes this generation must undertake—from Delhi to Baroda, the surveys of which are sanctioned; the Indus valley, from Mooltan to Kotree; more important than both, the line from Lahore to Peshawur; small cross lines north and south from Berar to Agra, most important in a military sense, as connecting the three which radiate out from Bombay eastward; a line from Calcutta to Darjeeling, and an extension of the Eastern Bengal line from Goalundo into the Assam valley, and towards the old route to China and Burmah, through Munnipore. The second reason is the frightful pace at which the extraordinary development of progress in India is adding to the expense of the civil administration. Seven millions have been added to the civil charges in as many years, and only the tight hand of Sir John Lawrence keeps the amount from being doubled. The rise of prices and the improvement of the governing machinery go hand in hand, and must continue to increase our expenditure at a far greater pace than the revenue will increase if left to itself."

METROPOLITAN TRAMWAYS.—The Metropolitan Tramway Company (limited), whose scheme we noticed last week, have given notice of intended application to Parliament for power to lay down street tramways for the conveyance of passengers and other traffic. Tramway No. 1 is proposed to commence from the Archway-road, near Highgate, and to pass along the Holloway-road, Upper-street, Islington, High-street, and City-road, to Finsbury-place. Tramway No. 2 is to commence in the Seven Sisters-road, pass along Park-road, Camden-road, High-street, Camden Town, Hampstead-road, and Tottenham-court-road, to near Oxford-street. Tramway No. 3 is to start from Union-street, Whitechapel, and to pass along the Whitechapel-road to the Broadway, Stratford. Tramway No. 4, from High-street, Clapham, to Kennington-park-road, Lambeth. Tramway No. 5 to extend from Kennington to Brixton-hill. Tramway No. 6, from Kennington to Westminster-bridge. Power to purchase lands and to make agreements with the street authorities. Each tramway is to occupy 5 ft. 3 in. in width. Power to raise money, and to reserve to the company the exclusive right of using carriages on the tramway with flange wheels adapted to run on edge rails. Another company has given notice of intended application for power to construct thirteen street tramways in Southwark and Lambeth. No. 1 is to pass along the New Kent-road, from St. George-the-Martyr, Southwark, to Camberwell. No. 2, from St. George-the-Martyr to Newington. No. 3, along the centre of the Westminster-bridge-road to Christ Church, Southwark. No. 4 to pass along the centre of the London-road and Blackfriars-road to Southwark-street. No. 5 from the Westminster-bridge-road to the Elephant and Castle. The company reserve the exclusive use of the tramways, having carriages with flange wheels adapted to run on the groove rails.

CHINESE GRASS.—The Duke of Devonshire writes to the *Times* to say that he is one of the 9000 who has planted Mr. Hallett's Chinese-grass seeds. His Grace had them planted however, three weeks later than the proper time. He writes: "They quickly 'entered an appearance,' grew, and flourished, without any further care or attention; and at the end of last month, the canes (of which there are from three to six on each plant) were nine feet high, with large heads of seed on them, which I fear will not thoroughly ripen owing to the late planting. Had they done so, I should say some of the heads would have borne as many as 5000 seeds. I think very few of Mr. Hallett's adversaries would care to face him armed with one of the canes, which are large in proportion to their height."

M. M. PETIN, GAUDET, AND CO.—The profits realised by this concern (otherwise known as the Naval and Railway Blast Furnaces, Forges, and Steel Works Company) amounted in 1866-7 to 145,799*l.*, as compared with 177,684*l.* in 1865-6. Although the profits somewhat declined in 1866-7, the total sales effected by the company in 1866-7 amounted to 1,374,178*l.*, showing an advance of 46,559*l.* as compared with 1865-6. The decline in the profits of 1866-7 is attributed to the general fall in the prices of metallurgical products, and to large expenses incurred in connexion with the Paris Exhibition. The company's productive resources are such that it can now turn out 60 tons of Bessemer cast steel per day.

THE MALTA AND ALEXANDRIA CABLE.—This line has been repaired, and is again in good working order.

A "TIN-POT" RAILWAY FOR ABYSSINIA.

A FORTNIGHT ago, we casually described Mr. Hadden's curious proposition for a sheet-iron railway in Abyssinia. A week later, our nimble contemporary, *The Engineer*, found out what we had said and repeated it almost, but not quite, in our own words, adding the illustration of a wooden to show what this wonderful railway would be like; and the *Times* has copied this descriptive text, omitting the woodcut. The young gentleman of *The Engineer* says, however, that Mr. Hadden's sheet-iron or tin-plate railway is "simple and practical," whereas we never said *that*. We will not object to adopt the first adjective; but it must in that case have its most extended application, extending even to the designer as well as to the design. Fortunately for the expedition (whether fortunately or otherwise for Mr. Hadden), Sir Robert Napier is himself an engineer, and he will be able, when he receives our present number, to compare our opinion of Mr. Hadden's temporary way with his own.

Mr. Hadden proposes to make either longitudinal or cross sleepers of flattened cylinders of sheet iron, closed at one end, and which are to be well rammed inside with sand or earth, like feathers in a bolster, and then closed also at the other end. These sleepers are to be so light that, before being filled, one man can easily lift one, weighing, say, 50 lb. or 60 lb. Once packed, these sleepers are to be laid on the ground, with little or no ballast, and the rails secured to them by clip pieces, one rivetted on and the other "made to turn like a door-button," and, the latter being turned and tightened, we are told that "all is secure!"

The thickness of the sheet iron is not given, but we suppose it may be $\frac{1}{4}$ in.; possibly more. Let the gaffer of a gang of men on an English line be shown a flattened sheet-iron cylinder $\frac{1}{4}$ in. thick, and large enough for a railway sleeper, and be told to ram it well with "sand, earth, or other convenient materials." He would, in all probability, burst it in ramming, or, at any rate, take the flats out of its sides, leaving it of nearly a cylindrical form. Then would come the closing of the end, perhaps by a lid, like that of a gas retort, but involving some care and fitting. When laid and used as a sleeper, it would receive a new kind of ramming—externally. The "earth or sand" would then yield to some extent, leaving a partial hollow within, and the sheet iron would rumble and crackle in fine style under passing loads, and would not probably be long in splitting open even if its closed ends did not burst, as would be more than likely. The sheet iron, lying on the bare and often stony ground, would soon be worn into holes, when the "sand, earth, or other convenient materials" would escape, and the sleeper would then offer no more resistance than a cigar-case. Really, we doubt if good, tough hides would not be more durable and altogether better than sheet iron. They could not be much worse. They would pack far better on board ship, in sending them out; for the sheet iron sleepers would claim, each, its full share of room, as if it were Norway fir of the same size. How the sheet iron would fare in the wet season, steaming in the heat, crackling under the loads, and grinding into the gravel, Sir Robert Napier, as an engineer, will be fully able to judge.

Why Mr. Hadden must make his sleepers "portable," or so far portable as to be carried by one man, we cannot see, unless it is his idea to employ but one man in laying his railway. In that case this *fidus Achates* will have about 2000—perhaps more—of these sleepers to carry, on his back or otherwise, for every mile laid, and in laying the second mile, taking with him one sleeper at a time, he will have a little walk of about 6000 miles, going and coming, this pedestrian journey increasing, progressively, by 4000 miles on each succeeding mile of way! He must needs be another pedestrian Watson, and would, we must hope, be able to do his 100 miles "inside of" 24 hours, supposing no emissary of King Theodore should "pot" him or "gobble him up."

If Mr. Hadden will turn, as Sir Robert Napier will have turned by the time he sees this clever plan, to the account which we republished a few weeks ago of the laying of the "track" of the Pacific Railway, he will learn how two, and even three, miles of line may be laid per day, not by sending one or more men forward with sleepers and rails on their backs, but by carrying these to the front on railway trucks, running over the line already laid. From this account Mr. Hadden, with his 200,000 tin-pot sleepers for 100 miles of way, may learn a useful lesson, and it is sincerely to be hoped that he will not trouble Sir Stafford Northcote nor Sir Robert Napier again until he has learnt and digested it.

ENGLISH IRONMASTERS IN BELGIUM.—A contract for 283 tons of Bessemer cast-steel rails, required for the Belgian State Railways, has just been let to the John Cockerill Company, at 12*l.* 11*s.* 6*d.* per ton. The second tender was that of the Barrow Hematite Steel Company (13*l.* 8*s.* 4*d.* per ton). Charles Cammell and Co. (limited), Sheffield, also tendered at 14*l.* 15*s.* 1*d.* per ton. The deliveries were proposed in the English tenders to be made at Antwerp. About eighteen months since, an English firm obtained a similar contract at 15*l.* 1*s.* 10*d.* per ton. The fall in prices indicated by the present adjudication is thus no less than 2*l.* 10*s.* 4*d.* per ton.

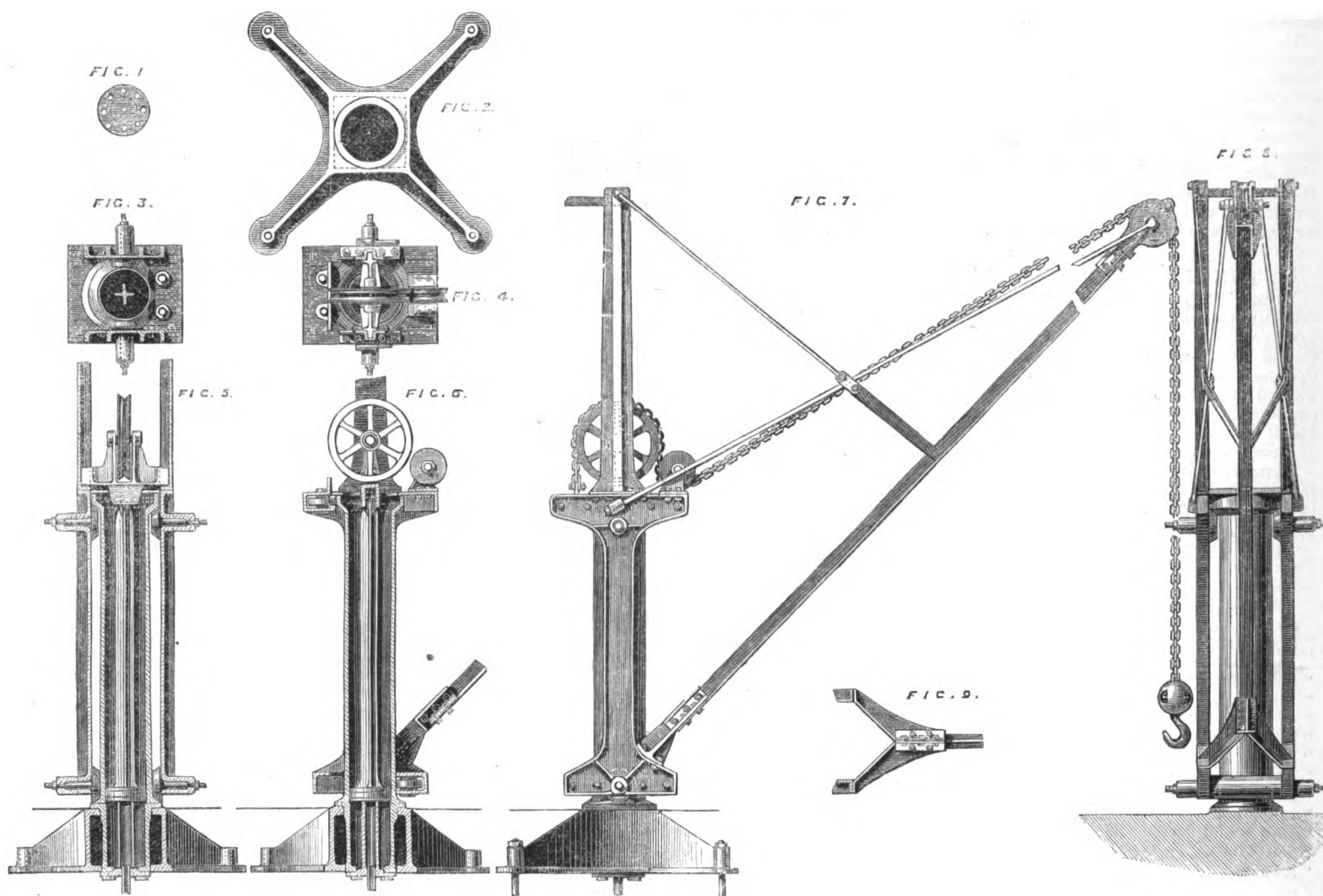
THE MONT CENIS TUNNEL.—At the close of October, 4555 metres out of the whole 12,220 metres of this tunnel remained to be pierced. During the first ten months of this year, the distance executed was 1320 metres, while during the whole of 1866 only 1025 metres were pierced. If the present rate of progress is maintained, the tunnel will be completed by 1871.

THE PARIS EXHIBITION MEDALS.—We read in the *Etendard* as follows: "On frappe activement au grand hôtel des monnaies du quai Conti les nombreuses médailles d'or, d'argent et de bronze des lauréats de l'Exposition universelle, avec leurs noms en relief sur le cartouche supporté par deux petits génies." This means, in English, that they are pounding away with all their might, at the French Mint, to get ready the gold, silver, and bronze medals which should have been struck and distributed long ago. We are glad to learn that the *lauréats* are to have their names struck, in relief, and that, too, between a couple of little geniuses.

SUBMARINE TELEGRAPHY.—A contract has been signed between the Portuguese Government and Mr. Rose, civil engineer, for a telegraph cable from Lisbon to Gibraltar.

30-CWT. HYDRAULIC CRANE, AT THE RIVER DON STEEL WORKS, SHEFFIELD.

DESIGNED BY MR. EDWARD REYNOLDS.



At the present time, when hydraulic power is becoming more and more extensively utilised at our large engineering works for lifting and other purposes, we believe that the annexed engravings of one of the 30-cwt. hydraulic cranes at the River Don Steel Works, Sheffield, will be interesting to many of our readers. The cranes in question were designed by Mr. Edward Reynolds, the engineer of the River Don Works, and there are seventeen of them in use at different parts of the establishment.

As will be seen by the engravings, the pillar of the crane is formed by the hydraulic cylinder, this latter being 12 in. in diameter, and being made of metal $1\frac{1}{4}$ in. thick at the bottom and 1 in. at top. The lower end of the pillar is slightly tapered, and is tightly fitted into the boss of a cruciform casting 1 ft. 6 in. deep at the centre, and measuring 4 ft. 4 in. across the arms. This casting is securely bolted down to the foundations of the crane by four $1\frac{1}{2}$ in. bolts; the foundations being simply formed of four baulks of timber, disposed in pairs so as to form a double cross. The water which is supplied at a pressure of 100 lb. per square inch, is led into the bottom of the cylinder by a 2 in. wrought-iron pipe, the cylinder cover, to which this pipe is connected, having a 3 in. tube cast on it, as shown in the vertical section, so as to form a rest for the piston when the latter is at the bottom of its stroke.

The piston, which is 4 in. deep, is cast in one piece with the piston-rod, this latter being of cruciform section, measuring 5 in. across the arms, where it joins the piston, and 5 in. across near the upper end. The top of the piston-rod is cylindrical, and enters a socket formed to receive it in a cast-iron crosshead, having arms working in cast-iron guides carried by the framing of the crane. The socket is fitted with a piece of brass against which the rounded end of the piston-rod bears, and as the latter is not secured in the socket, the frame of the crane, and with it the crosshead, can turn round without imparting their motion to the piston.

Referring to the engravings, it will be seen that the crosshead just mentioned carries a grooved chain-pulley, and over this pulley, which is 2 ft. 1 in. in diameter, the chain of the crane is led. A $\frac{5}{8}$ in. chain is used. On its way from the jib-pulley, the chain is first taken under an 11 in. grooved pulley carried by the framing, then over the crosshead pulley, and is then brought down and secured to the framing, as will be seen from the side elevation. It follows from this arrangement that the lifting motion imparted to the end of the chain is equal to twice the motion of the piston, and the stroke of the latter—6 ft. 10 in.—would therefore suffice for a lift of 13 ft. 8 ft. The jib of the crane is formed of 4 in. by 4 in. T iron, and it has a radius of 13 ft. 6 in., whilst the centre of its end pulley is 14 ft. 6 in. above the ground level. The upper end of the jib is supported by a pair of tie-bars 14 in.

in diameter, and to these bars struts are led from the jib about the middle of its length, as shown in the elevation. The lower end of the jib is bolted to castings which branch out laterally to the side frames of the crane, against which they abut, as shown in the figures.

The side frames, which are of cast iron, are for the greater part of their height 9 in. wide, this width being, however, increased to 2 ft. 9 in. at the upper and lower ends. The frames are stiffened by flanges 3 in. wide, and the thickness of metal in them is $\frac{1}{2}$ in. throughout. The frames are tied together by cross-stays, and are kept in their places on the crane-post by four pairs of rollers, arranged as shown in the various views. From these it will be seen that two of the pairs of rollers are vertical, and bear against conical collars at the top and bottom of the crane-post respectively; whilst the other two pairs are horizontal, and serve to prevent the frame from tilting. Thus the lower pair of horizontal rollers bear against the crane-post on the jib side and take the thrust of the jib, whilst the upper pair bear against the opposite side and take the pull of the tie-bars. There is no special arrangement for swinging the crane, as, the weights lifted by it being comparatively small, it can be readily swung by hand.

The cranes at the River Don Works, of the pattern which we have described, are formed to do their work well, and, from the simplicity of the construction, there is but little liability for them to get out of order. All the parts also are thoroughly accessible for inspection and repair. Our engravings have been prepared from a tracing kindly supplied by Mr. Edward Reynolds, by whom, as we have stated, the cranes were designed.

ROOTS'S BLOWER.—Although an application of an old invention, the rotary blowing-machine for cupolas and smiths' fires, brought out by Messrs. Roots, of Connersville, Indiana, U.S., is pronounced, by our American correspondents, to be the best for the purpose now known there. This is what is said of it by Mr. A. L. Holley, the well-known author of *Ordnance and Armour*, himself a practical mechanical engineer and now manager of the Pennsylvania Steel Works in the States. Mr. Hudson, the superintendent of the Rogers Locomotive Works at Paterson, U.S., while on a visit to London, spoke to us in high terms of this invention, and so does Mr. Dudgeon, of New York, who is now in London. Messrs. Thwaites and Corbitt, of Bradford, have made a number, under license from the patentee, and are carefully watching their working before bringing the new blower prominently before their connexion. Questions have so often been raised as to the validity of the patent, that this firm has taken counsel's opinion upon the matter, and which is in favour of the validity of the patent, as protecting the particular construction and application of this machine.

MESSESS. CHARLES LAFITTE AND CO.—Mr. George Bate, civil engineer, of 17A, Great George-Street, Westminster, formerly a director in the company of Messrs. Charles Lafitte and Co., and who failed some time since for upwards of 300,000*l.*, applied for an order of discharge from bankruptcy on Friday last. His accounts disclosed debts and liabilities to the amount of 322,280*l.*, and there were practically no assets. Of the liabilities, 230,000*l.* were under Chancery suits instituted by the shareholders of Charles Lafitte and Co. (Limited) against the bankrupt and other directors of that company, the National Bank, and the International Contract Company. At a former sitting the bankrupt passed his examination, the consideration of the order of discharge being adjourned in order to give to creditors the opportunity of coming forward to oppose. No opposition was now offered, and his Honour, having remarked upon the magnitude of the figures involved, said that as no creditor objected the desired order of discharge would be granted.

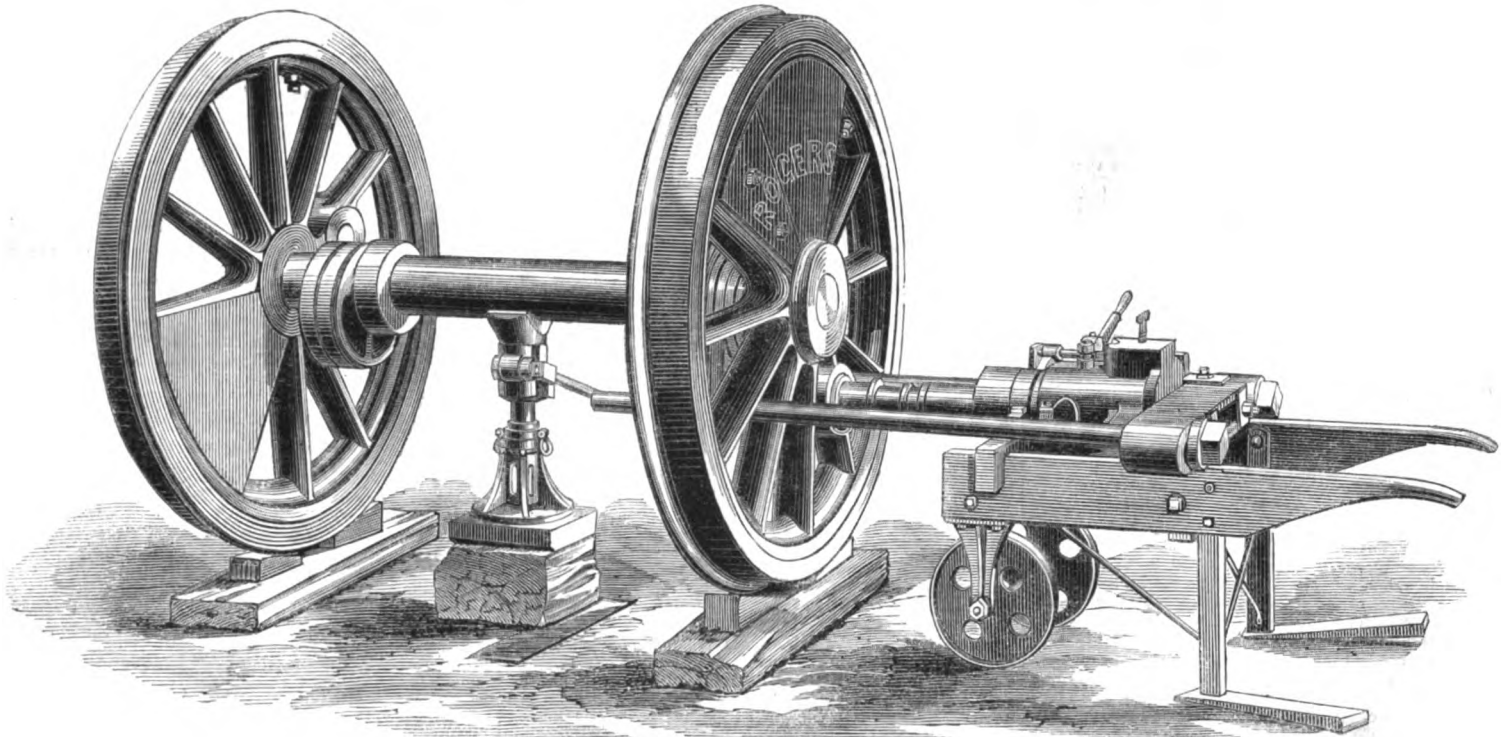
ACCIDENTS IN IRONSTONE MINES.—There were 81 violent deaths in the year 1866, in the inspected ironstone mines in Great Britain, an increase of 12 over the number in the preceding year; in the South Wales district the destruction of life amounted to one death for every 42,000 tons of ironstone raised; 41 of the deaths, half the whole number, were from falls of roof or of ironstone. Mr. Brough has to report a disgraceful case in Breconshire, in which the law was deliberately set at defiance, and two young women employed in the mine, one of whom was killed in a moment by a heavy fall of stone. The sub-contractor acknowledged that he employed the women because he found their labour cheaper than that of men. He was fined 5*l.* in each case by the magistrates; but the charge against the head contractor and overseer was dismissed. The inspector considered the latter the more guilty of the two.

THE NORTH-WEST PASSAGE.—Captain Hall, the Arctic explorer, has advised his friends in New York, that he will winter at Repulse Bay, and in April next will start with eight men for King William's Land, on his search for Sir John Franklin.

THE FATE OF THE RHONE.—During the lull which occurred at all places over which the hurricane passed, at about one o'clock, the Rhone put out. She had safely passed through a rocky channel leading to the open sea, but one more point to round and she was safe, when in a moment from the S.E.—whereas previously it had blown from the N.W.—the cyclone came down upon her with even more dreadful energy than ever. Twice she struck, and boats and spars and sheep-pens flew across the deck; then she parted amidships, the stern portion swung round, and the waves, rushing in between her decks, ripped them up as though with an explosion of gunpowder. And then and there she sunk in deep water with all on board, a very few only being afterwards saved.

HYDRAULIC PRESS FOR INSERTING LOCOMOTIVE CRANK PINS

DESIGNED AND CONSTRUCTED BY MR. RICHARD DUDGEON, ENGINEER, NEW YORK.



THE neatly arranged and useful machine which we illustrate above is one for inserting the crank-pins in, and withdrawing them from, locomotive wheels by hydraulic power. It is designed and constructed by Mr. Richard Dudgeon, of New York, whose admirable tube-expander, described in our columns some time ago, is now coming largely into use in this country. The machine consists of a hydraulic press mounted horizontally on a simple carriage for convenience of moving from place to place. In using the machine for forcing in a crank-pin, it is placed as shown in the engraving, the transverse stay at the back of the press being connected, by a pair of tie-bolts, with a similar stay placed inside the wheel-boss. The ram of the press bears directly on the end of the crank-pin, and the pressure is applied by working a small pump arranged on the top of the press-cylinder. For withdrawing a crank-pin, it is only necessary to draw back the ram and push the whole machine forward, so that a piece of iron can be interposed between the inner cross-stay and the inner end of the pin. A tube is then placed around the pin outside the boss of the wheel, and a cross-piece placed on the end of this tube, against which the ram of the press can bear, and then, on setting the press to work, the pin is forced out of the boss by the pressure exercised on its inner end.

The machine is, altogether, one which will be found very useful in all locomotive shops, and particularly in those in which the repairs of running engines are performed. Indeed, the convenience of performing such operations as the removal of crank-pins, &c., by hydraulic power, has already led to its adoption in this country for such purposes, and we some months ago illustrated and described a machine for removing the outside cranks from locomotive axles, which had been constructed and employed by Mr. Budge, at the works of the Great Northern Railway Company, at Peterborough. The machines made by Mr. Dudgeon are in extensive use in America, and at some of the locomotive factories to which they have been supplied they are sometimes employed for putting wheels on and withdrawing them from their axles, as well as for inserting and withdrawing crank-pins. They are made capable of applying a pressure of from 80 to 90 tons.

THE PROPERTIES OF THE CIRCLE.—Mr. H. Harbord, an ingenious gentleman of Hull, has sent the following result of his investigation of the properties of the circle to a provincial newspaper, trusting "it will afford some amusement if not practical benefit to society." The figures are as follows:

Square Root	.8862269254527
Area	.78539816339734548309993729
Circumference } of Circle }	3.14159265358938193239974016
Sum	3.92699081698672741549968645
Ratios	1.25

CANAL LIFTS.—The canal, originally surveyed by John Rennie (not Sir John, as the Exeter papers have it) between Exeter and Taunton, thus connecting the English and Bristol channels, was acquired two years ago, by the Bristol and Exeter Railway Company, whose line runs nearly parallel to it for a considerable distance. Between its summit level and Taunton, no less than seven water-balance lifts, each capable of lifting a boat and its cargo to a height of 40 ft., were constructed, about thirty-two years ago, by Mr. Green, of Exeter, and they have continued in use until very recently. The Bristol and Exeter Railway Company, however, finding that the canal was earning no money, have lately sold the lifts at auction, for old iron.

BRITISH SHIPS FOR CHINA.—The Chinese Government have just issued a set of regulations under which Chinese subjects may own foreign-built ships. They are to a great extent founded on our Merchant Shipping Act, which was no doubt introduced to their notice by Mr. Hart, the Inspector-General of Customs.

NEW RAILWAY IN WEST PRUSSIA.—The Prussian Government has recently conceded an important line of railway, which is already named the Direct Railway between Paris and Hamburg. It will extend from Hamburg, by the way of Bremen and Osnabruck, to Cologne. This line is expected to be of great service also to the cities of Kiel, Hamburg, and Bremen, as a means of supplying them with coal direct from Westphalia. Although the line has not been fully surveyed, it is expected to be completed in five years. The line is to cross the Weser, at Bremen, upon the bridge already constructed and opened for the Bremen and Oldenburg Railway.

A SERMON METER.—The Queen has fixed in the pulpit of the Chapel Royal, Savoy, a sandglass of the measure of eighteen minutes. It is devoutly to be wished that all her Majesty's clerical subjects will accept this wholesome hint, and that all "aggrieved parishioners" will subscribe to supply the pulpit of their churches with this admirable sermon meter.

RE FURNESS.—The case of Mr. Furness, the contractor, who failed about eighteen months ago, came on, again, on Wednesday, in the Bankruptcy Court, when Mr. Commissioner Holroyd decided that no further examination could be granted, the past delay having been unreasonable.

"NOTHING LIKE LEATHER."—The correspondent "Z." of the *Iron Trade Review*, upon whose letter we had occasion to comment, a fortnight ago, sends another letter to that journal, in which he is unable to offer any better evidence upon the question of steel v. iron than the following:—"The *Engineer* has a moderate and sensible article on this question on the 15th instant, an extract from which I shall be glad if you will publish, as it fully bears out the 'shallow' remarks which I made in my last letter." The *Engineer* showed us "moderation" and "sense" by declaring that a steel rail, one face of which had outworn twenty-two faces of iron rails, and which had then been broken sideways, and that after having been greatly bent by the wheels of a heavy engine thrown off the line in a collision, "had behaved exactly like an iron rail of the quality sold at 5l. per ton," and that its failure proved that the steel had been completely altered in constitution by "molecular deterioration," and argued that this instance showed that all steel rails were unsafe and liable to break at any moment! If this be "moderate and sensible," let the profession sit under the teaching of the journal in question for ever, for nine-tenths of all its articles are equally moderate and equally sensible.

THE ST. JOHN'S WOOD RAILWAY ENGINES.—Mr. Burnett, the engineer of the Metropolitan Railway, has this week had under steam, at the works of the Worcester Engine Company, at Worcester, one of the great engines making there for working the Metropolitan and St. John's Wood Railway, which has an incline of 1 in 27, three-fourths of a mile long, with a station half-way up. These engines, which we illustrated not long ago, have six coupled wheels 4 ft. in diameter; the cylinders (inside) are 20 in. in diameter, and the stroke is 24 in.

TECHNICAL EDUCATION.—Mr. Doulton has given notice that he will to-night (Friday) call attention in the House of Commons to the subject of technical education in schools.

THAMES STEAMBOAT LANDINGS.—At the last meeting of the Metropolitan Board of Works, the Works and General Purposes Committee submitted a plan of a bridge for the Westminster steamboat landing-place, and recommended that the engineer should obtain tenders from certain firms for that and other similar bridges, to the number of about twelve. The recommendation was agreed to, after the addition of some further names to the list of firms which were to be invited to tender.

REMINGTON'S CHANNEL RAILWAY TUNNEL FROM DUNGENESS TO CAPE GRISNEZ.—Plans and sections of this important project have just been registered in the Railway Department of the Board of Trade, and also laid before the Commissioners of the Treasury. The capital required for carrying out the whole work for a double line of railway is estimated at 7,000,000l., and the works are to be accomplished in from six to seven years.

THE GIBRALTAR SHIELD.—Sir John Pakington, in reply to a question from General Dunne, has confirmed, before the House of Commons, the report of the failure of the thirty-four targets sent to Gibraltar and Bermuda. A committee of inquiry has been appointed, but we think no blame can be found to attach to the makers of the shields, the faults being well known to be in the design.

INDIAN IRRIGATION.—It is understood that the Secretary of State for India is about to offer to the Indian Irrigation Company to take over the Behar and Orissa works on favourable terms—not less than par value of the shares in cash.

GAS IN CALCUTTA.—The Oriental Gas Company have divided 9 per cent. during their last financial year, 8½ miles of mains were laid as against 18½ last year, 298 new public lights were lighted, and an order for lighting 304 more has been lately received. New works are to be erected at Howrah, across the Hooghly, and these will be supplied with coal brought from but a comparatively short distance down the East Indian Railway.

THE PACIFIC RAILWAY.—The Pacific Railway has been constructed across the American continent as far as the eastern base of the Rocky Mountains. The contractors will soon cease operations for the winter on this section, and on the other which is being built eastward from San Francisco to the Rocky Mountains. It is confidently expected that this great railway will be completed by the spring of 1870.

THE FRENCH ARMY.—The active army of France on the 1st of October, 1867, the date of the last returns that have reached the Minister of War, consisted of 358,769 men in the interior, and 65,263 in Algeria, making a total of 424,032. But from that number is to be deducted about 40,000 on leave, which reduces the force to 384,032. At the same date the figures for the reserve were 226,486. The general total of the active army is therefore 610,518.

GAS-SCRUBBERS.—Mr. Livesey, of the South Metropolitan Gasworks, has designed a gas-scrubber, in which an immense wetted surface—90,000 square feet, or more than two acres—is presented to the gas by a simple arrangement of thin boards, placed within a circular tank 15 ft. 6 in. in diameter and 26 ft. high. This scrubber puts no pressure whatever upon the gas.

SOUTH LANCASHIRE AND CHESHIRE COAL.—The South Lancashire and Cheshire Coal Association has brought to a close a series of trials with regard to the various descriptions of steam coal furnished by the district. The result of the trials is pronounced eminently satisfactory.