

68 ft. depth without finding rock, and the water was 16 ft. deep. The great depth at which the rock is found at all places, except near the west shore, induced the consideration of plans of foundations independent of any support to be gained from it, except where it could be reached within a reasonable depth.

The consideration which has been given to the character of the deposit forming the bed of the river, and the changes which it undergoes, and the result of the attempted use of wooden piles in the river, not only at this place, but far above and below it, renders it questionable whether they can be driven so as to give a reliable support to the structure. The resistance of the earth and the strength of the wood will probably limit the depth to which wooden piles may be driven to about 30 ft.; and if a scour of 10 ft. should take place below the top of piles driven through that quantity of material, their supporting power will be so much reduced as to render them nearly useless. It would not be safe to drive them except by previously dredging to the probable depth of the scour, and then the timbers will necessarily be of such great length as to greatly diminish the effect of the blows of the hammer, and give them too little supporting power to sustain the imposed weight. New methods of driving wooden piles have been suggested; but the objections to their use are so great that the committee prefer other plans of foundations which they regard as more reliable for the case in hand.

The necessity of placing the foundations below the scour, and the great rise of the river at each annual flood, would require coffer-dams of more than 60 ft. in depth, and as these would be very costly and hazardous, the committee cannot recommend their use.

After a careful consideration of the subject, the committee agreed that the following plans would be entirely practicable, with no more risk or uncertainty in their use than is common in such undertakings:

1st. With the piers placed upon foundations of hollow iron piles, driven on the purely pneumatic principle, either to the rock, or where it lies at too great depth, by an expansion of their base, or driven by the use of sand or steam syphon pumps.

2nd. With piers of masonry carried below the scour of the river by the use of iron caissons, as in those built for the Susquehanna bridge, and resting on either wooden or small pneumatic piles.

3rd. With piers of masonry carried below the scour by the use of a combination of inverted and direct iron or wood caissons, the inverted caisson to be filled with masonry by the pneumatic process, and the direct caisson in the ordinary way.

4th. With the piers laid up either of solid or galleried masonry.

5th. That instead of masonry the iron pneumatic piles may be extended upwards to the bridge seat as columns of support, and strongly braced on the lines of the river and axis of the bridge.

Although expressing their entire confidence in the safety of either of the plans mentioned, the committee cannot satisfactorily decide, without more extended examinations than they are at present able to make, as to which of them it may be best to adopt, and they think it quite safe and proper to leave the selection with the engineer who may have charge of the bridge, as he will have more time and opportunity to procure the necessary data for making comparative estimates of their cost.

In the published minutes of the committee which are here appended is a description of the mode used in constructing the foundations for the Connecticut river bridge, the Susquehanna bridge, and those at the Pedee, Santee, and Harlem rivers. These include three of the plans named. The results of using one of these plans—that of the pneumatic pile—in European bridges are also known favourably to the committee.

The inverted caisson placed as deep as dredging can be conveniently carried, and then sunk still deeper, either by pneumatic process or by the use of sand or steam syphon pumps, would enable the masonry to be carried down to any depth that might be considered expedient, and perhaps do away with the necessity of using piles of any description.

By expanding the base of the masonry sufficiently to obtain the necessary bearing surface, and using concrete or rubble as a foundation for it to rest upon, it may be considered that the object in view, that is, a proper support for the pier and its load, is obtained.

At the joint meeting of the committee, and those on the Regiment of the River and Superstructure, it was unanimously agreed to adopt the plan of the minimum spans allowed by the law for crossing the main channel, namely, two of 350 ft. each in the clear; and the following preamble and resolutions were agreed upon:

Whereas the Federal law authorizing the construction of the bridge across the river at St. Louis requires, as per section XII., as follows:

Sec. XII. And be it further enacted that the bridge, authorised by the preceding section to be built, shall not be a suspension bridge, or a drawbridge with pivot or other form of draw, but shall be constructed with continuous or unbroken spans, and subject to these conditions: First, that the lowest part of the bridge, or bottom chord, shall not be less than 50 ft. above the city directrix at its greatest span. Second, that it shall have at least one span of 500 ft. in the clear, or two spans of 350 ft. in the clear of abutments. If the two latter spans be used, the one over the main steamboat channel shall be 50 ft. above the city directrix, measured to the lowest part of the bridge at the centre of the span. Third, no span over the water at low-water mark shall be less than 200 ft. in the clear of abutments.

And whereas the same law confines the question of the span over the main channel to one of 500 ft., or to two spans of 350 ft. each (clear width):

And whereas, by careful calculation, the amount of the materials and the cost of that portion of the bridge above referred to, arranged on the most judicious and economical spans for the remainder of the distance, will involve an extra cost of about three-fourths of a million of dollars:

And whereas there has been no bridge of the character of that which (in our judgment) is required at this place yet constructed, to furnish us with any reliable and certain data on the serious questions of materials and workmanship in spans of such great length: it is therefore

Resolved that we, as practical engineers, cannot conscientiously recommend to the parties in interest to venture upon the construction of spans of as great length as the maximum one prescribed by the law, and that therefore we do recommend for adoption the minimum spans allowed by the law as more economical, less hazardous in construction and maintenance, and affording ample accommodation to the commerce of the river and the port of St. Louis.

It was also resolved that, in view of all the circumstances of this case, we would recommend spans of less than 350 ft. in the clear, if the Federal laws permitted of such reduction.

In addition, it was resolved that the proper position of the west pier of the two long spans is at or near the line of low water on the St. Louis levee, and that the remaining space between the two long spans and the east shore can be most judiciously filled by spans of 264 ft. each, with spans at each end that will take in the entire width of each levee, unless it shall be found by estimate that the additional expense of the piers is considerably greater than the extra cost of spans of about 304 ft.

It is thought that while for all of the other piers the method of coffer-damming would be too costly, yet for the first pier at the low-water line on the St. Louis side, where the rock is soon reached, it may be adopted advantageously, and the masonry of the pier founded directly on the rock.

The committee examined the estimates of the chief engineer as to the cost of the foundations and piers, and are satisfied that they will be sufficient in amount. The plan on which he has estimated will probably cover the cost of that of any of the other plans, and is taken by the committee as the basis of cost of that portion of the bridge which has been assigned to them to consider. He contemplates a pier located as already mentioned on the St. Louis levee, located on the rock. The next pier will be 368 ft. east, and will divide the main boat channel. The depth of the rock below low water is 45 ft., overlaid by about 30 ft. of sand, although this depth of material changes with every flood. It is contemplated here to sink iron pneumatic piles of 8 ft. diameter until they reach the rock, into which they will be firmly secured; upon these, at the level of low water, will rest the masonry. The next pier will be 368 ft. from the last described, at a point where the rock is 83 ft. below low water. This will also rest upon pneumatic piles, which, however, will not be driven to the rock, as the cohesion of the material to their sides, and the bearing of their extended bases, will give ample support at a depth considerably less than that of the rock below. The next three spans will be of 264 ft. each, resting also on pneumatic piles. The rock at these points is still deeper than at the other places mentioned, and the supporting power will therefore be obtained in the same way. The next pier being near the east shore, he thinks it may be found advisable and safe from its position to place on wooden piles, cut off below the scour line, but in this estimate the foundations for this pier were regarded as being similar to the others.

A careful revision of the details of the chief engineer's estimate satisfies the committee that a sufficient sum in gross has been arrived at to amply cover the cost of the foundations and piers upon either of the plans which have been recommended by it for adoption at this place. The aggregate amount for these items is \$2,541,007.

In conclusion, the committee would say that in their deliberations they have been influenced by a strong professional interest in a work whose magnitude demanded of them the best knowledge, consideration, and judgment that could be applied to it. So many peculiar features show themselves here immediately below the confluence of the two greatest rivers that have ever heretofore been presented to the profession to deal with, that they have approached the problem of founding a structure of the size proposed with great caution.

Many of the committee were notified at an early day that this question would be brought before them, and at the meeting it was found that much individual examination of the subject had already been made, assisted by the practical experience which they had gained in the construction of their works. In committee, therefore, a varied and comprehensive knowledge was developed, which greatly assisted in the solution of the difficulties to be met with at this place, and it enabled the members, after free discussion, to arrive at results with great confidence. They now offer them to the Board for its intelligent examination, and would be glad to receive from it any suggestions which may occur to it on the subject entrusted to its charge.

E. S. CHESBROUGH,
W. S. SMITH,
GEO. A. PARKER,
L. J. FLEMING,
C. L. MCALPINE,
W. J. MCALPINE,
A. ANDERSON.

REPORT OF THE COMMITTEE ON SUPERSTRUCTURE AND APPROACHES.

Your committee, to whom was referred the subject of superstructure and approaches of the bridges, respectfully beg leave to report, that on examination of the charters of the Bridge Company, and the laws of Congress regulating the spans of bridges on the Mississippi river, it is found that the one authorized at St. Louis "must not be a suspension-bridge, or a draw-bridge with pivot or other form of draw, but must be constructed with continuous or unbroken spans, and subject to these conditions: First—That the lowest part of the bridge, or bottom chord, shall not be less than 50 ft. above the city directrix at its greatest span. Second—That it shall have at least one span of 500 ft. in the clear, or two spans of 350 ft. in the clear of abutments. If the two latter spans be used, the one over the main steamboat channel shall be 50 ft. above the city directrix, measured to the lowest part of the bridge, at the centre of the span. Third—No span over the water at low-water mark shall be less than 200 ft. in the clear of abutments."

The foregoing conditions are such as do not admit much latitude in the choice of lengths for the spans, particularly when considered in connexion with the cost of the necessary substructure, and the fact that the width of the river to be spanned at low water is but about 1792 ft. Among the alternatives allowed by the law as above recited, the first is, that one span

may be 500 ft. in the clear, while all the others must be at least 200 ft. in the clear. If 500 ft. should be adopted as the principal span over the main navigable channel, it should obviously be located near the St. Louis shore; and the site of the pier for the support of the western end of this span should be at or near low-water mark on the St. Louis levee, where a solid rock foundation will readily be obtained. To insure a clear opening of 500 ft. between the piers, the length of truss required cannot be much less than 520 ft., making the point of location for the next pier at that distance from the levee, leaving the space to be filled between it and the Illinois shore 1272 ft. This space of 1272 ft. admits of being filled with six spans of 212 ft. or five spans of 254½ ft., or with four spans of 318 ft., or with three spans of 424 ft.

The second alternative is to build two spans of 350 ft. each in the clear, requiring a length of truss of about 368 ft. Beginning at the point of location of the first mentioned pier at low-water mark on the St. Louis levee, after putting in the two spans of 368 ft. each, there will remain a space of 1056 ft., which may be filled with five spans of 211½ ft., or with four spans of 264 ft., or with three spans of 352 ft. From low-water mark on the Illinois shore to the proper point for an abutment on the east side of the East St. Louis levee is 160 ft., making the whole distance from the second 368 ft. span, 1216 ft., may be equally divided into four spans of 304 ft. each.

The further consideration of this question involves a knowledge of the regimen of the river at this place, and of the foundations for the piers. Therefore, the committee on this subject requested a joint meeting of those to whom these questions had been referred. Such a meeting was held, and after an elaborate discussion of the whole subject, it was unanimously resolved by the members of the joint committee, "That, under the circumstances of the case, it is expedient to construct the spans over the main channel of 350 ft. in the clear;" and they expressed by resolution "their unqualified disapprobation of spans of 500 ft." The joint committee also recommended the arrangement above described of spans of 264 ft. between the main channel and the east shore.

It was proved in joint committee that the cost of a span of 520 ft. will be more than twice as great per foot of bridge as a span of 368 ft., and not less than three times as great as a span of 304 ft.; consequently, the cost of one span of 520 ft. will be equal to the two spans of 368 ft., and one and a half spans of 264 ft.; that is, for the cost of one span of 520 ft., no less than 1150 ft. of bridge in spans of 368 ft. and 254 ft. may be built.

Two general plans for the superstructure and approaches of the bridge have been considered by your committee, one involving the use of four trusses and the other of but three trusses for each span. The plan contemplating the use of four trusses, provides a clear space of 14 ft. in width between the two middle trusses, to be occupied as a railway, with four rails, to accommodate the three different gauges of the lines centring at St. Louis. Between the middle and outside trusses, clear spaces of 17 ft. each provide for two carriage-ways, either one of these carriage-ways being of ample width for the passage both ways of street cars, and all the common vehicles of travel and transportation. Outside of all the trusses, two side-walks, 8 ft. each in the clear, with substantial railings, are to be added, making the whole width of superstructure 75 ft.

The second general plan contemplates but three trusses per span, omitting one double-track carriage-way and one sidewalk. In other respects this plan is much like the one first mentioned. Of these two plans, the first seems best adapted to the wants of St. Louis and the public generally, and is, therefore, the one which the committee would recommend.

Beginning at the low-water mark at the St. Louis levee, two spans of 368 ft., and four spans of 264 ft., will span the river to the low-water mark on the Illinois shore at Bloody Island; one span of 160 ft. will reach from low-water mark across the levee at East St. Louis, to an abutment where the embankment to form the eastern approach should also abut. From the point first mentioned, to wit, the low-water mark at St. Louis, one span of 264 ft. will reach across the levee to the block on the west side of the levee, and where pedestrians will be furnished with especial accommodations for ascending to and descending from the side-walks of the bridge, besides the usual means at either end of the bridge of gaining access to them.

Going westerly from the river, a span of 160 ft. and a span of 85 ft. will succeed. At this point, the identity of width of the structure, and its general characteristics, will end. The railway tracks and the carriage-ways, with the side-walks, will be carried forward on independent structures; the railway over a succession of 85 ft. spans, and of colonnades, on a slightly ascending grade, over the various streets and blocks, for a distance of 1964 ft., to Broadway. The independent carriage-ways and the side-walks will have a gradual descent for a distance of 595 ft. to the streets.

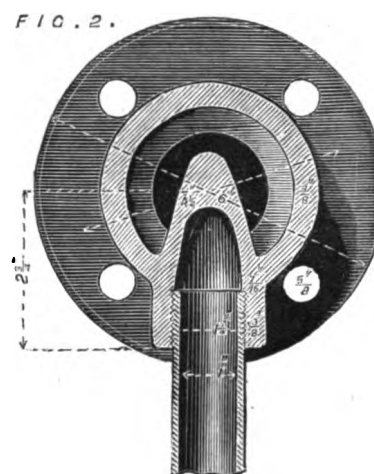
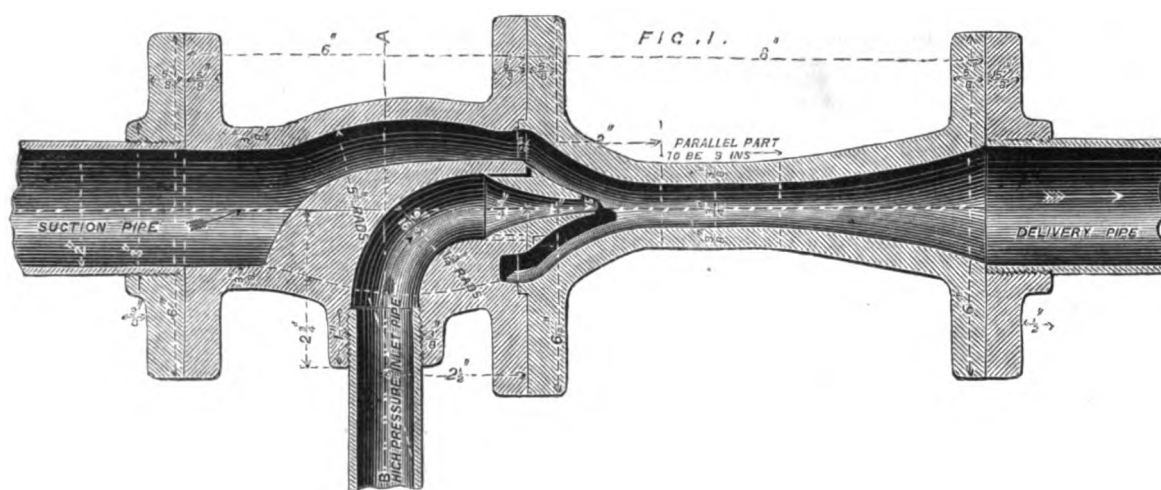
A map of a portion of the city of St. Louis, showing more fully the location, extent, and termini of this bridge as herein proposed, and some details of the plan on a large scale, has been prepared.

The maximum moving load assumed for the railway, is one locomotive engine, weighing 88,000 lb., its tender, 50,000 lb., and a train of loaded cars, weighing 2184 lb. per foot of the track occupied by the cars; the train being of a greater length than any one span of the bridge. This is believed to be as heavy a load as has ever been made up for a single engine, and heavier than any railroad bridge has hitherto been required to sustain.

The moving load upon the carriage-ways is assumed to be 100 lb. per square foot of an available width of 14 ft., or at the rate of 2800 lb. per lineal foot of the bridge. On the side-walks the maximum weight of people that can possibly come, is assumed at 70 lb. per square foot, or 1120 lb. per foot of bridge. A proper railway track for this bridge will weigh 800 lb. per foot. The timber and plank necessary for one carriage-way will weigh 660 to 600 lb. per foot. The tramways for carriages, and the rails for street cars, bolts, spikes, &c., will weigh about 160 lb. per foot. An allowance for dirt, ice, snow, &c., is made, equal to the weight of snow 1 ft. deep, equal 8 lb. per square foot, or 150 lb. per foot of each carriage-way, including the guard timbers and chords. The weight of carriage-way is, therefore, from 720 to 900 lb. per lineal foot, according as it may

WATER-JET PUMP AT THE RIVER DON STEEL WORKS, SHEFFIELD.

DESIGNED BY MR. EDWARD REYNOLDS.



We give, above, engravings of the ingenious water-jet pump which we noticed last week as being in use at Messrs. Vickers, Sons and Co.'s works at Sheffield, for raising water from the race in which the fly-wheel of the engine driving the tyre-mill runs. This pump was, as we stated in our last number, designed by Mr. Edward Reynolds, the engineer of the works where it is in use, and it is found to answer its purpose perfectly. The wheel-race from which the water is raised is 14 ft. deep, and the pump is worked by water supplied under a head of 240 ft.

The action of the pump will be readily understood from the engraving. The water supplied under the 240 ft. head is discharged through a jet .15 in., or a little over $\frac{1}{4}$ in. in diameter, into the "barrel" of the pump, which is $\frac{1}{4}$ in. in diameter. The "barrel" is enlarged at each end to join the suction and delivery pipes respectively, these being both 2 in. in diameter, as shown in the figures. The inlet-pipe through which the high-pressure water is led into the pump is 1 in. in diameter. The small jet is of brass, and the remainder of the pump is of cast iron.

The pump is placed about the floor level, 14 ft. above the bottom of the wheel-race, yet, notwithstanding that the suction-pipe has no foot-valve, the pump primes and starts itself perfectly when the high-pressure water is turned on. There is only one point in the fixing requiring particular attention, and that is that the delivery-pipes should not have such easy bends as to allow the jet from the nozzle to pass out without filling the barrel. If the pump was fitted with a straight delivery-pipe open at the end, the jet would of course play freely through it; and it would then be necessary to temporarily throttle the outlet, say, by placing the hand over it, so that the water might fall back and fill the working barrel. As soon as the barrel is filled, the pump will draw from the suction-pipe, and continue working without any further attention.

Messrs. Vickers, Sons and Co. have now a considerable number of these pumps in use at the River Don Steel Works, and the experiments so far made show that they give an excellent duty—about 72 per cent. of that theoretically due to the full quantity of water expended. Messrs. Vickers are, however, at present making an experimental apparatus for the purpose of determining accurately the proportion of useful effect obtained under various conditions; and we hope soon to be able to place the results of their experiments before our readers.

RAILWAY CARRIAGE OF MEAT AND MILK.

A CORRESPONDENT of the *Times* makes some useful suggestions with reference to the carriage of meat and milk by rail. He says:

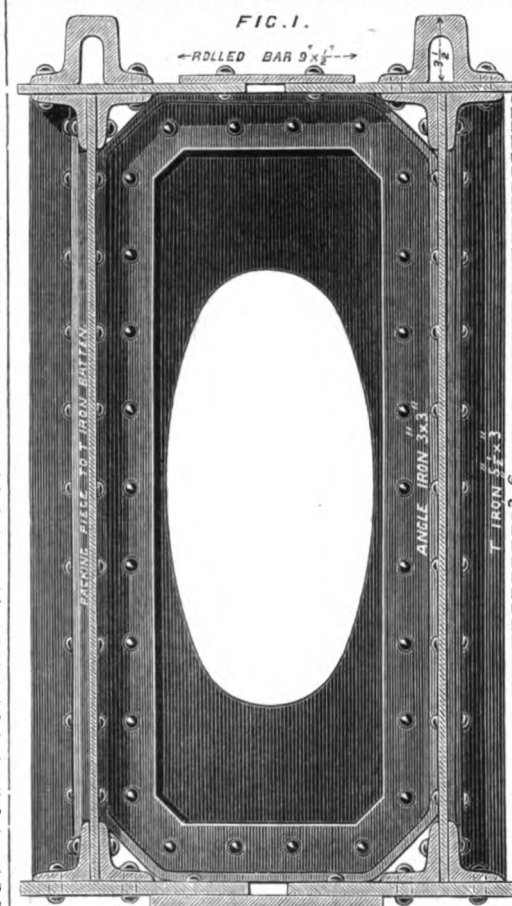
"The prices of meat in London would correspond much more closely with the lower prices of distant towns if there were better means of sending the meat to London. This remark applies both to that which is sent to the London butcher and to the private consumer in London. The railways have no special arrangements for the reception, carriage, and delivery of meat. It ought never to be packed tight, nor in heavy masses, nor exposed to undue heat, or dust, or drying winds. It ought never to be handled from the time it is first cut up to the time that it is sold by the butcher or dressed by the cook. There ought to be special meat-vans on all the railways, and each country gentleman, cattle salesman, or country butcher who consigns a dead bullock, or calf, or sheep, to a customer in London, ought to be able to place his meat on hooks or shelves in a portable larder, which should be such as two men can easily lift and place in the meat-van, there to remain undisturbed throughout the railway journey, and thence to be removed, without opening the larder or touching the meat with the hand, into the cart of the London butcher, or into the larder of Paterfamilias, as the case may be.

"The arrangements for the carriage of milk by rail in England are disgraceful to all concerned. The large cans in which the milk is stowed are known in the trade as 'churns'—and truly they are well named, for the milk in them is half churned by the motion. They are never quite full, so that the milk has plenty of room for exercise; they are large and unwieldy, so that two men are required to lift each can, and it gets banged about *quantum suff.* The cans are exposed alike to heat and cold, and travel in the common open trucks. Compare this brutal treatment of

milk with the French plans. In France the milk is packed in a small can, which one man can easily lift. It is filled full, and by a simple contrivance it is so stoppered down that the contents are fixed by the stopper, and cannot be moved in the cans—i.e., cannot be churned there by the motion. Add to this that in hot weather the cans are enclosed in coverings of some textile fabric, which are watered from a fine rose whenever they become dry, and that the cans themselves are placed in convenient covered milk vans, and you see how much better they manage these things also in France, and how greatly our present scanty and miserable supplies of milk in London might be extended and improved by the exercise of a little energy and common sense."

GIRDERS AT THE RIVER DON STEEL WORKS.

In the course of the description of the River Don Steel Works, which appeared in our last number, we mentioned some 50 ft. girders in the melting-house, which had their top and bottom flanges made up of bars and angle irons rolled in lengths equal to that of the girders. We now subjoin an engraving showing a section of one of these girders, which are of box-section, and carry the traversers. The bottom flange or bottom of the "box" is made up of three plates, each 12 in. by $\frac{1}{4}$ in.; and the top flange consists of two plates,



each 12 in. by $\frac{1}{4}$ in., and one plate 9 in. by $\frac{1}{4}$ in. The top flange is further strengthened by the two traverser rails being rivetted to it, these rails, which weigh 82 lb. per yard, being, like the bars and angle irons, rolled in lengths equal to that of the girder. The depth of the girders is 3 ft. 6 in. over flanges. The fact of the flange bars and angle irons being

made in 50 ft. lengths enables all joint-pieces to be dispensed with, thus giving the girders a very neat appearance, whilst at the same time the cost is not increased. The plan of using long bars for the flanges in this way is, however, open to one objection, and that is that it prevents the flanges from being decreased in section towards the ends of the girder, in proportion to the strain upon them, as they would be under ordinary circumstances.

THE MONT CENIS RAILWAY.—That enterprising paper, *The Engineer*, has sent a special correspondent to the Mont Cenis, and, in order that this gentleman's labours may not be entirely lost to the profession, we reprint a few of his observations for the benefit of our readers. Respecting what—actuated by a strong desire to exhibit his intimate acquaintance with the French language—he terms the *Fell système* (query, would not a Frenchman have said *système Fell*?), he expresses himself as follows:—"Gauge, curves, gradients, and especially the machine that has to work upon them, are all new, as I felt strongly in being drawn over the mountain behind one of the Fell engines; but I felt as strongly in the power it manifested for its work, in its perfect tractability, and especially in the sense of safety enjoyed—that as the Rocket was the true type and progenitor of the ordinary locomotive, so we had in front of us, in its essential qualities, the parent of the mountain engine." That's what he says; and we say—!!!! In a later part of his letter he states: "In riding upon the engine it is felt that the application of the centre rail continuously, irrespective of gradient, would be an advantage for another reason. The horizontal wheels which bite the centre rail are never thrown out of gear, and accordingly whirl in the air when the easier gradients are reached and the centre rail is dispensed with. The action of the engine is instantly felt to be less steady and satisfactory, although it may be not less safe. The wasted whirling produces unpleasant noise, and takes away the sense of grip experienced when the middle rail is acted upon. The moment the tapered end of the centre rail again enters between the horizontal wheels the noise ceases, the unsteadiness is corrected, and it is felt that the tractor is properly fulfilling its purpose and working as it is designed to do." We should think that the sight of the horizontal wheels, of the engine on which he was riding, "whirling in the air," accompanied, as this "wasted whirling" was, by an "unpleasant noise" must have severely shaken the nerves of our contemporary's correspondent, although we should have thought that it must have been rather pleasant than otherwise to be relieved from "the sense of grip experienced when the central rail is acted upon." The correspondent of *The Engineer*, however, thought differently, and he evidently became more composed when the "unpleasant noise" ceased. In conclusion, may we ask, is it Bottom, or Snug, who is representing *The Engineer* on the Mont Cenis?

RAILS IN RUSSIA.—Mr. H. B. Froom, of St. Petersburg, has contracted for Bessemer plant for making railway bars in Finland. They are to be sold to the Russian railway companies at 20l. per ton, iron rails selling at 14l.

THE PAS-DE-CALAIS.—The coal extraction of the Pas-de-Calais was largely increased last year, having been carried in 1866 to 18,061,638 hectolitres, as compared with 15,548,350 hectolitres in 1865. In 1861 the extraction was scarcely 9,000,000 hectolitres. For 1867 it is set down at 20,000,000 hectolitres.

OUR FOREIGN TRADE.—The declared value of our exports for September show a slight decrease in value as compared with September, 1866, due, however, to the lower prices of cotton goods, the total value of those shipped being less, although the quantity has increased. There is an increase of 26 per cent. in the value of iron exported, and of 22 per cent. in that of coal. The total value of our exports for the first nine months of the present year has been 137,202,497l., showing a reduction of only about 3½ per cent. from the unprecedented total of last year, notwithstanding the lower valuations at which our principal goods have been shipped in consequence of the altered prices of cotton and other staples. Contrasted with the first nine months of 1865, there is an increase of 14½ per cent.

ST. ETIENNE.—A foundries, forges, and steel works company has been recently established at St. Etienne. The company proposes to apply itself to the manufacture of steel rails, iron and steel tyres, axles, plates for ships, and cannon of various kinds.

MANUFACTURE OF GUN-COTTON.

THE places at which the manufacture of gun-cotton has ever been extensively carried on are but few in number. Soon after Schönbein, in 1846, made known the manner in which the material could be prepared, its manufacture was taken up to some extent at the powder-mills of Bouchet, near Paris, and in this country Messrs. Hall also commenced making it at their works at Faversham. At the latter works, however, a disastrous explosion occurred, which was attributed by the jury to the spontaneous combustion of the cotton; and after this the manufacture was discontinued, a large quantity of gun-cotton which happened to be on stock at the time being buried. This was in July, 1847. In France, also, the manufacture was abandoned after a time, the French Commission being unable to produce a material possessing the required qualities; and in Prussia, where the manufacture of gun-cotton had also been taken up by the Government, the experiments, which were carried on for eight years, were brought to an end by the blowing up of the factory. More recently, the process of manufacture advocated by Baron von Lenk was taken up strongly in Austria, where a special factory was erected at Hirtenberg; but Baron von Lenk's system did not prove perfectly successful, and in 1865 the Austrian Government gave orders that the ordnance which had been specially constructed to be used with gun-cotton should be altered so that they could be used with powder, the use of gun-cotton being from that date practically abandoned in the Austrian service.

Notwithstanding these failures, however, the advocates of gun-cotton—and notably Professor Abel, the director of the chemical department of our War Office—continued their researches; and, thanks to these, the manufacture of gun-cotton has been very greatly improved, and is now established on a better basis than ever. At the present time gun-cotton is being manufactured in this country at two places, the one being the Government Powder Works at Waltham Abbey, and the other the extensive works of Messrs. Thomas Prentice and Sons, of Stowmarket, a firm who, by their extensive experiments on a manufacturing scale, have done much to bring the gun-cotton manufacture to its present state. The two chief features in the processes now followed, as distinguished from those carried on by Baron von Lenk, are the pulping of the cotton after its conversion, and the admixture of this pulp, in some cases, with a certain proportion of plain cotton pulp, for the purpose of retarding the charges, or diminishing the rapidity of their combustion. The various processes followed during the manufacture of the cotton will, however, be best explained by a description of Messrs. Prentice's works at Stowmarket, which we now propose to give.

The gun-cotton factory of Messrs. Thomas Prentice and Co. is situated on the outskirts of the town of Stowmarket, by the side of a stream which furnishes a supply of water for washing purposes, and also drives a water-wheel, by which the pulping machinery is worked. The factory consists of two distinct divisions, one devoted to the manufacture of mining charges, and the other to the production of cartridges for small arms, there being besides some shops common to both departments, where the conversion of the cotton and its formation into pulp are carried on.

The raw material is received principally in the form of "waste." Formerly gun-cotton was made exclusively from cotton wool, but Baron Von Lenk introduced the use of cotton in the forms of hanks or skeins, it being urged that these were more readily penetrated by the acids than the wool, which tended to cake into a mass when immersed. Now, however, it is found that cotton in almost any form answers equally well for the manufacture of gun-cotton, the processes now followed ensuring thorough conversion in all cases. The first thing done is to thoroughly cleanse the raw material. This is effected by boiling it in an alkaline solution, then drying it in a centrifugal machine, and then again boiling it in clean water. After the second boiling, it is again partially dried in a centrifugal machine, and any remaining moisture is thoroughly removed, partly by exposing the cotton to the atmosphere, and partly by placing it on shelves in a drying chamber heated artificially to about 120°. The drying of the cotton has to be very thoroughly effected, as any moisture which might remain in it would, by combining with the acids used for conversion generate heat, and set up a destructive action. The centrifugal drying-machines, which are extensively used at various stages of the manufacture are of ordinary construction, each consisting of a cylinder with wire-gauze sides, caused to revolve horizontally at the rate of from

500 to 800 revolutions per minute. A number of the machines at Stowmarket are worked from shafting driven by a horizontal engine, and others are driven each by a special engine placed close to the machine, these engines having their crank-shafts arranged vertically, and the fly-wheel of each engine being connected directly by a belt to the pulley on the spindle of the corresponding drying-machine.

The cotton, after having been thoroughly washed and dried, is weighed out in the drying-room into charges of 1 lb. each, each charge being placed in a wooden box in which it is passed into the converting-room. There each charge is placed separately in a bath containing the mixed acids, the mixture in which the cotton is submerged consisting of three parts, by weight, of sulphuric acid and one part of nitric acid, this mixture being allowed to cool down—a process which occupies two or three days—before the cotton is placed in it. After immersion, the charges of cotton are strained until each contains only about ten times its weight of acids, and each charge is then placed in an earthenware jar, and covered down. In order to prevent any heating of the cotton from taking place, the jars containing it are arranged in a kind of shallow trough, through which a current of cold water is kept constantly flowing. The building in which the conversion of the cotton is effected is ventilated by a shaft in which an artificial current is maintained; but the ventilation can scarcely be called perfect, and it is doubtful whether the fumes arising from the acids could not be more completely removed by a series of flues connected with the shaft and arranged so as to draw off the air from the floor of the room close to the bath in which the acids are contained. This system of ventilation has been advocated by General Morin, and has, we believe, been found very effective in similar cases.

The action which takes place when the cotton is immersed in the mixed acids is as follows: Cotton, when pure, is one form of cellulose, and is an organic compound consisting of thirty-six equivalents of carbon and thirty equivalents of hydrogen—both combustible or oxidisable elements—together with thirty equivalents of oxygen, its composition being thus expressed by the chemical formula $C_{36}H_{30}O_{30}$. Nitric acid, on the other hand, is a powerful oxidiser, and if added to cotton, and its action assisted by heat, it will rapidly oxidise, not only the hydrogen, but a portion of the carbon which the cotton contains. In the manufacture of gun-cotton, however, instead of the action of the acid being assisted by heat, care is taken to abstract any heat as soon as it may arise, and the action of the acid is thus moderated, only a certain proportion of the hydrogen being oxidised, and the carbon being unaffected. The nitric acid, as we have said, mixed with three times its own weight of sulphuric acid, and the purpose fulfilled by the latter is that of intensifying the action of the nitric acid by absorbing the water with which even the strongest nitric acid is diluted, and also the water set free by the action of the nitric acid upon the cotton. The hydrogen removed from the cotton is replaced by an equivalent quantity of nitric acid, which has lost a portion of oxygen, and has thus become peroxide of nitrogen, and it is the introduction of this component which gives the gun-cotton its explosive qualities. The peroxide of nitrogen is a powerful oxidising agent—although not so powerful a one as the nitric acid—and it only requires the aid of heat to enable it to oxidise the carbon and the remainder of the hydrogen contained in the cotton, and convert them into gases with explosive rapidity. The heat necessary for setting up this action is supplied when the cotton is ignited, and the action is aided by the oxygen contained in the cotton itself. The proportion of the hydrogen originally oxidised by the action of the mixed acids depends upon the strength of those acids, and upon the purity of the cotton subjected to them. According to Mr. Hadow, of Kings' College, who has devoted much time to the investigation of the chemical changes which go on during the process of conversion, there are four distinct varieties of gun-cotton, each containing a different proportion of peroxide of nitrogen. When pure cotton, and the most concentrated nitric and sulphuric acids—of the specific gravities 1.5 and 1.84 respectively—are used, he states that nine equivalents of the hydrogen contained in the cotton are replaced by nine equivalents of peroxide of nitrogen, its composition being thus expressed by the formula, $C_{36}H_{21}9(NO_4)O_{30}$. This Mr. Hadow gives as the composition of Baron von Lenk's gun-cotton; in the three other varieties he states that the number of equivalents of hydrogen replaced by peroxide of nitrogen are eight, seven, and six respectively. By the process of conversion the cotton is not altered in appearance, but

it is materially increased in weight in the proportion of about 7 to 4.

To return, however, from this somewhat long digression, to the manufacture of gun-cotton as carried on at Stowmarket. The cotton, after being exposed to the action of the acids for forty-eight hours in order to ensure its thorough conversion, is removed from the jars, and placed in a centrifugal drying-machine, which removes the greater proportion of the free acids. On its removal from the centrifugal drying-machine it is plunged suddenly into a strong fall of water received by a tank, in which the gun-cotton placed in the fall is allowed to remain for a short time. The object of placing the gun-cotton in the fall of water, or "drench-bath," as it is called, is to ensure the sudden and complete submersion of the material, and thus avoid the heating and decomposition of the cotton which would take place at the surface of the water if the cotton was immersed gradually. On its removal from the drench-bath, the gun-cotton is again dried in a centrifugal machine, and then placed in a bath through which a current of water constantly flows for forty-eight hours. After this it is again dried, and then placed in a second bath for a similar period, these alternate washings and dryings being repeated until the gun-cotton has passed through eight baths successively, remaining forty-eight hours in each.

After having been removed from the eighth bath and dried, the cotton is ready for pulping, a process which is in itself a washing of the most effective kind. This process we must next proceed to describe.

(To be continued.)

PLUMBAGO STEEL.

TO THE EDITOR OF ENGINEERING.

SIR,—Two or three items in your article on "The River Don Steel Works," published last week, bring to mind a fact I am in possession of, which might be of interest to those engaged in the manufacture of steel, and one which, if acted upon, may lead to an improvement in the present mode of steel-making. Some three or four years ago, when steel-making was first commenced at Syracuse, N.Y., Messrs. Sweet, Barnes and Co. had a Sheffield melter, who advanced the idea that we could not make the best steel so long as we used plumbago crucibles. Partly to test the soundness of this notion, and partly perhaps to gratify our love for novelty, we instigated the following experiment:

About 8 lb. of bar iron, such as we were using for steel-making, but of small section, was cut into suitable lengths, and one-half packed in an old crucible with layers of charcoal between, and sealed up the same as iron is usually packed for converting; the other half of the iron was packed in the same way in every respect, except that powdered plumbago was used for packing instead of charcoal. The two crucibles were then placed in the same fire, and subjected to the same heat for about four days. The result from the one packed in charcoal was, what all expected, *blister steel*, and from the other, what but few would have expected, *blister steel also*, and to all appearance of equally good quality; in fact, we could not detect any difference in the two, though whereas the charcoal had lost a considerable in bulk, there seemed to be about as much plumbago as before. The part which we will now call plumbago steel, for want of a better name, was melted, using plumbago and manganese in the same proportions as charcoal and manganese are usually used in the melting pot, and cast into a 1½ inch round ingot. The ingot was drawn down in the usual way, and from one end of the bar a chipping chisel was made, which proved to be above the average quality, and from the other end of the bar a paring chisel, which was admitted by all wood-workmen who tried it to be equal to the very best they had ever seen.

Now, if plumbago carbon was very injurious to steel, steel made from plumbago entirely ought to be very poor, which is not the case.

Although the result of the experiment was very flattering, the argument against continuing it was that a very expensive material, and one difficult to obtain, had been used in the place of a cheap one; besides, at that time, the manager of the works had plenty of experiments of his own to try. So much less plumbago than charcoal was consumed in converting the iron into steel, that a careful trial might show the former to be as cheap as the latter; and, again, if plumbago was used with the manganese, there certainly would be less danger of its burning out as charcoal will do when the crucibles are kept hot for a long time before melting.

"As we are to look for improvement in the unlikely as well as the likely," even the Bessemer steel makers might carbonise their iron, if not as cheaply, at least as definitely with plumbago as by the use of spiegelisen, and perhaps with even better results as regards quality.

I am, &c.,

S.

CREUSOT.—There appears now no reason to doubt that this great establishment has secured an order for eighty locomotives for Russia. The price named as that at which the contract was taken is 86*l.* per ton. It was necessary, in order to obtain the contract, to pay down a *cautionnement* of 32,000*l.*, and the locomotives are to be delivered at Riga before half the purchase money is paid over. In other words, Russia requires long credit.

STEEL SHAFTS.—The Bolton Steel and Iron Company has lately forged a Bessemer steel shaft 11 in. in diameter, and 30 ft. long, under their 25-ton steam-hammer.

PROGRESS OF INDIAN RAILWAYS.

The "masterly inactivity" policy of the present Viceroy of India can, fortunately, exercise but little influence upon the completion of railways already sanctioned and under construction; but under a more energetic and enterprising ruler India might, ere this, have seen the commencement of fresh lines of communication, and from the extension of which alone can any prospect arise of a proper development of those resources with which the country has been blessed, and, consequently, of an increase to the national wealth and to the imperial revenues. Having once embarked on the encouragement of railway construction, it is impossible for the Government to stop with the lines already sanctioned. Experience has shown, only too clearly, how vain it is to suppose that private enterprise will undertake such works without the stimulation of a 5 per cent. guarantee; all those companies who have attempted it being now unable to proceed without, at least, an equal amount of Government subsidy. The programme roughly sketched out by Lord Dalhousie is yet far from complete, but it is impossible to doubt that it must, ere long, not only be fully worked up to, but also extended. Metropolitan railways have not yet even been started in India, but they are very much required in Calcutta, and such lines must, sooner or later, be constructed there to meet the demands of local traffic. Madras, too, could well support a few short lines of a like character; but the requirements of Bombay will probably be sufficiently met by the main lines which run through the island.

With regard to the progress made towards completing lines already sanctioned, it is now announced that through communication between Calcutta and Bombay, *via* Jubbulpore and Nagpore, will be permanently practicable, from the 1st of October, in the comparatively short space of 116 hours, or 4 days and 20 hours. The first part of the journey from Calcutta to Allahabad will be got over in about 31 hours, the fares per rail being Rs. 59 2 6, and Rs. 29 9 3, for the first and second classes respectively. From Allahabad to Jubbulpore the journey per rail will occupy 17 hours, first and second class fares being respectively Rs. 21 6 and Rs. 10 11. From Jubbulpore to Nagpore the time of the journey per dak gharry will be 36 hours, and the fare for one seat, with an allowance of 80 lb. of baggage, will be Rs. 100. With such restriction in the amount of language, it is scarcely probable that this route will be generally adopted by overland travellers, unless some provision be made by the company for the safe conveyance of the additional baggage which any one setting out for the seaport is sure to carry with him. From Nagpore to Bombay the time of the transit per rail is 32 hours, and first and second class fares Rs. 50 10 and Rs. 25 5 respectively. The total charge, first class, from Calcutta to Bombay, will be Rs. 231 2 6, and, second class, Rs. 165 9 3.

On the Madras Railway, north-west line, the progress made is such that it is expected the line will be opened as far as Gooty by December next. This will facilitate and considerably accelerate the conveyance of mails between Madras and Bombay.

The Pondicherry Government have received intelligence from France, by telegraph, that the imperial Government has sanctioned a subsidy for the construction of the proposed branch line of railway to connect Pondicherry with Conjeeveram. The undertaking will, it is believed, be carried out by an English company, and completed in two or three years. Pondicherry will then, perhaps, be linked by railway with all the chief cities of India. Elsewhere, in Madras, the railways are progressing, and the long talked of scheme for connecting Coimbatore and Ootacamund by rail of some kind is again attracting attention.

At the suggestion, in the first instance, of the Board of Directors in London, the Madras Government have sanctioned the introduction, as an experimental measure, of running coolie trains on the Madras Railway at the reduced rate of two pice per passenger per mile. The carriages are to be of the most inexpensive character, without seats, and are to be attached to goods trains running at low speeds. The experiment is to be tried for six months.

The opening of the Great Indian Peninsula Railway to Hurda is likely to be deferred indefinitely by a most untoward accident. A large bridge over a river called the Chota Towa has been bodily carried away by the force of heavy floods. Still there is hope that the line will be available for passengers and the heavy railway material that has to go forward, as a tramway might be put across the bed of the river, as was done at the Taptec.

THE METROPOLITAN RAILWAY.

REPORT OF AN EXAMINATION OF THE AIR IN THE TUNNELS OF THE METROPOLITAN RAILWAY.

London, October 23, 1867.

HAVING received instructions from the directors of the Metropolitan Railway Company, through Messrs. Burchell, their solicitors, by letter addressed to Dr. Bachhoffner, to examine and report the state of the atmosphere in the different tunnels on their line, and on the sanitary condition generally of the stations and tunnels, we beg to present the following as the result of our investigations:

We proceeded in the first instance to obtain samples of the air in the tunnels, and we collected them on three separate occasions, namely: first, immediately after the trains had ceased running at night; secondly, just before they commenced running in the morning; and, thirdly, in the afternoon between four and five o'clock, the period of the day when there is generally the largest amount of traffic.

The samples, twenty-eight in number, were taken at different places in each tunnel, and at different altitudes; some near the crown of the arch, some near the ground, and others on a level with the heads of the passengers. These samples were analysed for sulphurous acid, carbonic acid, carbonic oxide, coal gas, and oxygen.

The presence of sulphurous acid was sought for by the most delicate chemical test with which we are acquainted, namely, its action upon iodic acid and starch, which we have ascertained is capable of showing the presence of one part by volume of sulphurous acid in 100,000 parts of air, but we could not in any case discover by such test the presence of this acid; from which we conclude that its volume was less than the above in the tunnels. The proportion of carbonic acid by volume in 10,000 parts of the air in the several tunnels and stations was as follows:

	Maximum.	Minimum.	Mean.
Tunnel between Bishop's-road and Edgware-road, 2 a.m. September 3	4.1	4.1	4.1
Tunnel between Edgware-road and Baker-street, 1 to 3 a.m. Sept. 3	5.2	4.3	4.8
road and Baker-street, 2 to 4 a.m. Sept. 6	5.4	4.7	5.0
street, 4 p.m. September 7	...	...	5.7
Baker-street Station, 4 p.m. September 10	...	...	6.2
Tunnel between Baker-street and Portland-road, 1 to 3 a.m. Sept. 3	6.0	4.6	5.1
road, 2 to 4 a.m. Sept. 6	4.5	4.2	4.4
road, 4 p.m. September 7	...	...	6.9
Tunnel between Portland-road and Gower-street, 1 to 3 a.m. Sept. 3	6.0	5.1	5.5
street, 2 to 4 a.m. Sept. 6	6.1	4.5	5.1
street, 4 p.m. September 7	...	...	12.7
Gower-street Station, 4 p.m. September 7	...	...	5.7
Tunnel between Gower-street and King's-cross, 1 to 3 a.m. Sept. 3	5.4	4.4	4.9
cross, 2 to 4 a.m. Sept. 6	5.2	4.3	4.6
cross, 4 p.m. September 7	...	...	9.1

The amounts of carbo-hydrogen (coal gas) and of carbonic oxide present were so small as to be barely discoverable by the most delicate processes of analysis. Lastly, we ascertained that the amount of oxygen in the air of the tunnels and stations was not in any case deficient.

These results prove that in no instance was the air found to be vitiated to any material extent, although it will be seen that the air taken in the afternoon was less pure than that taken at night. The researches of Regnault, Bunsen, and other eminent chemists, and more recently those of Dr. Angus Smith, show that what may be termed "model or normal atmospheric air" in cities and large towns consists in every 10,000 parts by volume of

Oxygen	2,096
Nitrogen	7,900
Carbonic acid	4
	10,000

It is the last constituent which when in excess renders the air impure, and, in proportion to its increase, so is the air made unfit for respiration. Experiments conducted by Dr. Bernays and Dr. Angus Smith have shown that in several of our London theatres at about 10 o'clock p.m., in many other places of public resort, and especially in some of our law courts, the quantity of carbonic acid in the atmosphere of those places varied from 10 to 32 parts per 10,000; and from the "Army Report" (vol. v. page 272) it appears that in some fairly-ventilated barracks at Aldershot the quantity of carbonic acid at midnight amounted to 6.42 per 10,000 of air, and at 5 p.m. it amounted to 7.59 per 10,000. Even in the streets of Manchester, in foggy weather, it has amounted to 8 parts per 10,000 of air.

In order to determine the atmospheric conditions of these tunnels by comparison with the condition of the air in the tunnels of other lines of railway, we took samples of the air from several tunnels near London; and from these, which we designate by numbers only, we obtained the subjoined results: Tunnel No. 1—4.7 carbonic acid per 10,000 of air by volume.

" 2—12.1	"	"
" 3—4.6	"	"
" 4—4.3	"	"
" 5—7.8	"	"
" 6—4.5	"	"
" 7—5.3	"	"
" 8—4.3	"	"
" 9—4.2	"	"
" 10—5.1	"	"
" 11—4.3	"	"
" 12—4.2	"	"
" 13—4.6	"	"

Our inquiries were next directed to the quality and quantity of the fuel used in the engines, and to the mode by which its combustion is effected. The plan adopted (with which we cordially agree) is to diminish as far as practicable the combustion of the fuel during the passage of the trains through the tunnels and stations. The steam in the boiler is raised in the open air to a temperature and pressure which, by experience and daily

practice, is found sufficient to work the trains through the tunnels, and when the trains come again into open space, fresh steam is then generated sufficient to propel the trains through the next journey, when the process is again repeated; by which means the engine-driver is enabled, when passing through the tunnels and stations, to close the firebox and damper so as merely to keep the fire in such a condition that it may be easily revived at either end of the journey.

The evolution of the products of combustion is thus almost entirely confined to that portion of the journey when the trains are passing through the open spaces.

The coke is of a superior quality, being made from a coal which is known to be more than usually free from iron pyrites, and it is burnt in the ovens for twenty-four hours longer than the ordinary coke generally used upon railways. In addition to which a staff of eight men and a foreman are constantly employed in examining and selecting the coke so as to ensure that none but the best quality of coke is transmitted to London for the use of the Underground Railway.

To determine the percentage of sulphur in the coke, thirteen samples were submitted to chemical analysis, and these gave an average proportion of 0.26 per cent. of sulphur, which is about one-fourth the quantity found in ordinary coke. As regards the coke, therefore, we see nothing to which we can take exception, but, on the contrary, we are of opinion that the best available means are used for obtaining a fuel as free from deleterious matter as possible, in addition to which the combustion of the same is conducted with the view of preventing as far as possible the escape of offensive gases.

The presence of sulphur, or, more correctly speaking, of sulphurous-acid gas, in the tunnels and stations, which at times is appreciable both to taste and smell, more particularly on those days when the external atmosphere is unusually dense, must not be taken as an indication that this gas exists in dangerous quantities, for as little as one part of this gas in 100,000 parts of atmospheric air is strongly perceptible both to taste and smell, and paper moistened with a solution of iodic acid and starch becomes tinged with a blue colour when exposed for a few minutes to air having the above proportion of sulphurous acid. On several occasions we have exposed this delicate test to the air in the tunnels while passing through them, both in the carriages and on the engines, and, although the quantity of air thus brought into contact with the test has been considerable, yet, it has only been during the time of active traffic that the test has shown the presence of sulphurous acid, and then in an insignificant degree. In addition to the above, we beg to point out another cause which communicates to the air, more particularly in the stations, a pungent smell, which, although disagreeable, cannot in the slightest degree be regarded as injurious to health: we allude to the partial combustion of the wood forming the brakes when acting upon the tires of the wheels in checking the speed of the train as it approaches the stations.

The number of trips made by the trains through the tunnels daily amounts to 358, of which 284 are by the narrow-gauge trains, and 74 by the broad-gauge. Each of the narrow-gauge trains occupies 20,000 cubic feet of space, and those of the broad-gauge 23,000 cubic feet. The length of time occupied by each train in passing through the tunnels and stations is ten minutes. There are numerous openings communicating with the external atmosphere above, amounting in the aggregate to 3164 square feet, and distributed in the following manner: namely Baker-street station, 1362 square feet; Portland-road station, 863 square feet; Gower-street Station, 939 square feet. The western end of the tunnel at Edgware-road opens in a large area called the yard, and at the eastern end of the tunnel at King's Cross an opening has been made directly into the atmosphere, 40 ft. in width, in addition. By an extensive series of thermometric observations, we find that there is an average difference of about 1.7° Fahrenheit between the temperature of the tunnels and that of the external atmosphere; the mean outside temperature being 70° Fahrenheit, while the air in the tunnels had a mean temperature of 68.3° Fahrenheit, so that it was 1.7° Fahrenheit colder than the external atmosphere. During the winter months this condition will possibly be reversed; but in either case there will be a rapid change of air by an ascending and descending current. Having regard to the cubical volume of the trains, the short time occupied by them in passing through the tunnels and stations, the large volume of air which they displace, and the increased impetus given to the horizontal movement of the air by the rapidity of their transit, we are of opinion that the vitiation of the atmosphere cannot be of a serious character, and this accords with the results of our analysis.

A careful inspection of the tunnels has also shown that they are well constructed, and are generally dry and free from infiltration of liquid or other matter prejudicial to health, with the exception of a portion of the tunnel between Portland-road and Gower-street; to this we directed the attention of Mr. Fenton immediately after our first inspection; and we are happy to be able to add that the defect was at once attended to, and is now in a perfect sanitary condition.

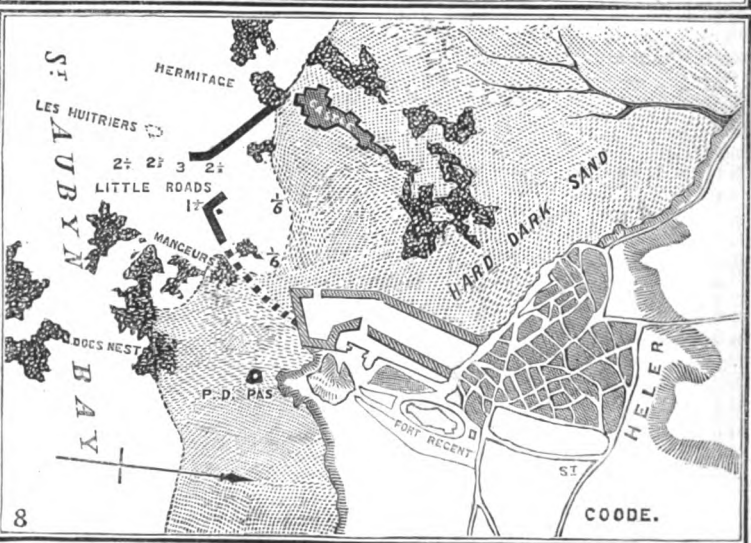
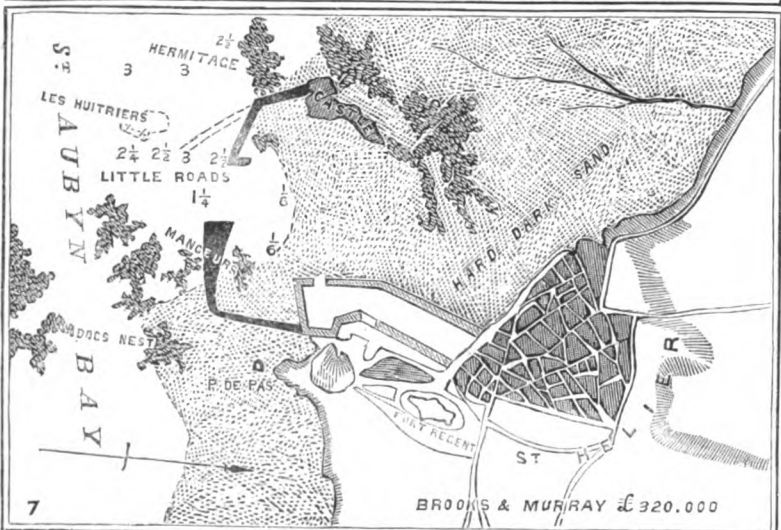
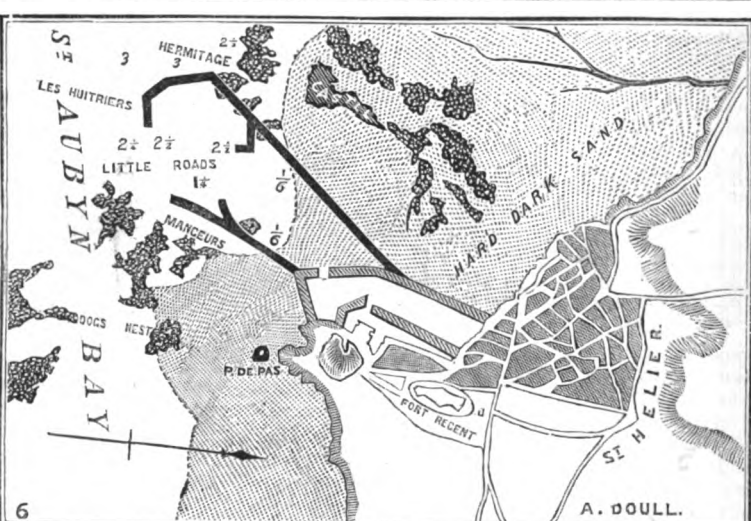
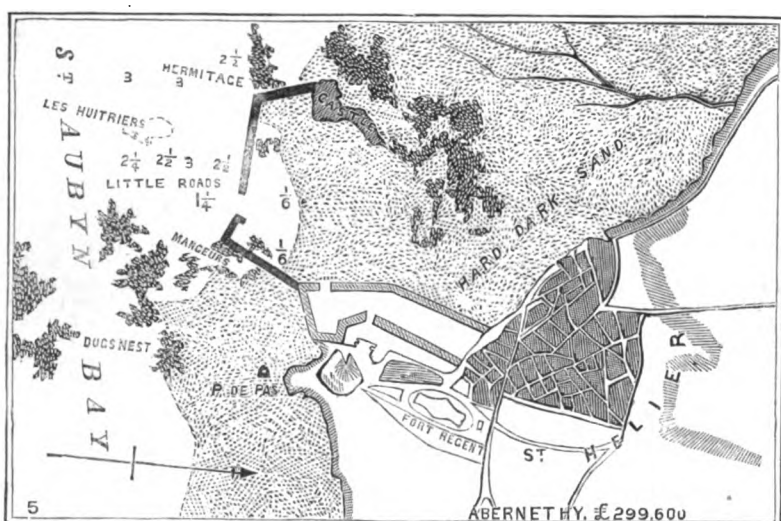
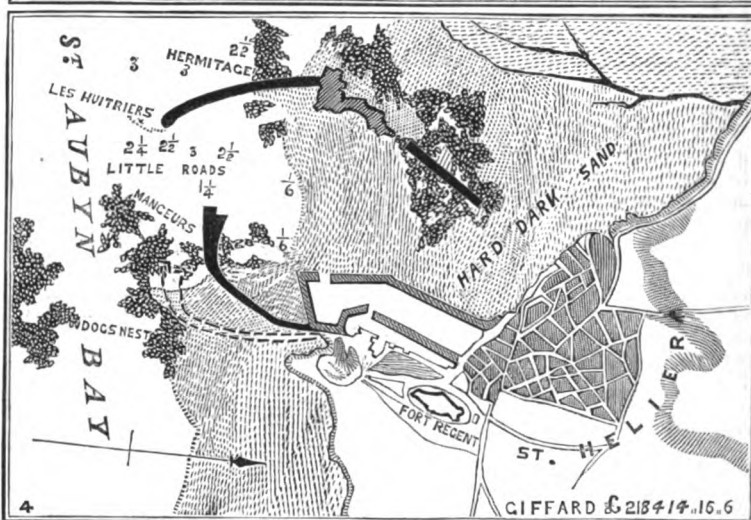
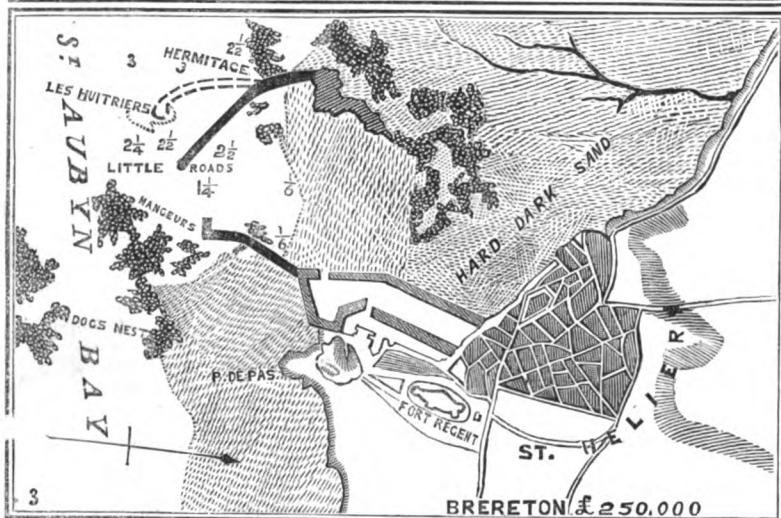
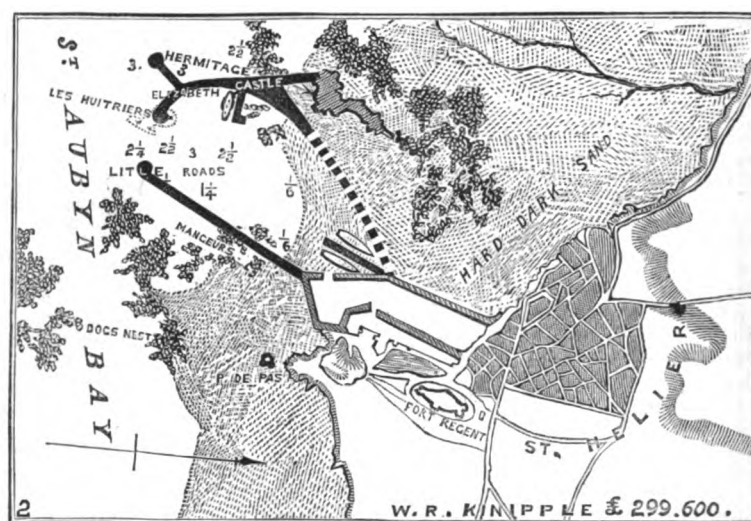
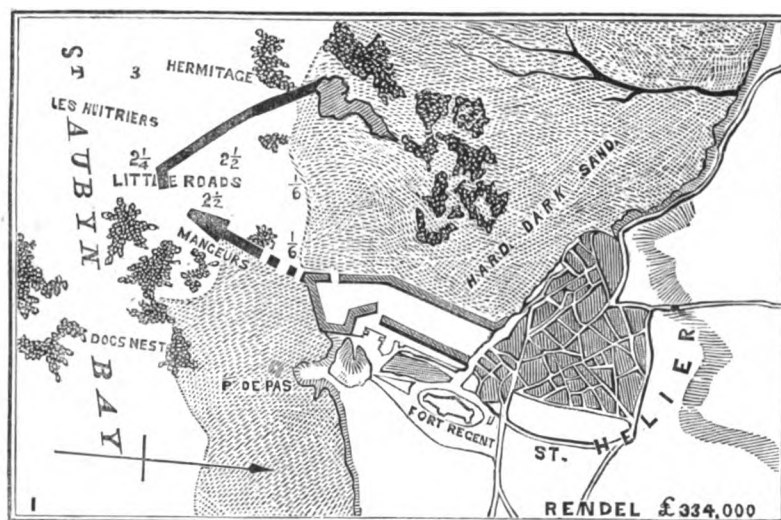
We find on inquiry that the general health of the *employés* is such as to afford unquestionable proof of the sanitary condition of the air in the tunnels. From a statement furnished to us by Mr. Fenton, it appears that the percentage of sickness and mortality of these persons is considerably less than that of the *employés* on the Great Western Railway. To this fact we may add the results of our own personal inquiries, which fully confirm it, as many of the engine-drivers and guards have, we find, been in the service of the company since the opening of the line. They are to all external appearance robust healthy men, and they have assured us that since they were first appointed they have scarcely had a day's illness.

From the foregoing facts, we are enabled confidently to state that the atmosphere of the Metropolitan Railway is not unwholesome or injurious to health.

(Signed) GKO. H. BACHHOFFNER, Ph.D., F.C.S., &c.
HY. LETHBRIDGE, M.B., M.A., &c., Professor of Chemistry in the College of the London Hospital, and Medical Officer of Health for the City of London.
J. WHITMORE, M.D., &c., Medical Officer of Health and Chemical Examiner of Gas for the Parish of St. Marylebone.

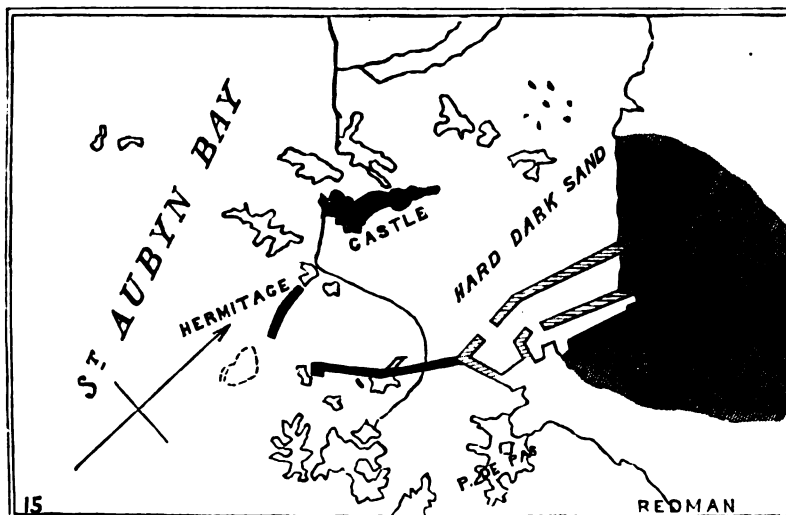
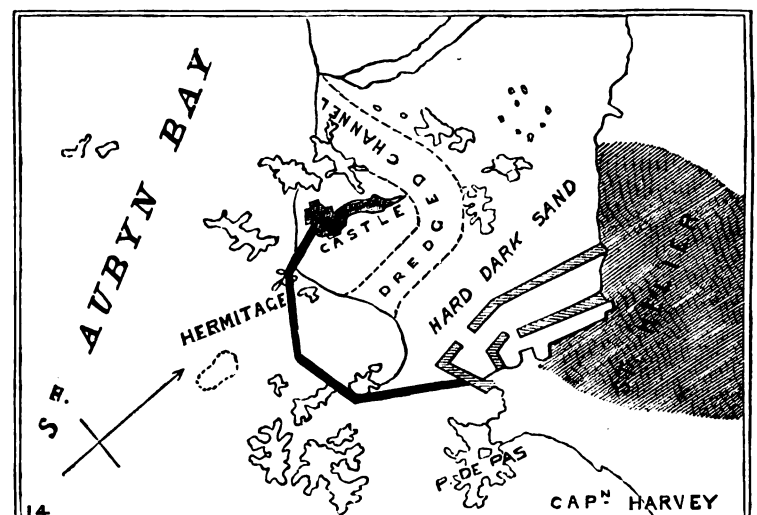
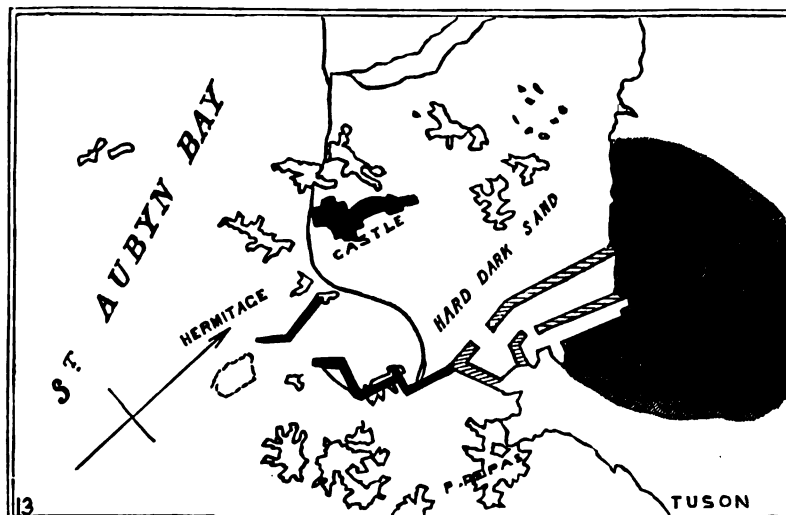
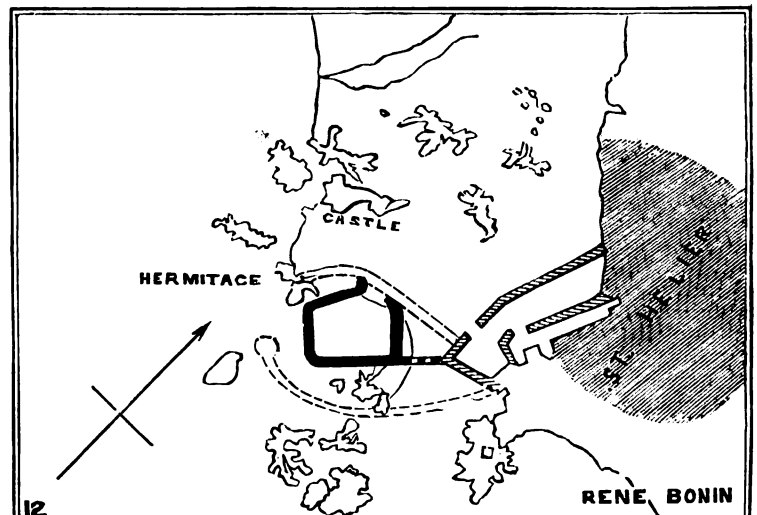
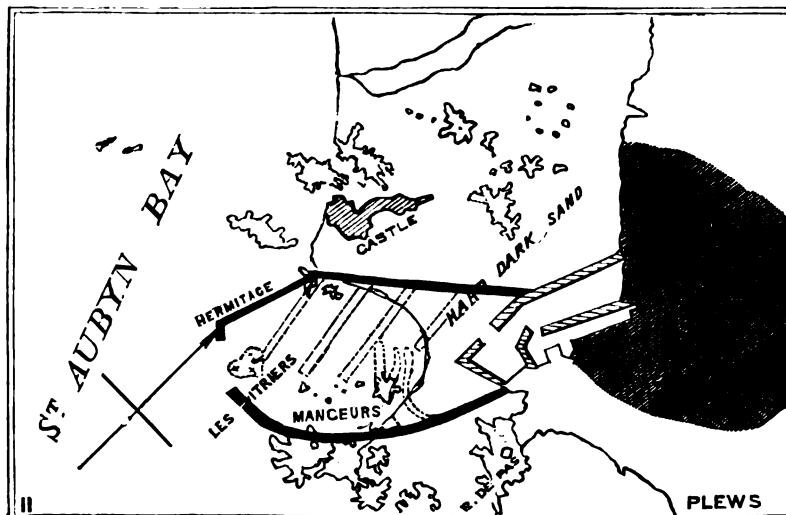
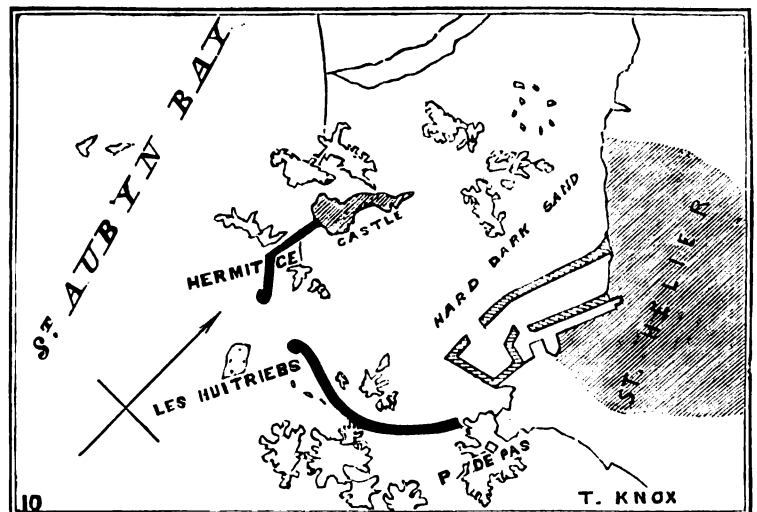
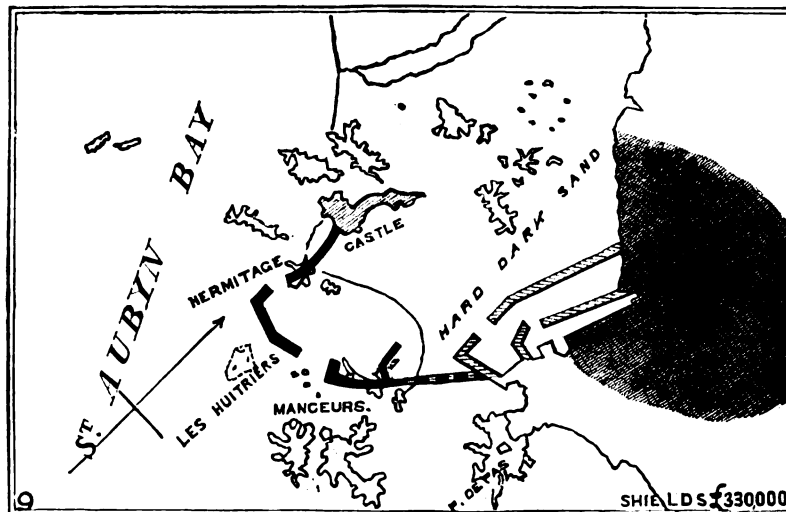
PLANS FOR THE IMPROVEMENT OF THE HARBOUR OF ST. HELIER, JERSEY.

(For Notice, see Page 416.)



PLANS FOR THE IMPROVEMENT OF THE HARBOUR OF ST. HELIER, JERSEY.

(For Notice, see Page 416.)



THE HARBOUR OF ST. HELIER, JERSEY.

We have referred, in another part of the present number (*vide* page 416), to the competitive plans which have been sent in to the Jersey authorities for the improvement of the harbour of St. Helier; and we give, on this and the opposite page sketches showing some of the principal of these plans. Each of these sketches bears the name of the engineer by whom it was proposed, but, for convenience of reference, we subjoin a table in which the various names and estimates are given.

Reference No.	Name of Engineer.	Estimated cost.
		£ s. d.
1	... Rendel ...	334,000 0 0
2	... W. R. Kimpfle ...	299,600 0 0
3	... Brereton ...	250,000 0 0
4	... Giffard ...	218,414 18
5	... Abernethy ...	299,600 0
6	... A. Doull ...	...
7	... W. A. Brooks and J. Murray ...	320,000 0 0
8	... Coode ...	...
9	... Shields ...	330,000 0 0
10	... T. Knox ...	...
11	... PLEWS (this competitor sent in five plans)	...
12	... Renè Bonin (dated July, 1863)	...
13	... Tuson ...	...
14	... Captain Harvey ...	...
15	... Redman ...	...

PARSONS'S PATENT BOLTS.

If we wish to break a bar of iron, wood, or other material, we first "nick" it all round, and afterwards bend it, or give it a few blows, the force then required being, as every mechanic knows, but a fraction of that required to effect rupture if we had not submitted the bar to the preliminary process of "nicking." It would appear that we are only now becoming alive to the importance of this fact, and of its obvious corollary that if we wish a bar to sustain a maximum amount of "fatigue," we must carefully eliminate everything of the nature of "nicking."

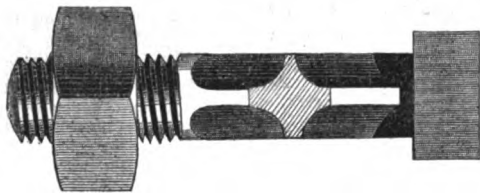
A little consideration will divest the case of the apparently paradoxical result that, by adding metal to a bar injudiciously, we may most seriously detract from its power of resistance, or, in other words, that it is not, as commonly stated, the *strength of the weakest* part merely, which governs the resistance of the whole, but the *weakness of the strongest* part also.

Now, by nicking a bar, and so suddenly reducing the sectional area at that point, we not only increase the unit strain, but we concentrated the deflection or the elongation of the fibres, as the case may be, at that point. The "fatigue" of the metal consequently is greater, the elastic limit is soon passed, and the bar breaks through the fibres, whose elasticity has been destroyed, that is, of course, through the "nick."

The vital importance of avoiding, wherever practicable, any sudden reduction of section was forcibly illustrated by some recent experiments on steel flanged rails $4\frac{1}{2}$ in. deep, tested by pressure applied at the centre of 5 ft. bearings. With the solid rails of uniform section, the maximum deflection before rupture averaged 10 in.; but when the uniformity of section was destroyed, by punching a hole 1 in. diameter through the bottom flange, the ultimate deflection averaged somewhat less than 1 in., under a breaking strain—but one-half that borne by the unpunched rail.

Now, testing this result by the new coefficient of strength introduced by Mr. Mallet—the dynamic resistance to rupture—or the foot-pounds of work done in rupturing the material, represented with sufficient accuracy by the product of the breaking weight and half the ultimate deflection, we find that, although the sectional area of the rail was reduced some 6 per cent. only, the resistance it could offer to a blow, or general "fatigue," was less in the proportion of $(\frac{1}{2} \times 1) : (1 \times 10)$, or 1 to 20, that is, 95 per cent. of its original resistance to such agencies was forfeited by the "nicking" effect due to the punched hole.

These results are fully corroborated by the interesting experiments on the patent bolts of Mr. Parsons, carried out on Tuesday last, at the works of Messrs. Burton and Waller. The object aimed at by Mr. Parsons is the attainment of uniform section, with the consequent uniform rate of elongation—the maximum due to the material—throughout the whole length of the bolt; and in order to obtain this desideratum, without introducing the practical inconvenience of a smaller diameter at the shank, he grooves that portion of the bolt in the manner shown in our engraving. It



will be observed, that the shank of the bolt will fit the hole through which the screwed portion must be passed, and that it will consequently retain the relative positions of the parts screwed together as effectively as an ordinary bolt.

In order to appreciate fully the true value of the results arrived at in these experiments, it will be desirable to consider briefly some of the facts already deduced from previous experiments bearing on the general conditions of the case.

To obtain a correct estimate of the comparative advantages of different types of screwed bolts, it will not be sufficient to base our conclusions on the ultimate resistance per square inch only. That of course is an important element; but it will be necessary also to take into consideration the comparative diameters and lengths of the bolts, the rates of elongation, the reduction of the sectional areas at the point of fracture, the loss of area at the screwed portion, and the mode adopted in cutting the thread.

With reference to elongation, Mr. Fairbairn's experiments show that the proportional amounts increase

with decrease of length. Thus the absolute ultimate extension of a bar 10 ft. long was found to be 26 in., equal to .216 per unit of length, whilst that of a bar 10 in. long was 4 in., or nearly .42 per unit. This result Mr. Kirkaldy tells us is due to the drawing out of the metal suddenly just before rupture, or otherwise the elongations would be tolerably uniform.

To test the influence of diameter, the following experiments were made by Mr. Kirkaldy: A bar of iron $1\frac{1}{2}$ in. diameter was cut into five pieces, of which four were reheated and reduced in the rolling-mill to $1\frac{1}{4}$ in., 1 in., $\frac{3}{4}$ in., and $\frac{1}{2}$ in. diameter, and then cut to equal lengths. The respective elongations per unit were found to be .283, .267, .252, .238, the corresponding breaking strains being 56,869; 57,379; 58,190; and 59,708 lb. per square inch, exhibiting an increase of strength per unit of area, and a decrease of elongation per unit of length, as the diameter was successively reduced.

The contraction of sectional area at the point of rupture is also a very important element in determining the value of a bolt. The amount varies considerably with different qualities of iron and different modes of treatment. If the strain per square inch on the original area of the bar only be taken into account, hard and brittle iron may often present an apparent superiority over tougher and much better metal. If we estimate the actual strain per square inch at the point of rupture, the superior iron will always show a higher result. The reduction of area varies from some 15 per cent. in common Scotch iron to 70 per cent. in Swedish charcoal iron.

In conducting his valuable series of experiments on screwed bolts, Mr. Kirkaldy discovered the curious fact that bolts cut with a new die exhibited an inferiority of some 16 per cent. below similar bolts cut with an old tool. This difference is about the same as that existing between the original bars and the screwed portion, and we think no comment on this fact is needed to impress upon every one the necessity of attending to the form of thread employed in any experiment made for the purpose of comparison with previous ones.

We are now in a position to make an analysis of the experiments on Mr. Parsons's bolts of the class shown in the engraving, the diameters being $\frac{7}{8}$ in., length of shank (reduced in area in varying proportions) $2\frac{1}{2}$ in., length of screwed portion $1\frac{1}{4}$ in. The bolts were placed in a block of iron, and the nuts were turned with a long spanner till the bolt was fractured. The number of turns required to effect rupture, the twist on the bolt itself, and the point of rupture, are noted in the following tabular form:

Form of Bolt.	No. of Turns of Nut.	No. of Turns of Bolt.	Point of Rupture.
1. Ordinary...	2	$\frac{1}{4}$	Screwed portion
2. Patent. Minimum section of shank	$5\frac{1}{2}$	$\frac{1}{4}$	Shank
3. Patent. Maximum shank ...	$5\frac{1}{2}$	$\frac{1}{4}$	Screwed portion
4. Ordinary...	$2\frac{1}{2}$	$\frac{1}{4}$	Ditto.
5. Patent. Medium shank ...	$4\frac{1}{2}$	$\frac{1}{4}$	Ditto.
6. Ditto. ...	$6\frac{1}{2}$	$\frac{1}{4}$	Shank

The pitch of the threads being uniform, the elongations will be nearly proportional to the difference between the revolutions of the nut and the bolt. The rate of elongation per unit thus deduced, and the percentage of diminution of area for each specimen is shown below:

	Elongation per unit of length.	Diminution of area per cent.
1 ...	.07	8
2 ...	.20	26
3 ...	.20	20
4 ...	.08	9
5 ...	.17	26
6 ...	.21	34

The above data show us that the bolts failed by the combined action of tensional and torsional forces, and from what we have already advanced, it will be seen that the "work done" in rupturing either of the bolts, or, on the other hand, the resistance it would offer to a blow or jerk, is directly proportional to the rate of elongation, the iron proving to be of average uniform quality. Now the average elongation of the patent bolts was .195 in., whilst that of the ordinary ones was .075, or a ratio of 2.6 to 1. The ratio of the best proportioned patent bolt to the ordinary shows an advantage of 2.8 to 1. The importance of this direct practical exhibition of a superiority, indicated in an equally decisive manner by theoretical consideration, will be estimated at its true value by most practical men.

It is obvious that the elastic grip of the new bolt will be greater in the same ratio, and that the friction on the nut under this grip will prevent its turning,

and so obviate the necessity for double nuts in many instances.

The bolts tested were designed for fish-plates, and they are undoubtedly well adapted to do the required work. For fastening armour plates and other work liable to rough usage, the advantages this bolt possesses of maintaining the maximum amount of elasticity due to the material, and at the same time preserving the position of the plates by a close bearing of metal to metal throughout the whole length of the shank, will give it an unquestionable superiority over most other attempts at effecting the same results.

THE PHOENIX FOUNDRY, GLASGOW.

No. II.

In our last week's number we described some of the details of the manufacture of large-sized cast-iron pipes as at present carried on at the Phoenix Foundry, Glasgow, and we will now continue our review of the appliances and modes of operation accumulated by the experience of a whole generation of ironfounders in these old-established and interesting works. The best class of water and gas pipes are now, without exception, turned and bored at their ends so as to make a tight and true metallic joint when joined together in great lengths. The machines for turning and boring these pipe ends are different in their construction from common engineer's lathes, and resemble more closely the so-called hollow lathe, to which we have occasionally referred, or the lathes for turning the trunnions of large guns, of which we gave an illustration on page 641 of vol. iii. of *ENGINEERING*. The pipes are mounted in bearings upon a strong longitudinal bed, and, after being properly centred and adjusted, are held steady and immovable during the whole operation. The cutting tools, arranged in a circle in even numbers, and at a circumferential distance of about 4 in. apart, are made to revolve by the main spindle of the lathe, and the whole headstock is traversed forward and backward upon the bed for giving the necessary feed motion. Each pipe requires to be turned outside at one end, and bored inside its socket at the other end; and accordingly each machine is fitted with two headstocks, one at each end, and arranged in a similar manner, the only difference being that one headstock carries a boring-head with several cutters at its outer circumference, while the other headstock has a hollow turning-head, with the cutters set to gauge inside of it to the circle required for the end of the pipe. The cutters are ground to the proper angle both at their side and at their face, and they cut with both their edges simultaneously. The cutters produce a ringing noise in their action, showing that vibrations cannot be avoided, however steadily the pipes may be fastened and held down in their collar bearings. It is, therefore, a necessary precaution to arrange the cutters in pairs, and in symmetrical positions as far as possible, in order to equalise their pressure all round the pipe. The feed motion for the headstocks consists of a simple rack and pinion gear, worked by means of a long lever by the attendant. This is very convenient, since the length of pipe to be turned or bored never exceeds a few inches, and a quick return motion for the headstock is by these means equally at the command of the workman. The pipes turned and bored at their ends in this manner can be fitted together with great ease, and with a superior accuracy in every respect to the common pipes, in which the tightness of each joint depends principally on the packing. The turned and bored pipes make a tight metallic joint, their surfaces being coated with a thin layer of red lead and oil only for gas-piping, and with an equally thin coating prepared of Roman cement for the joints of water-pipes. The finishing of the joints saves a great deal of labour and expense in laying the pipes, and it does not increase the cost price of the pipes themselves by more than about 5 per cent.

Pipes of less than 6 in. internal diameter are not moulded by machinery, nor furnished with a collapsing frame-bar in the centre of their core. To the production of these articles, and of other castings of smaller sizes which are moulded entirely by hand, the third distinct portion of the Phoenix Foundry is devoted. This is a series of sheds or buildings covering a very extensive area, and subdivided into numerous tracts and yards according to the different kinds of work produced in each division. In a foundry making small articles for the current trade of ironware, *i.e.*, a great and varied number of articles of small dimensions and weights, a very large floor area, in proportion to the number of cupolas and to the total mass of metal cast, is required in order to accommodate the very numerous moulding-boxes, and leave a sufficient passage between the rows of the latter. No cranes are required for

this department, and the arrangements are all very simple, although on a very large scale. The pipes of small diameters are moulded in green sand or in dried moulds, according to the requirements of quality. Their cores are built up round a central bar by straw ropes, and are finally covered with loam. The moulding is done by hand, each mould being maintained in an inclined position, both during moulding and casting. The patterns are of wood or iron, according to the number of casts required; but the number of casts which a good wooden pattern will permit, if carefully handled, and of a tolerably simple form, is very surprising. In fact, the great danger of wooden patterns is not the injury from use, but that to which they are subjected when in store and out of employment, exposed to the atmospheric influences and changes of temperature, which, even with great care, cannot be avoided. Some very remarkable patterns are those for moulding long articles of half-round sections, such as, for instance, a cast-iron gutter or long water-trough. The unequal contraction of the metal at the two surfaces, the one concave, the other convex, causes the article to take a different shape from that of the mould in cooling. A pipe of this class, if moulded from a straight pattern would, after cooling, be found bent to a considerable extent. It is therefore necessary in moulding to make provision against this peculiar mode of shrinkage, and to give to the pattern an amount of bend or curve in the opposite sense to that which the contraction of the metal will produce, so that the two opposite curves will balance each other, and the pipe after solidification will come out straight from a mould shaped to a curve. The exact shape and proportion of curvature to be given to the pattern in anticipation of the opposite tendency of contraction is a matter requiring great experience, and it would form one of the most complex problems for the ingenuity of a mathematician to solve by a general formula. The moulders, however, readily succeed by a few trials, making a pattern, first of all, according to judgment and experience, and casting a sample from that. The shape of the sample indicates the direction in which any errors may be corrected, and generally, after a very few trials of that kind, a curved mould is produced which will give a perfectly straight article when cast from. Amongst the great variety of small castings made at this foundry for what is called the general trade, there are some kinds of hemispherical kettles or pots, which are produced in extraordinarily large numbers. They are made for export, and are destined to form primitive household and camp utensils at the extreme borders of civilisation. The metal in these articles is very thin in proportion to their diameters and contents. Some vessels fully 1 ft. in diameter are cast with no more than $\frac{1}{8}$ in. thickness of metal. Other very thin castings made at the Phoenix Foundry are the circular casings for gas-meters. The iron runs perfectly well into these very narrow forms, and the castings are sound and smooth all over their surfaces. With regard to the quality and strength of the castings made at the Phoenix Foundry, very careful observations and tests are continually carried on. Of the mode of testing every single length of pipe by hydraulic pressure we have already given an account. The strength of the iron in the sleeper and chair foundry is tested regularly by a machine constructed at this foundry, and of which we expect to give an illustration very shortly. From each cast two or three bars are made, for being tested by this machine. The bars are 2 in. deep and 1 in. broad by 3 ft. 6 in. long. They are inserted in the testing-machine upon supports exactly 3 ft. apart, and a direct weight is applied on the centre of each bar. The machine is so arranged as to put on gradually increasing weights in succession, and to measure both the breaking load and the deflection at the moment of fracture, or at any other desired moment. A bar made from the cast of Griffin's patent sleepers, which we have seen tested by this machine, bent with a load of 30 cwt. to the extent of 0.4 inch deflection without breaking, and showed a small permanent set only after removal of the load. The same bar broke afterwards with 34 cwt. applied to it in the centre. This great strength of iron, which we have no reason to consider far above the general average of the quality produced at the Phoenix Foundry, is very far above the average quality of foundry iron in general. We need only refer to the able paper recently read by Mr. Ewing Matheson before the Society of Engineers, and published in our columns, to point out how nearly this test corresponds with the very best results known at present in this country.

THE VARTRY WATERWORKS.

SEVERAL of the mishaps connected with the prosecution of the Vartny Waterworks, constructed from the designs of Mr. Neville, C.E., to supply Dublin with water, have been already chronicled in our pages. Of these the most momentous was the partial failure of the great dam of the Roundwood reservoir, and the feeling of insecurity in the Vartny thence arising has been such as very much to impair the value of property in that quarter. Mr. Tighe, the owner of the fine domain of Rosanna, which would be exposed to the fury of the flood should a rupture of the dam take place, has consequently brought an action against the Dublin corporation, and has recovered from them 12,061*l.* as compensation for the injury done to his property. The following comments upon the event appear in the *Irish Times*, of Saturday week last:

"The jury in the case of Tighe *versus* the Corporation of Dublin, after a careful and minute investigation, have awarded 12,061*l.* as compensation to Mr. Tighe. This large sum measures the probability that the Vartny embankment will burst. If there were no such probability, no compensation would have been given. The chances of failure in the embankment must be great indeed when 12,061*l.* is granted to compensate for them. The residents in the neighbourhood of the embankment and the citizens of Dublin may well be alarmed at the result. For the verdict means that, after an examination of several engineers, and an exploration of the embankment itself, a jury found that there is a strong probability that the embankment will give way, no one can tell how soon.

"Although not a drop of water from the Vartny has yet been received for use in Dublin, for years past the Vartny water tax has been imposed upon the citizens. In fact, the impost has been levied ever since the Vartny Bill was passed. If the amount of this tax is added, as it should be, to the money borrowed, and to that lost, as in the case of Mr. Tighe, we will find that more than half a million of money has already been expended on this unfortunate undertaking. There is not the slightest doubt, and we say it advisedly—that Parliament must be petitioned to grant power to borrow further moneys. We have to expect further bursts in embankments, further damages, and further outlay, so that it is impossible to foresee when the enormous drain upon the property and industry of the citizens can end. The scheme has already seriously injured the city. Our taxation has been enormously increased, and now we have the mortification of knowing that, in the judgment of a jury, there is a strong probability that the works will give way and effect an amount of damage fearful to contemplate."

TRACTION RESISTANCES ON RAILWAYS.

(Continued from page 385.)

Heating Surface.

THE power of locomotive engines depends principally upon two elements—their heating surface, and their adhesive weight, that is to say, the weight resting upon the driving wheels.

Let us first calculate the number of horse power obtainable from each unit of heating surface.

At their maximum service speed, our various engines are capable of developing the following amounts of work:

	Horse power.
Crampton engine	400
Mixed "	300
Goods " (weight 33 tonnes=32.4 tons)	
English)	300
Goods engine (weight 30 tonnes=29.46 tonnes)	
English)	275
Goods engine with eight wheels	400

The power developed by the engines may be sometimes greater for a short time; but that is only what may be termed a *coup de collier*.

By dividing the amounts of work developed by an engine by the area of the heating surface, we find the number of horse power obtainable from each unit of surface, as follows:

		Horse power developed	
		per square metre of heating surface.	per square foot of heating surface.
Crampton engine	...	1.8	= 0.1207
Mixed	" ...	3.0	= 0.278
Goods	" (six wheels)	2.5	= 0.232
"	" (eight wheels)	2.0	= 0.185

The number of horse power obtainable from each unit of heating surface thus increases as the speed at which the engine is run becomes greater; and the firebox surface is of greater proportionate value than the total heating surface.

Adhesion of Locomotives.

In order to calculate the tangential effort exercised at the point of contact of the rail and driving wheel, we have to add to the tractive force, shown by the dynamometrical curve, the force necessary to effect the movement of the engine and tender, considered as vehicles. This force is known from the experiments of which we have spoken.

From the numerous examples given in our tables, we conclude that, for a sustained tractive effort, an adhesion of $\frac{1}{4}$ can be counted upon in good weather, and of $\frac{1}{5}$ in bad weather. In tunnels the amount of the adhesion is not generally greater than $\frac{1}{5}$.

We can now obtain from our experiments a practical formula for calculating the loads of locomotive engines.

Let P =the gross load in tonnes which can be drawn by a locomotive at the speed, V , over a line of known profile (V is expressed in kilometres per hour);

r =the resistance per tonne of the load, P ;

P' =the weight in tonnes of the engine and tender;

r' =the resistance per tonne of the weight, P' , considering the engine and tender as vehicles;

S =the total amount of heating surface, in square metres;

N =the number of horse power obtainable from each square metre of heating surface;

P'' =the adhesive weight of the engine;

m =the coefficient of adhesion.

The effort when running will be

$$Pr + P'r'$$

The work per second will be

$$(Pr + P'r') \times 0.277 \times V.$$

And we ought then to have

$$(5) (Pr + P'r') \times 0.277 \times V = S \times N \times 75.$$

Also, in order to prevent slipping, it is necessary that

$$(6) Pr + P'r' \leq m \times P''.$$

We have determined, by our experiments, the values of the coefficients, r , r' , N , and m . It is possible, then, by means of these two formulae, to calculate the maximum load which can be taken by any known engine, and the speed at which this load can be drawn.

These formulae serve also to solve the inverse problem, and to determine the principal elements of a locomotive which will draw a load, P , at the speed V , over a line of known character.

Thus in the formula (5), considered as an equation, there may at first be given to P an approximate value, from which may be deducted the value of S . Afterwards the formula (6), considered as an equation, will permit of the determination of P'' . The values of S , P' , and P'' may be afterwards slightly altered to suit details of construction; but the problem will have received its best solution if it is contrived to render equal two by two, the relative components of the formulae (5) and (6).

M. Dieudonné afterwards communicated a note, forming an appendix to the general *mémoire*, upon the production of steam in locomotive engines.

In the series of experiments to which the note referred, the water was measured in the tender by means of a graduated scale.

In the case of a Crampton engine, the power developed was 407 horse power, and the vaporisation per square metre of heating surface was 42 kilogrammes=8.58 lb. per square foot (2 per hour).

In the case of goods engines the vaporisation was not more than 16 to 18 kilogrammes per square metre=3.268 lb. to 3.677 lb. per square foot.

These experiments show that the quicker an engine runs, the greater is the production of steam per square foot of heating surface, and consequently the greater is the amount of work developed. As far as the production of steam is concerned, it would, therefore, be advisable to increase the speed as much as could be done without injury to the working parts.

In these experiments, the quantity of water used per tonne per kilometre varied with passenger trains from .704 litre in the case of express trains to .445 litre* in the case of ordinary trains, these quantities being respectively equal to .2534 gallon and .16 gallon per ton per mile. In the case of goods trains, drawn over a line of similar character, the consumption of water per tonne per kilometre was 0.88 litre (.3168 gallon per ton per mile) with an eight-coupled engine, and 1.39 litres per tonne per kilometre (= .499 gallon per ton per mile) with engines of the class known as No. 20. The consumption of water per horse power was thus found to be less as the speed was greater.

The respective consumptions were:

	litres.	gallons.
Express trains	0.23	= 0.0828
Ordinary passenger trains	0.44	= 0.1584
Goods trains	1.48 to 1.85	= 0.5328 to 0.666

The results are explicable by the fact that in the fast-running engines the steam was cut off earlier in the stroke than in the case of those running at slow speeds.

The quantity of water not utilised averaged 30 per cent. of the total consumption.

To the resistances of the engine considered as vehicles, determined by the experiments already described, it is necessary to add the resistance created by the pressure on the working parts.

M. Dieudonné calculated the amount of theoretical work developed by the action of the steam on the piston (the effect of the back pressure being allowed for), and compared the amount thus calculated with that shown by the dynamometer to have been utilised in traction, the tractive effort measured being that exercised upon the drawbar of the first wagon of the train.

In the case of an engine of the class, known as No. 20, it was found that a theoretical power of 226 horses was expended thus:

192 horse power upon the drawbar.
34 " upon the transportation and friction of the engine.
The proportion of the theoretical work utilised is thus in this example:

$$\frac{192}{226} = 0.85.$$

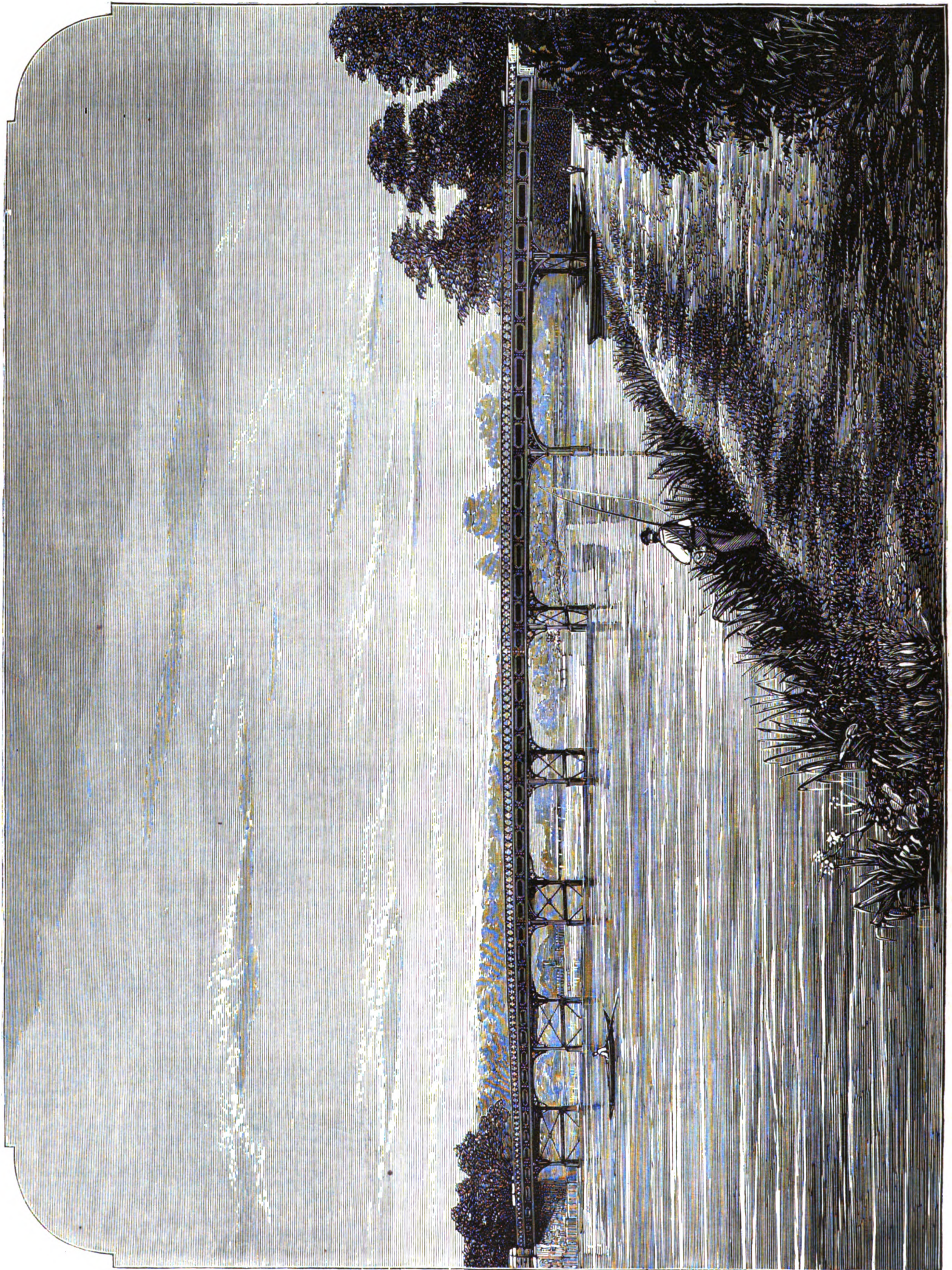
THE CLEVELAND IRON TRADE.—The Cleveland pig iron market continues brisk. The demand does not at present show any symptoms of decline, and a good deal of business has been done. Stocks in the railway warrant stores have fallen somewhat below 73,000 tons. A large quantity of Cleveland pig is being shipped for Scotland. Continental deliveries are of about the usual extent. As regards the foundries there are some rumours as to orders for pipes, but the work is not yet given out. Tenders are expected to be made shortly for a large quantity of railway castings for India. In rails, deliveries for Egypt and the north of Europe are still actively proceeding.

STEAM SHIPPING.—The Postmaster-General has accepted a proposal of the Union Steamship Company for a bi-monthly despatch to the Cape of Good Hope.

* In the abstract of MM. Vulliein, Guéhard, and Dieudonné's paper published by the Société des Ingénieurs Civils, these quantities are—evidently by mistake—given as 7.04 and 4.45 litres respectively.

BRIDGE OVER THE RIVER THAMES, AT COOKHAM.

DESIGNED AND CONSTRUCTED BY MESSRS. PEASE, HUTCHINSON, AND CO., ENGINEERS, DARLINGTON.

(For Description, see Page 403.)

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.

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MEETING NEXT WEEK.

SOCIETY OF ENGINEERS.—Monday evening, November 4, 1867, at 7½ o'clock. Continuation of paper on "Mechanical Saws," by S. W. Worsam, junior. And discussion.

ENGINEERING.

FRIDAY, NOVEMBER 1, 1867.

TECHNICAL EDUCATION.

AN account has appeared in the newspapers this week showing how certain Birmingham law-students distinguished themselves under examination, one placing the Alps in the island of Sardinia, another giving to the Duke of Marlborough the rank of admiral and the command of the Spanish Armada, and another ascribing to Ben Jonson, the dramatist, the famous dictionary of Doctor Sam Johnson, the philologist. We are not certain that every pupil, articled to an engineer, would, even at the end of his three years' apprenticeship, acquit himself very much better under an examination in natural philosophy, engineering history, and the principles of engineering design. For so-called engineering pupilage is at best but a sorry make-shift for a really sound technical education. As Englishmen we all admire our engineers, whose profession indeed has its birthplace and home in England, and we admire them the more because our best engineers have almost always been self-made men. But the self-made man, until his energy and ability have placed him far forward on the road to success, always works at a tremendous disadvantage. He must be a sort of steam-engine driven to ten or twelve times his nominal power; the constant pressure upon him approaching closely to his elastic limit, if not to his bursting strength; and, we may add, his wear and tear and consumption of fuel are such as only a constitution of steel can stand. But our self-made engineers have not until within the last few years been compelled to compete with highly educated and well trained members of their own profession abroad, men who have made all that we have done their careful study, and who have had, besides, the advantage of instruction in principles such as but comparatively few among ourselves have ever enjoyed. In France, in Germany, and in Switzerland, engineers are not left to "pick up" their education, nor could they for a moment look upon that really absurd and abortive mode of acquiring knowledge with the complacency peculiar to ourselves. Imagine the boy left to "pick up" reading, writing, and arithmetic in a merchant's or a solicitor's office! And it is but another form of the three R's which the engineering pupil is commonly left to pick up in an engineer's office—the reading of engineering terminology, of drawings, and of specifications—the writing of the engineer, which, like that of the artist, is in pictured forms and symbols—and the arithmetic of the engineer, which is the grandest of all arithmetic, the arithmetic of natural philosophy and of constructive art.

No one denies or doubts the value of systematic technical education, but, as with every great question, it is left to "the authorities." It may be depended upon as certain, however, that neither the sovereign, nor Parliament, nor the lay press, nor the popular orators who speak but for the good of the people, will

move in this matter, and that the real work is to be done by engineers themselves. Let them begin. Indeed, there was a beginning, months ago, at the Hôtel du Louvre, Paris, where a number of English jurymen and others at the Paris Exhibition met and discussed the importance of this question, and subscribed handsomely towards its solution; among others Paraffine Young, who wrote down his name with 5000l. at the end of it. Still we hear nothing of the result. There is, of course, no want of means. Look at the 50,000l. subscribed, last year, for middle-class education in the metropolis. Look at the 100,000l. and odd subscribed this year by the ironmasters, engineers, and merchants of Glasgow for the new building of the Glasgow University. And, although the objects were not precisely the same, look at the 25,000l. quickly subscribed, three years ago, by the civil engineers to their benevolent fund, and an equal subscription, last year, towards the erection of a new home of the Institution, a sort of palace of the profession, not yet, however, to be commenced because of the opposition of certain members. What would the Frenchmen, with their admirable *Ecole Centrale*, and their *Conservatoire des Arts et Métiers*, think of an appropriation of even 25,000l. for a school of engineering technology? There is indeed no difficulty as to means, and shall there be any in recognising the importance of the subject to which they should be applied? And yet, as we have said already, it is the engineers who must move in this matter: either the Institution of Civil Engineers or the Institution of Mechanical Engineers, or both. Of the first there might be reasonable hope of action; of the second, managed as it really is by a Birmingham inspector of engines and railway material, we fear there is none. Neither has ever encouraged engineering thought, but both content themselves with dry descriptions of works, useful no doubt, but which it is the business of the engineering press, and not of great professional bodies, to collect and publish. We incur no risk of a charge of egotism in saying that tenfold more, and at least equally valuable, descriptions of works, industries, and inventions appear yearly in our own columns than in all the Transactions of all the engineering bodies in the kingdom, and that our descriptions are twenty-fold more widely circulated and read. It is time that our great professional bodies distinguished themselves by initiation, as well as by the interchange of information among members. The subject of technical education is one the most worthy of their efforts. Really sound engineering schools, or one at least, has become a positive want, and the want should be at once supplied, with a view of meeting the increasing competition of a better educated engineering from abroad. A school is needed in which, without attempting to make the pupils exclusively mathematicians, geometricians, chemists, physicists, or mechanicians, they should be taught all the impartable natural science and knowledge of mechanical principles possible, and be exercised in designing, estimating, and actually constructing works and machines. Work should be combined with study, and the study should be made to include that of current and progressive as well as of established practice, and also that of commercial engineering, engineering history, the position of engineers abroad, the patent laws, &c.

It is time that the engineering institutions should move in this matter, for, if they do not, no system of technical education is likely to be established among us which can possess the confidence and approval of engineers themselves.

THE BESSEMER ROYALTY.

It is frequently asserted, and we find it repeated in Messrs. William Bird and Co.'s Circular for the present month, that the introduction of steel rails is retarded by reason of the royalty, amounting to rather more than 1l. per ton of bars, now paid upon the Bessemer process. There can be no doubt that if this royalty were to cease at once, and if makers of rails would lower their prices by its full amount, a somewhat greater demand would be found for steel rails. But the increase in the demand could not be great, inasmuch as few, if any, companies who were unable or indisposed to buy at 13l. would buy at 12l., so long as they could have iron rails at 6l. or 7l. Those companies who have extensively adopted steel did so at a time when its price was greater, by more than 1l. per ton (or by more than the royalty), than now; and the superiority of steel over iron is so great, not only in respect of its greater durability, but in the better working condition of the permanent way which it secures, with a consequent saving in locomotive power and locomotive expenses, that the companies whose

officers have had full experience of steel rails would, undoubtedly, continue to buy them, and lay them down, even at 18l. or 20l. per ton, knowing them to be really cheaper than iron, even at these increased prices. The main reason why steel is not now almost universally substituted in the place of iron on railways is the general difficulty which even sound railway companies have in raising money beyond earnings; for, in the case of steel, its increased cost, over iron, would naturally be charged to capital, and this means new shares or new debentures. Whether the royalty was off or on would make little difference, for, even at 1l. per ton, it bears but an insignificant proportion to the intrinsic value of the steel, which, as compared with iron at 6l., may be truly said to be worth 30l. per ton, if not indeed much more.

We have, in a former article, shown the fallacy of the opinion entertained by a few, that the price of steel rails will be less than now after the expiration of Mr. Bessemer's principal patent, by at least the amount of the royalty. No opinion could be more erroneous, and the reasons are easily comprehended. Mr. Bessemer has a series of patents, all or nearly all of them essential to the best results from his process, and some of these have still ten or twelve years to run. A considerable royalty will continue to be paid upon these; and although this may not amount to the full royalty now paid, the makers of steel rails will refuse to give the whole of any reduction to purchasers. So far, they have made but little profit themselves, the competition in the manufacture and sale of steel rails having been among the sharpest ever known in the trade.

The principal reason, and one which every business man will fully comprehend, why the price of steel rails must increase, even when the royalty is taken off, is that our markets and market-prices are now at the lowest ebb. Companies having money might buy now, and with advantage, even for their requirements as far ahead as 1870. Prices must certainly be much higher before they will ever be as low again. Trade, in nearly all its departments, is at its worst, and manufacturers are glad of anything that will keep their works going, and just cover expenses. When trade does revive, as it must, and probably within two or three years, prices must rise. Manufacturers who have worked without profit during a dull period must and will make up for their self-denial when orders are again plenty. Labour, too, is constantly rising in price, and the workmen will lose no opportunity afforded by improved trade for making fresh demands. The competition among steel-makers for the better kinds of English iron and for spiegeleisen is steadily increasing the market value of those essential materials for the Bessemer process. It is not unlikely that, after the lapse of the principal Bessemer patent, and the diminution of the royalty, steel rails, now at 12l. to 14l. per ton, will be then sought and purchased at from 14l. to 16l.

ROUTES IN ABYSSINIA.

THE following particulars, by W. Munzinger, Esq., the French Vice-Consul at Mussowa, relative to the practicability of the road-tracks in Abyssinia, obtained by him during a journey from Amphilla to the Abyssinian plateau, undertaken in June last at the express invitation of Colonel Merewether, will not be without interest to many of our readers at the present time, although the subject is one more particularly appertaining to the geographer than the engineer. In his communication to Colonel Merewether, Mr. Munzinger states as follows:

"Abyssinia has many easy entrances. There are oblique plains and successive terraces bringing up to the high table-land—through the Afar country to Adsd; from Tudjorra to Hayk; from Mussowa to Kajahkor; from Bogos to Hamasu; from the Baika to Adjabo, &c. The difficulty begins only on the table-land, it being divided and cut in pieces by a great quantity of very deep ravines with water-streams, so that there is great difficulty in communication from one portion of the table-land to the other. The king's camp being at Debra Tabor, and the prisoners at Magdala, action will evidently be directed towards the south; but I cannot but suppose that at the end of the rainy season, on the news of an army having invaded the country, the king will change his residence. Most probably he will block himself up at Magdala with his prisoners; less probable is it that he will stay at his present residence so as to induce the enemy to approach Magdala, and then make a retreat to Kuara, taking his prisoners with him. For him it would be very easy work; but not so for an army, the road from Magdala to Debra Tabor being intersected by many deep and steep ravines. I repeat, that it is the less probable supposition, because the king is at present

not beloved enough to expect from his soldiers the devotedness the fatigues of such a retreat would require. But, nevertheless, it may not be wholly useless to calculate on its possibility. The principal direction being so fixed towards Magdala, there is an option between the two roads. The first is that which would bring an army as quickly as possible to the high table-land, the edge of which should be pursued until the latitude of Magdala is reached; the second, along the great line of the mountains, profiting by the terraces which accompany steadily the highlands.

"The shortest line from the sea to the highlands is that from Zula, or from Mussowa, to Tokunda. As for the starting points, there is no great difference between Zula and Mussowa; the former is shorter by a few miles, and has more water, but has no good landing-place. Both roads join at the river Hadass, which offers a very easy road till the ascents of Tokunda. From Tokunda till Lake Hayk the road follows the edge of the table-land, 6000 ft. to 7000 ft. high, with very little irregularities, and no deep valley to cross, touching Senafey, Addigrat, Tshelikut, Wodjerat, and Hayk, which is only three journeys distant from Magdala. It is useless to quote here some itineraries I have collected about this road, because the true distance could not be ascertained; and happily they will not be needed, because all this tract has plenty of water and vegetation, and no difficult, narrow, or steep passages. It is well cultivated, well peopled, and has a cool healthy climate. The second road starts from Hanfila point. During the summer it would certainly be a dangerous undertaking to bring a body of soldiers across the Salt Plain—the line from Boka coast to Rognely would then be preferable, but from December there would be no great difficulty. From Hanfila till Didik there are water and wood. The narrow passage of Didik would easily be mended in a few hours. The great difficulty would be the section of the road from Didik to the edge of the Salt Plain, excepting heavy rains had fallen. The water on both sides of the Salt Plain is drinkable. The road is very rough, but the stones can easily be thrown aside. From Magdala upwards the road leaves nothing to be desired. From Ayla to the first village of Azebo (Bedda) is four to five days' march. The first half of the road is made difficult by three ascents, after which the plains of the Doda are reached, extending to the frontier of the Azebo. The Azebo country extends to near Hayk, the road pursuing an immense plain full of villages, and rich in water and vegetation. Ashangi, which lies 2000 ft. higher, would be left to the right. The Azebo country appears 3000 to 4000 ft. above the sea. To reach Hayk there is a very high ascent, and then the road joins that of the highland. If the two roads are compared, it will be seen that each has its peculiar advantage. The higher road brings an army at once, without any fatigue from sun or climate, to a green and cool highland—an immense advantage to European soldiers. It goes through a well-peopled and well-cultivated country, where, the first antipathy being overcome, most victuals might easily be procured; it goes through Abyssinia proper. It has, however, the great disadvantage, that it is not fit for a prolonged camel transport—not from the difficulties of the terraces, but from its climate, which is cool and dewy, while the country is poor in thorn-trees fit to feed cattle upon. It would be an excellent road for mules, bullocks, &c. As to the lower road, it has many disadvantages. Most of it goes through a very thinly peopled, hot, barren country, where nothing is to be got excepting meat; it requires several forced marches. The tribes of the country live without government, laws, or religion. But its great advantage is that camels laden at Hanfila will reach Hayk, and even Santa, without difficulty, and will support themselves through the whole country. Besides that advantage, a part of the road being Egyptian, and the rest belonging to a great number of small chiefs, it would be easy to keep communications open without military occupation. The Egyptian Government would protect its portion until the Salt Plains were reached, and the chiefs on the other side would be easily won by small presents."

THE METROPOLITAN RAILWAY.

WITHIN the last few months three or four passengers have died, suddenly, in the trains of the Metropolitan (underground) Railway, a line upon which twenty-five millions of passengers are carried yearly. At the respective inquests upon the deaths of the passengers so dying, it was proved that they were previously suffering from diseases predisposing to sudden death; but on the occasion of the last inquiry

of the kind, Dr. Lankester, the coroner, endeavoured to force from the medical witnesses an admission that the atmosphere of the tunnels of the railway was foul, and that this foulness had hastened, if it had not directly caused, death. We took up this question, in considerable detail, in our impression of September 6th last (page 199), and showed that, from the manner in which the tunnels have from the first been worked, there could be no injurious accumulation of either carbonic or sulphurous acid gas in them. Relying upon facts fully attested by the science of chemistry, and by our own knowledge of the working of the line, we advanced certain predictions as to the purity of the atmosphere of the tunnels; and, without wishing to appropriate any credit for having done so, we may now say with justice that the results of careful chemical analyses have more than confirmed all that we said. Of what we did say we may here quote the following extracts:

"The tunnel of the Metropolitan Railway resembles, in its mode of working, no other railway tunnel in the kingdom. Although trains are constantly passing through it, the engines have no artificial draught upon their fires, and their steam is wholly condensed in tanks of cold water. We do not say that no consumption of coke goes on in the tunnel, but, as no steam draught is kept up on the fire, the production of carbonic acid gas must necessarily be small, and the production of sulphurous acid gas must be, of course, almost infinitely less still. We have good reason to believe that not more than 10 lb. of coke is actually burnt per mile, while the steam blast is off; and assuming this to be pure carbon, it would produce 38½ lb. of carbonic acid gas, and this, at atmospheric temperature, would occupy 319 cubic feet. It would be discharged from the locomotive chimney at a temperature of perhaps 600°, or even more, and would therefore have a volume more than twice greater than that at atmospheric temperature; but as it would be soon chilled against the walls and roof of the tunnel, our estimate of 319 cubic feet will still hold good. Now the cross sectional area of the tunnel is 400 square feet, and each mile of its length therefore contains 2,112,000 cubic feet of air, within which the 319 cubic feet of carbonic acid gas would be diffused. Atmospheric air of average purity contains 1/1000 of its bulk of carbonic acid gas, or less than the 1/4 part of 1 per cent., and it is only when this proportion is increased by about one hundredfold, or to 4 per cent., that air becomes fatally dangerous for respiration. Now the discharge of 319 cubic feet of carbonic acid into a space of 2,112,000 cubic feet would increase the proportion of gas by less than one-half that which exists in all pure atmospheric air."

"For ourselves, we have never detected the characteristic scent of carbonic acid in descending the stairs of the stations of the Metropolitan Railway, and yet we meet it in the neighbourhood of every brewery, distillery, and vinegar factory, and learn of no attendant danger to health or life in consequence of it. As for sulphurous acid gas, we believe it will be found almost beyond detection. The worst coke contains not more than 1½ per cent. of sulphur, and that burnt in the engines of the Metropolitan Railway contains, we know, a very much smaller proportion. Even if it contained one-half per cent. of sulphur, which it does not, it would produce but 1/32nd as much sulphurous acid gas as carbonic acid gas, and the proportion of the former in each compartment of a train would be less than that occasioned by lighting a cigar with a friction match."

At the time when the above was written, Professor Rodgers, Dr. Bachhoffner, Dr. Letheby, and Dr. Whitmore were about to undertake a careful analysis of the air of the tunnels, and these have now been completed. We publish, on another page, the reports of the three last-named chemists, and we may here repeat a portion of Professor Rodgers's report, as read and received as evidence at the adjourned inquest, this week, upon the death of a young woman who died on the underground railway in August last. He said: "He had carefully analysed and tested the air contained in the tunnels of the railway between Bishop's-road and King's-cross stations, and he had made comparative experiments in other tunnels. The atmosphere in a pure condition consisted of a volume of 79.19 measures of nitrogen, and 20.81 of oxygen, and every 10,000 measures of air contained from 3.7 to 6.2 measures of carbonic acid. On the 4th of September he found that, in 17 cubic inches of air taken from each of the tunnels between the hours of 3 and 5 P.M., tested for carbonic acid, that with the exception of the air from the Gower-street and King's-cross tunnel (which contained a more notable quantity), only a small trace of carbonic was indicated. On the 10th of September, between 10 and 11 P.M., he determined the quantity of carbonic and sulphurous acids contained in 17 cubic inches, and during his transit backwards and forwards from King's-cross to Bishop's-road he found 13 measures of carbonic acid in 10,000 of air, and 1 measure of sulphurous acid in 40,789. Carbonic acid was evident in 17 cubic inches of the air taken from the Gower-street and King's-cross tunnel. On October 2, in the same tunnel, he found 18.7 measures of carbonic in 10,000, and 1 measure of sulphurous acid in 23,913. On October 28, between 8 and 9 P.M., he found traces of carbonic evident in 17 cubic inches in all the tunnels. On the 4th of September he found that the following were the percentages of oxygen in the tunnels: Bishop's-road, 20.48; Edgware-road, 20.60; Baker-street, 20.30; Portland-road, 20.10; Gower-street, 18.7. In the Blackheath tunnel, on September 28, it was 20.0. The air of Pimlico on September 21 contained 20.9. On October 24 the percentage was as follows: Box Tunnel, 20.3; Birkenhead Tunnel, 20.1; Wolverhampton Tunnel, 20.5; at Wellington Barracks, 12.42 at 2 ft. 6 in. from the floor.

"Replying to the coroner, Professor Rodgers said he did

not think the deficiency of oxygen would act injuriously upon a delicate person passing through the tunnels, and he did not think that the amount of carbonic and sulphurous gas in the tunnels would act injuriously upon the woman. There was not a sufficient accumulation of these gases to be injurious to the public health. If the woman had eaten heartily, was laced tightly, and had a diseased heart, he did not think the deficiency of oxygen would have hastened her death.

"The Coroner: Do you believe that the railway may be used by the public with a perfect certainty that they will not be injured by so doing?"

"Professor Rodgers said he did believe so, but added that the air of the tunnels was one which should not be constantly breathed."

The reports of Drs. Letheby, Bachhoffner, and Whitmore showed even less carbonic and sulphurous acid gas, and we need only refer to them, printed in full as they are in another column. The conclusion is especially important, however. It runs thus:

"From the foregoing facts, we are enabled confidently to state that the atmosphere of the Metropolitan Railway is not unwholesome or injurious to health. (Signed) J. H. Bachhoffner, Ph.D., F.C.S., &c.; Henry Letheby, M.B., M.A., &c., Professor of Chemistry in the College of London Hospital, and Medical Officer of Health for the City of London; J. Whitmore, M.D., &c., Medical Officer of Health and Chemical Examiner of Gas for the parish of St. Marylebone."

We will add only a few remarks of Dr. Letheby's, upon his examination by the coroner. He said:

"That the nose could detect the presence of sulphurous acid when it could not be detected by a chemical test. One part of sulphurous acid in 100,000 parts of air would make people cough. The gas arising from a partial combustion of the wood when the brakes were being used would irritate the mucous membrane; but he did not think the proportion in the tunnels was such as to produce any bad effect. Coke contained 0.26 per cent. of sulphur, and 6 lb. of coke were consumed per mile in the tunnels and stations. The length of the tunnels and stations was 11,066 ft., or 2.09 miles. The cubic contents of the tunnels without stations was 4,606,792, and the number of trains passing up and down during eighteen hours was 358. If that calculation was worked out, it would be found that, supposing the whole was hermetically sealed, there would be upon the whole of the coke burnt in that atmosphere a quantity of sulphurous acid amounting to 4 in 10,000 per volume. The proportion would be 2.95 of sulphurous acid on 10,000 of air, supposing no change of atmosphere took place, and the percentage would be 0.00295, which was quite incapable of doing any one mischief, even, as he said, if the whole place was hermetically sealed."

"Dr. Letheby then explained how he tested the air, and said the atmosphere they were all breathing in the room was three times as bad as any he had found in the tunnels."

We need hardly add that the verdict of the coroner's jury upon the painful case brought before them was "Death from natural causes." But we may point to this case, as one of many instances in which the principles of science may be applied with certainty, and apparently in the spirit of prediction, to the solution of questions of seeming difficulty to the uninitiated.

HARBOUR OF ST. HELIER, JERSEY.

A COMPETITION which has much attracted the attention of engineers is that which is now taking place for improvements in the harbour of St. Helier, Jersey; and those of our readers who have experienced the dangers of being landed there, from the steamers, in small boats, when the tide is too low to permit the access of the steamers to the dock, will readily concur in the conviction of the Jersey authorities that there is much room for improvement. In furtherance of this object, the estates of the island, in the early part of this year, advertised that they would, in the autumn, be prepared to receive designs, and consider plans, that might be submitted for effecting their purpose. To stimulate competition three premiums were offered, the first, we believe, being one of three hundred guineas; but, as it was also intimated that the author of the approved design would, in all probability, be appointed to carry out the works, here was the real bone of contention. It was also, we believe, intimated that the island was prepared to expend some hundreds of thousands on the works. Further, to ensure having the ideas of some of our leading harbour engineers upon the subject, Messrs. Rendal, Abernethy, Coope, and Giles were each stimulated by a special retaining fee of one hundred and fifty guineas.

Under such circumstances, and in the present depressed state of professional occupation under which Great George-street lingers, the prospect of a keen competition was inevitable. Upwards of thirty-seven competitors have contributed designs—many of them more than one, and these are now on exhibition, to the public, at St. Helier. Amongst the names attached to them, we recognise those of many of the most eminent men in the profession; and if the committee, on whose shoulders the onus of selection rests, do not secure one answering all their requirements, it certainly cannot be from a lack of counsellors; rather should we

fear the opposite verification of the old adage, "Too many cooks spoil the broth."

On a careful inspection of the various designs, we are struck with the similarity that exists between many of them—a fact that will, we think, materially assist the selection. Striking out the incomplete and most *outré*, the distinctive features of the remainder may be classified into groups, from which, again, a little careful consideration will enable them to choose the most matured designs.

The first point, however, to be determined by the committee will naturally be the depth of water it is desirable to aim at; and upon this we would strongly urge our opinion that, with a view to any possible development of future traffic to this thriving little spot, the scheme be dealt with in no niggardly way, but one sufficiently bold and comprehensive to give security to shipping, a safe approach, a fair depth of water of twelve or fifteen feet even at low tide, and ample space be adopted. Such a course is, in the end, the most economical; and had the money expended on the old harbour—now dry long before low water—been contributed to a bolder scheme, a fresh start might not now have been necessary.

In adopting one that complies with these requirements, it by no means follows that it should be at once completed in its entirety, but might be proceeded with contemporaneously with the development of the resources of the island, as we entertain a strong conviction that to proceed at once to an expenditure of some two hundred and fifty to three hundred thousand pounds would be to cripple the resources of the port by the burden of a debt to which, for some years, they can never be equal; but to this we will again revert, merely adding, in passing, that the development of a harbour should slightly lead and not follow in the wake of the natural expansion of trade due to improved accommodation.

As the number of competitors is such as to make it a matter of interest to many, we give, on pages 410 and 411 sketches, copies of the notes we made at the time of our inspection, which will show the general scope of those of the designs that most engrossed our attention. They are drawn to scale, and, with their assistance, a reference to a plan of the harbour will enable those interested to trace out the salient features, whilst they are probably accurate enough for the casual observer not specially interested in the matter.

Reference to a map will at once show that the exposed situation of the islands renders them specially subject to western and south-westerly gales; hence the finger of nature would seem to point to the two prominent masses of rock, on which the Fort and Hermitage stood, as the base from which a breakwater should spring. The Platte rocks, again, stand out as so natural a termination for this, that to fall short of them would be to throw away the benefit of a natural barrier and base; whilst to leave them outside the entrance would endanger the approach of vessels, and also so curtail the size of the harbour, and consequent depth of water, that by the time the works are completed the committee would very likely find they might with advantage commence their labours afresh. We would therefore combine the Platte rocks in the scheme, and further at some future time like to see the rock known by the name of the Ozelers either blown up or pressed into the service of protecting the entrance, as one competitor suggests, or a groyne from the principal breakwater.

The fine sweep of St. Aubyn's Bay causes the ood-tide to set in from both sides, and the two currents meet at the line connecting the castle ro with the shore, along which the road—dry at low tides runs; hence the freest access should be given to the entrance of the tidal water, and as the south and east of the harbour are tolerably protected by the rocks, we do not see much to be gained by any works on that side. Many of the competitors show an open viaduct leading a road to the landing-stage or pier-head. But we would ask, why land on this side at all? It happens to be so at present; but is not the other side, under the lee of the Hermitage rock, the most sheltered, with the deepest water? There, too, is the business end of the town, and at that end the only room for extension. Moreover, it is much nearer, avoids the passengers landing the long circuit of the docks, and the works there would constitute the finest marine promenade in Europe, a matter of no slight importance when the number of visitors is considered; for we see by a local paper that 22,000 landed at St. Helier between May and September of the present year. An open iron viaduct, carrying a tramway, would not be a costly item; its liability to accident must be but slight, as the bank from the Fort to

the shore so shoals the water that ships do not, as a rule, pass that way. Any extraordinary cases might be easily accommodated by a drawbridge, which we venture to say, in practice, would never be used. We notice this in one or two designs, and have a strong conviction that it is in the right direction. A sum of fifty or sixty thousand, we have a shrewd suspicion, would accomplish this, and provide a jetty under lee of the Hermitage, which, resting on the Crapaud rock, would afford shelter and landing-place for, say, a couple of steamers. The outer breakwater could then be proceeded with at leisure, as the funds at their disposal admitted. By the autumn of next year the first part of such a scheme might be carried out, and a good steamboat-landing secured; and this, after all, is the great point at present aimed at—the first point to be achieved—and should it be found sufficient for the purpose, the future can then be considered.

Such are our general views upon the matter, based upon a hasty inspection of the designs. It will be for the committee to determine what shall be done, and we imagine their decision cannot be long delayed. Difficult as the task before them may be, if they call to their aid the opinion of the pilots and captains frequenting the port, they will have the best advice they can possibly get upon the general plan, the engineering details of which may with safety be left in the hands of any of the eminent competitors for execution. We shall await with interest the decision, all we hope is it will be awarded free from any other considerations than those of merit, and that the error, too common in many such cases, may not be perpetrated, of referring the plans to some engineer, who either selects that of a friend, or, picking pieces out here and there from others, produces one which he calls his own. With such a list of competitors, what more engineering advice is needed? what better can be got?

STEEL UNDER THE MICROSCOPE.

An experienced steel-maker can estimate very closely the precise quality, chemical composition, tensile and compressive strength, and even the mode of treatment which a steel has undergone, by looking at its fracture. The appearance of the crystalline texture, which is more or less discernible by the naked eye, and the method in which the reflected light gives certain variations of lustre, are the scanty yet very important indications from which, by a series of guesses as to probabilities, an opinion may be formed which has every chance of being correct. This being the case, it seems very obvious that, by the assistance of the microscope, we should be capable of observing the texture of steel and iron fractures more correctly and more minutely, and a smaller amount of experience or nicety of observation should be sufficient—should enable us to form a correct opinion of the qualities of any given sample of steel. This is the case, and to such an extent that it is most astonishing how metallurgists could have neglected the use of the microscope to such an extent as it generally has been. We have already drawn attention in this journal to the interesting researches made by M. Schott, the manager of Count Stöhlberg's foundry, at Ilseburg, upon the appearance of liquid and solidifying cast iron under the microscope, and we can quote the experience of this able metallurgist as to the advantages to be obtained from microscopic observation of various kinds of steel. M. Schott, at his visit to the Paris Exhibition, made some most remarkable "guesses," as some steel-makers would call his conclusions, with regard to the qualities and method of manufacture of many hundreds of steel samples exhibited there, and of which he, in many cases, had no other knowledge than that which he could gather through the aid of a small pocket microscope, made of two pieces of rock crystal, formed into a very powerful single lens. A pocket microscope of this kind ought to be the companion of every man interested in steel or steel manufacture. Lenses of the usual kind, even if piled up in sets of three or four, are entirely insufficient. The lens must be of a very small focus, and properly achromatic. A little practice is sufficient to enable the user to "see" through this lens; but it is, of course, not quite so easy to learn the meaning of what is thus seen, and to estimate from the appearance the quality of the steel inspected.

M. Schott has established for himself a kind of theory which, we believe, will be useful to those of our readers who desire to use the microscope in their researches upon the qualities of steel. M. Schott contends that each crystal of iron is an octahedron, or rather a double pyramid raised upon a flat square base. The heights of the pyramids in proportion to their

bases are not the same in different kinds of steel, and the pyramids become flatter and flatter as the proportion of carbon decreases. Consequently, in cast iron and in the crudest kinds of hard steel, the crystals approach more to the cubical form from which the octahedron proper is derived, and the opposite extreme, or the shaft wrought iron, has its pyramids flattened down to parallel surfaces or leaves, which, in their arrangement, produce what we call the fibre of the iron. Between these limits, all variations of heights of pyramids can be observed in the different kinds of steel in which these crystals are arranged more or less regularly and uniformly, according to the quality and mode of manufacture. The highest quality of steel has all its crystals in parallel positions, each crystal filling the interspaces formed by the angular sides of its neighbours. The crystals stand with their axes in the direction of the pressure or percussive force exerted upon them in working, and consequently the fracture shows the side or sharp corners of all the parallel crystals. In reality good steel under the microscope shows large groups of fine crystals like the points of needles, all arranged in the same direction, and parallel to each other. If held against the light in a particular direction, each point reflects the light completely, and a series of parallel brilliant streaks are shown all over the surface. Now, the exact parallelism of the pointed ends or of the streaks of light is one of the most decisive tests for a good quality of steel, and this is not visible quite so frequently as might be generally imagined. On the contrary, a great majority of steel fractures show crystals arranged in parallel groups or bundles, as before described, but clustered together in several distinct crystalline layers, which are not parallel to each other. The consequence is that the needle-points, visible under the microscope, appear to cross each other at certain places, or at least they point in such directions that, if elongated, these lines would cross each other at a short distance in front of the fractured surface. Wherever the crossing actually takes place, a ridge or line is generally visible to the naked eye, and the colour of the two parts of the fractured surface which contain the different groups is different, since the light which falls upon one group at the proper angle for reflection will be in such a position with regard to the other group as to throw the points of the crystals into the shade. The one part of the surface, therefore, will appear bright or silvery white, while the other will look dark or grey in colour. As usual, inferior specimens are more instructive than the best qualities, because there the peculiarities and faults come out most strikingly. We have seen a piece of a Bessemer steel block from a spoiled charge, in which the crystalline structure of the spiegel-eisen was seen in some spaces, particularly at the edges of the air-bubbles, perfectly distinguished from the coarse-grained crystals of the mass of steel all round. This mass, moreover, contained groups of very different character within itself. In a specimen of steel or iron made by another process we could discover clearly defined crystals of pyrites, indicating the existence of sulphur in an unexpectedly tangible manner. Repeated melting, heating, or hammering of steel has in general the effect of reducing the sizes of crystals, and also of laying them more parallel. Still there seems to be a difference between the treatment which gives parallelism and that which causes the reduction of sizes in the crystals. The former seems to be principally due to the action of the heat, and repeated melting is the great panacea in this respect. The small-sized crystals, or what is called fine-grain, can be obtained by mere mechanical operations. In fact, hammering at a dull red heat, or even quite cold, is known to produce the effect of making the grain of steel extremely fine. This is a property, however, which is lost by reheating, and at a sufficiently elevated temperature steel seems to crystallise in large grains, which remain if it is allowed to cool slowly and undisturbed by mechanical action.

STATISTICS OF BRITISH INDIA.

THE commercial rise and progress of our East Indian possessions are set forth most concisely in the third statistical abstract for the several colonial and other possessions of the United Kingdom, recently published. It is found from this valuable compilation of figures that the area of British India is 956,436 square miles, and that in 1861 its population consisted of 143,271,210 persons. The gross amount of public revenue increased from nearly 28 millions sterling in 1852 to more than 45½ millions in 1865, and the gross expenditure within the same period increased from 27 to 46 millions sterling. The public debt of India has,

during the last thirteen years, increased by 23 millions, and in 1865 amounted to 98,477,555 $\frac{1}{2}$. The total tonnage of vessels entered and cleared in 1865 is represented by 4,268,666 tons, 3,228,284 of which belonged to British and 1,040,382 to foreign craft, these figures not including those vessels employed in the coasting trade. The total value of imports rose between 1852 and 1865 from 17 to 49 $\frac{1}{2}$ millions sterling, of which sum 5 and 21 millions sterling represented the value of bullion and specie, and 10 and 23 millions sterling respectively the total value of imports from the United Kingdom alone. The total exports were valued in 1865 at nearly 69 $\frac{1}{2}$ millions, which represents an increase of more than 48 millions sterling during the past thirteen years. The principal articles imported to British India, exclusive of bullion and specie, are cotton twist and yarn, cotton piece goods, spices, malt liquors, copper, salt, and wines. Of articles exported in 1865, raw cotton produced 37 $\frac{1}{2}$ millions; opium, nearly 10 millions; rice, 5 millions; seeds, nearly 2 millions; and raw wool and raw silk, each more than 1 million sterling. The quantity of opium annually exported during the past thirteen years reached its maximum in 1865, but its greatest value in 1863. Wool exports have regularly and progressively increased, 7,057,161 lb. weight having been shipped in 1852, and 23,432,689 lb. weight in 1865.

EXTRACTING COPPER ORE.

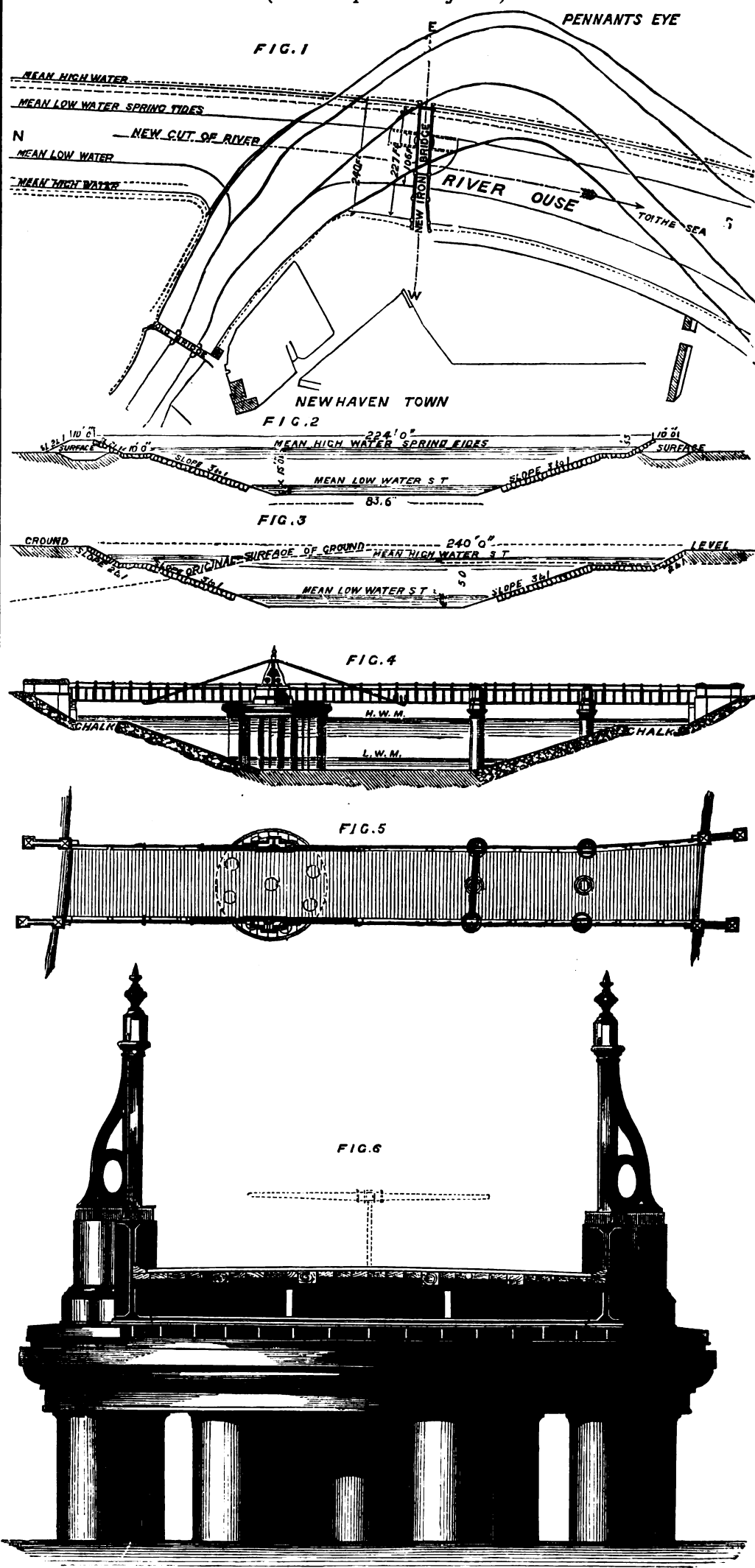
A NEW process for extracting copper from poor ores has been recently introduced in America. The patentees of this process are Messrs. Whelpley and Storer, of Boston. The process consists in first grinding the ore into fine powder, and afterwards calcining the latter in a vertical furnace or kiln with a down draught, and having its fireplace at the top. The fuel for calcination is also reduced to powder, and blown into the kiln along with the air from the top. The calcining effects a conversion, by oxidation, of the sulphides of copper and of some other elements into soluble salts, whilst the surplus of sulphur is converted into sulphurous acid gas. All these products can be drawn out and retained by water, and consequently the whole bottom or base of the furnace is formed as a large water-trough. This trough extends to a considerable distance in front of the furnace, and ends in a cistern or well filled with water. An Archimedian screw is kept revolving at the bottom of the water-trough, and this pushes all the calcined ore forward through the trough until it is finally deposited into the cistern. The water is thereby made to dissolve all the salts of copper, which are afterwards used for precipitating metallic copper, or for the production of copper salts. The first experiments, on a large scale, were made by Messrs. Whelpley and Storer, at East Boston, with a furnace 18 ft. high; but a new furnace is being now erected by the patentees of the process at Harvey Hill Mine, near Quebec. This is to be 30 ft. in height, and is expected to reduce 50 tons of 7 per cent. ore per day. The machinery for pulverising the ore is somewhat similar to some quartz crushing-mills, only it works at a very high speed. The necessity of having a water-trough at the bottom of the furnace for the immediate reception of the calcined ore has brought the downward draught into request. The fuel and ore, both in a powdered state, are blown into the furnace at the top by means of fans, along with the air required for combustion; and the heat to be obtained in this manner, viz., by mixing powdered fuel with a current of air, and passing it through a highly heated square, is said to be extremely intense. The dust of ore remaining after extraction of the copper is in some cases the most valuable portion of the ore, and occasionally the only one utilised. This is the case with auriferous copper ores, which, after having been calcined and deprived of all soluble matter in this manner, contain the gold in a form which is best suited for extraction by mercury.

CHARENTES RAILWAY.—The inauguration of the Rochefort and Angoulême section of this railway has just taken place. The section forms the principal concession of the Charentes Company. It is 73 $\frac{1}{2}$ miles in length, is connected at either extremity with the concessions of the Orleans Company, and traverses two of the principal wine-producing departments of France.

RAILWAYS IN RUSSIA.—A line from Warsaw to Terespol, the last section of which has just been inaugurated, is 193 versts in length, and has twelve stations. The concession of this line was accorded to M. Leopold Kronenberg by an imperial ukase, dated October 21, 1864. The line was to be opened for traffic in five years, that is, by the autumn of 1869. It will be seen, however, that traffic has been commenced two years earlier than has been anticipated.

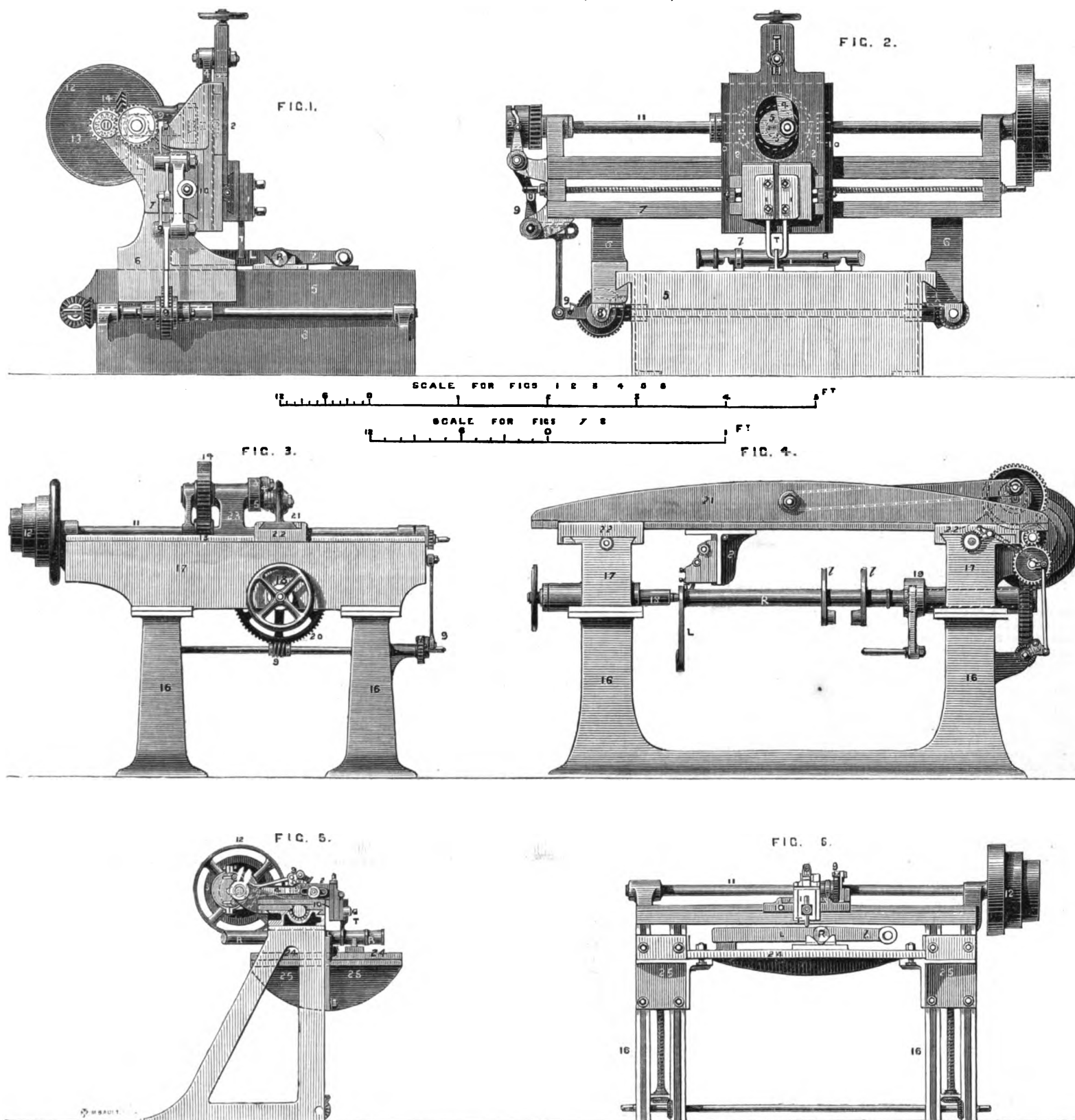
NEWHAVEN HARBOUR IMPROVEMENTS.

(For Description see Page 420.)



MACHINES FOR FINISHING LOCOMOTIVE ENGINE DETAILS.

DESIGNED BY MR. STEPHEN ALLEY, ENGINEER, GLASGOW.



It is now becoming the general practice to forge the lifting-arms and weigh-bar of a locomotive engine in one piece, and a series of special machines (applicable, however, to other purposes) has been designed and patented by Mr. Stephen Alley, of the firm of Neilson Brothers, Glasgow, for finishing this class of work. These machines, which are three in number, are represented by the above engravings.

The first machine, represented in side elevation in Fig. 1, and in front elevation in Fig. 2, is more particularly designed for shaping the levers, L, forged on a locomotive reversing-shaft, R. In this machine, two cutting tools, T, facing each other, are employed for simultaneously shaping the opposite sides of a lever, L. The tools, T, are held in tool-boxes, 1, which, by means of a right and left handed screw adjustment, can be set more or less apart on a head or slide, 2, and a vertical reciprocating motion is imparted to the slide, 2, and through it to the tools, T, by a revolving crank-pin, 3, and connecting-rod, 4. The reversing-shaft, R, is fixed upon a stationary table, 5, formed with openings in its top surface to receive any levers projecting in a different direction from the lever, L, that is being operated upon. A bridge-piece, 6, 6, 7, is traversed along the table, 5, by screws, 8, worked by a feed motion, 9, whilst a saddle or slide, 10, which is

arranged so that it can be adjusted horizontally thereon, carries the vertically reciprocating slide, 2, with the cutting tools. The machine is actuated by means of a transverse horizontal shaft, 11, having pulleys, 12, on one end for a driving-belt from an overhead shaft; this shaft, 11, is carried by brackets formed on the bridge piece, 7, and by means of a groove and key turns a bevel pinion, 13, held by a bracket on the saddle, 10. The bevel-pinion, 13, drives a bevel-wheel, 14, on a short horizontal shaft carried by the saddle, 10, and having on its front end a disc, 15, in which is adjusted the crank-pin, 3, for actuating the vertical slide, 2. The edges of the levers may be planed in the same machine without removing the reversing shaft, by causing the bridge piece to travel at a suitable speed with a planing tool fixed upon it.

The second tool is represented in side elevation in Fig. 3, and in front elevation in Fig. 4, and is for shaping the rounded ends and bosses of the levers, L, *l*; this machine is also capable of shaping the edges of the levers. The framing of this machine comprises four standards, 16, on which are fixed parallel to each other two slide-beds, 17. The reversing shaft, R, to be shaped is centred between an adjustable centre, 18, carried by one slide-bed, 17, and a boss, 19, carried by the other slide-bed, 17, and fitted with a worm-wheel, 20, and

feed-gearing, 9, for being turned slowly round. A long tool carrier or beam, 21, is arranged to reciprocate horizontally above and parallel to the shaft, R, by means of a revolving crank-pin, 3, and connecting-rod, 4, and one or more tool-holders, 2, can be fixed at any part of this beam, to operate on any part of the shaft, R. The reciprocating beam, 21, works in guides upon slides or saddles, 22, at each side, and these slides can be moved on their beds, 17, at right angles to the shaft, R, by screws, 8, actuated by feed gearing. This motion is for shaping the edges of a lever, L, on the shaft, R, and when this is being done the shaft, R, is kept stationary with the lever, L, in a horizontal position. The first-motion shaft, 11, with its pulleys, 12, is carried by brackets on one of the slide-beds, 17, and it actuates a pinion, 13, by means of a groove and key; this pinion, 13, being held by a bracket, 23, attached to one of the saddles, 22, and being in gear with a spur-wheel, 14, on a shaft carried by the bracket, 23, and having on its front end a disc, 15, holding the adjustable crank-pin, 3, for working the beam or slide, 21. The third machine, shown in sectional end elevation in Fig. 5, and in front elevation in Fig. 6, is also designed for shaping the edges or sides of the levers, L, *l*, forged on locomotive reversing shafts, R. In this machine the cutting tool,

T, has a horizontal reciprocating motion produced by a revolving eccentric, 3, and connecting-rod, 4, whilst the tool-holder or box, 1, is upon a slide, 2, working in guides in a saddle, 10, which is moved by feed gearing, 9, along a horizontal slide-bed, 17, in a direction at right angles to that of its reciprocating motion. The shaft, R, to be operated upon is fixed on an open frame, 24, one side of which is adjustable, and which is carried by slides, 25, at each side, such slides being adjustable vertically on the standards, 16, of the machine. The framing is arranged or shaped to admit of parts of the piece, R, which is being operated on, being got under the tool-slide, 2; the details in connexion with this slide being arranged as far as possible above the framing, whilst the front part of the tool-slide or the tool-box, 1, is made to overhang or project downwards to reach the work.

IMPROVEMENTS IN NEWHAVEN HARBOUR.

In the engravings on page 418, we illustrate the principal portions of the works recently carried out to effect certain improvements in Newhaven harbour, on the coast of Sussex.

This harbour is situated at the embouchure of the river Ouse, and may be said to have taken the place of the ancient haven of Seaford (one of the famous Cinque Ports), now silted up, and protected against the waters of the sea by an artificial dam of shingle and fascines, extending in an easy curve from the mouth of the Ouse to Seaford Cliff, a distance of about four miles. The same dam also, together with an artificial embankment on the left bank of the river, prevents an extensive tract of pasture land from being overflowed by the sea at high tides; that land is actually from 3 ft. to 5 ft. below high-water spring tides, and at an earlier period has been entirely submerged by the sea, as still is evidenced by the cliff-like appearance of the base of the hills there, belonging to the group known as the South Downs.

Thus, while the decayed haven of Seaford, sufficiently important at one time to enjoy the privilege of sending two members to Parliament, testifies either to the wasteful ignorance of former generations in matters of harbour engineering, or to the impotency of man against the occult power of the sea, both to waste away natural shores or to recede from them; the hundreds of acres of land, covered with plentiful herds of cattle grazing, so to speak, below the level of the water, which have been thus reclaimed, testify equally well to the energy and thoughtfulness of later generations; nor is it at all surprising that, with examples like these before them, the Navigation Commissioners of the River Ouse should have taken the step in the right direction which we are about to describe.

From a commercial point of view, Newhaven harbour has become of some importance, in consequence, chiefly, of the passenger traffic which is carried on through it between this country and France by the London, Brighton, and South Coast Railway, that being both the cheapest and, in our opinion, the finest route between London and Paris; and partly, also, owing to the importation through it, *via* Dieppe, of some of the produce of Normandy, so largely consumed in this country.

From a military point of view, it is of considerable importance, because the four miles of artificial beach before mentioned, rising with an easy slope, afford an enemy good opportunities for landing; and by seizing upon the harbour, which admits vessels of from 15 to 20 ft. of draught at high tides, it might be used for purposes of refitting, and be made into a general basis of operations. This fact has not been overlooked by the central Government, who are now erecting a large fort there, which will command the whole of the beach extending between Newhaven and Seaford, and who have also purchased a suitable site to form a naval depot within the harbour.

The river Ouse, which is affected by the tidal waters over a distance of about twenty-five miles, the rise and fall in Newhaven harbour being from 15 to 20 ft., follows a winding course, with many sharp bends, two of which occurred just near its embouchure, between the northern extremity of the town of Newhaven and the sea, as is shown in dotted lines upon the general plan, Fig. 1; and as the fate of the port of Seaford plainly proves that the sea has a tendency to silting up in these quarters, these bends were doubly dangerous to the existence of the harbour, because by checking the velocity of flood tides, and causing eddies and slack currents, as must have been the case, they facilitated and occasioned the deposit, at the very mouth of the harbour, of the earthy matter which the water holds in suspension, and by retarding the velocity of the ebb tide they, on the other hand, prevented that effective scour which is the only means for keeping open and improving tidal harbours of this description.

To this effect the engineers to the commissioners, Messrs. Hood and Jacob, have rectified the course of the river from near its mouth to the northern extremity of the second bend, and have thus obtained a practically straight channel over a distance of some three miles; the old bed of the river, just where it swept past Pennant's Eye, has been completely filled up, excepting only a small portion at the southern extremity of that bend, so that the ebb tide meets with no retarding cause in the harbour proper, which thus receives the full benefit of the scouring effect of the tide; the whole of the second bend, however, a portion of which only is visible on the plan, has been left as it was; but as the direct action of the tide is through the new cut, there is little doubt but that in course of time this arm of the river will silt up.

Sections through the new bed of the river opposite Pennant's Eye, and across the new cut, are shown in Figs. 2 and 3; the materials for the embankments were principally taken from the new cut, and as the whole of these low lands must at one time have formed an estuary of the sea, these materials are chiefly composed of sand and clay. To prevent the bank from slipping at the place north of the new bridge, where it rests in the old bed of the river, a row of piles has been driven there, and, throughout the entire length of the new work executed, the inner slopes of the bed of the river are pitched with chalk rubble down to low-water level, the chalk rubble being gathered from the foot of the cliffs outside the harbour.

The scour, we are informed by the harbour-master, has been considerably improved by these alterations, and the velocity of

the tide opposite Pennant's Eye, and near the new bridge, cannot be less now than seven or eight miles per hour; we therefore anticipate very good results to the harbour from them, and cannot but congratulate the engineers upon the important work thus carried out under their directions.

Over the northern bend of the river, just opposite Newhaven town, and close to the inn where Louis Philippe made a halt in 1848, there is an old drawbridge which before these works were executed, formed the connecting link of the two sides of the river on the Brighton turnpike road; this bridge, which it was almost impossible for any heavily laden cart to cross, was the private property of a company who levied heavy tolls both from foot-passenger and all other traffic. In order to facilitate communication between the two sides of the river, the navigation commissioners, the railway company, and, we believe, the Government agreed jointly to erect a new bridge suitable at once for railway and ordinary traffic over the new bed of the river just opposite the railway station; and as the old bridge leads now upon an island formed by the new cut, and the old channel not filled up, it has become useless, and the commissioners have had to pay a large sum of money (we believe some 10,000*l.*) as compensation for the value of the property. The new bridge, however, remains entirely free, to the great benefit of the trade of the town, by which we have no doubt the railway company will ultimately profit.

This bridge, the site of which is shown on the general plan, Fig. 1, and which is illustrated by Figs. 4, 5, and 6, is composed of a fixed approach on the western side of the river of about 80 ft. in length, in two spans, each of a 35 ft. clear opening; and of a movable portion of about 148 ft. in length, which swings round upon its centre, leaving a clear water-way 50 ft. wide in mid-channel.

The fixed approach is supported on the land side by a brick abutment, which, including a footing of concrete 3 ft. thick, is carried down to a depth of 9 ft. only below the original surface of the ground, and rests upon a foundation of sand mixed with clay; on the water side each span rests upon three cast-iron caissons, 5 ft. in diameter, sunk to a depth of from 29 ft. to 32 ft. below high-water level, which gives the deep-sea caissons a hold of 13 ft. in the bed of the river, the ground consisting, as before, of sand mixed with more or less clay. The swinging portion of the bridge is carried in the centre by nine cast-iron caissons of the same dimensions as the former, sunk to a depth of from 35 ft. to 42 ft. below high-water mark, giving them a hold of from 20 ft. to 23 ft. in the same kind of ground as before mentioned. At its western extremity it is carried by the three caissons which form the eastern support of the approach, and at its eastern extremity by a brick abutment, whose footings are at about the level of the bottom of the old bed of the river, and rest upon a layer of 4 in. elm planking, carried by a treble row of piles, with the spaces filled in by a layer of concrete 3 ft. thick; the piles are of an average length of 16 ft., and are 12 in. squares in cross section.

The superstructure of the bridge consists of a framework of wrought-iron plate girders, which carry a roadway 27 ft. wide made entirely of timber.

The main girders of the approach are of an even depth of 5 ft. throughout, with full web of $\frac{1}{2}$ in. plates 3 ft. 5 in. wide, every alternate joint being covered by T-iron stiffeners 4 in. $\times$ 2 in. $\times$ $\frac{1}{2}$ in., and the other joints by plain strips 6 in. $\times$ $\frac{1}{2}$ in.; the top and bottom flanges are respectively 1 ft. 6 in. and 1 ft. 9 in. wide, and are formed of a single layer of plates $\frac{1}{2}$ in. thick in the centre, tapering to $\frac{1}{4}$ in. at the ends; the angle irons which unite the flanges and the web are 8 in. $\times$ 3 in. $\times$ $\frac{1}{2}$ in. in section, and the rivets are $\frac{3}{4}$ in. in diameter and 4 in. pitch.

For the purpose of calculating the strength of the girders, we shall take the top flange as being the one of least sectional area, and also take into account the top member of the angle-iron; the total area thus obtained amounts to 7.93 square inches, and as the clear span is 35 ft., if we take the factor of safety at $\frac{1}{2}$ the breaking weight, the load equally distributed which one of these girders can safely carry is

$$W = 2 \times \frac{20 \text{ tons} \times 5 \text{ ft.} \times 7.93 \text{ sq. in.}}{35 \text{ ft.}} = 45.3 \text{ tons,}$$

or for two girders 90.6 tons, which gives a load of about 24 tons per foot run, or $1\frac{1}{2}$ cwt. per square foot; and as the weight of this portion of the superstructure itself amounts to about $\frac{1}{2}$ cwt. per square foot, the carrying capability of this portion of the bridge amounts to a little more than a hundredweight per square foot. If, instead of taking the top member of the angle-iron only, the whole were taken into account, the effective sectional area would amount to 9 $\frac{1}{2}$ square inches, and the carrying capability of the bridge would be increased to $1\frac{1}{2}$ cwt. nearly; but we do not think that, in a thin shallow girder like these, it is advisable to reckon upon any strength to be derived from the vertical member of the angle-iron, because the girder would in all likelihood be considerably out of shape before that member was called upon to sustain any considerable strain.

The cross girders, which occur every 6 ft. 10 in., are 2 ft. deep, with $\frac{1}{2}$ in. web, and top and bottom flanges 8 $\frac{1}{2}$ in. wide $\times$ $\frac{1}{2}$ in. thick; the angle-irons are 4 in. $\times$ 3 in. $\times$ $\frac{1}{2}$ in., and the rivets $\frac{3}{4}$ in. in diameter $\times$ 4 in. pitch; the area of the flanges of these girders is 5 $\frac{1}{2}$ square inches. By again taking into account the horizontal member of the angle-iron only, the equally distributed load which they are able to carry is

$$W = 2 \times \frac{20 \text{ tons} \times 2 \text{ ft.} \times 5\frac{1}{2} \text{ sq. in.}}{27 \text{ ft.}} = 16.3 \text{ tons,}$$

corresponding to a load of 1.77 cwt. per square foot; and deducting the weight of the girder and the roadway, there remains $1\frac{1}{2}$ cwt. per square foot, for the carrying capability of the cross girders; the strength of these may, therefore, be said to be in harmony with that of the main girders.

The main girders of the swinging portion are 5 ft. 6 in. deep in the centre, tapering down to 5 ft. at the ends, and are braced up by a couple of suspension rods, which, by means of a cast-iron bracket and a pin passing through the eyes of the rods, are applied to the bottom flange at a distance of about 27 ft. from the ends of the girders, and by means of a strong cast-iron framing, firmly bolted to the upper half of the turntable. They are carried up to a height of nearly 16 ft. above the bottom flange of the girders. This arrangement of trussing is chiefly intended to assist in carrying the weight of the movable structure when it is swung open; when that has taken place, the rods may

be said to have to carry the whole of the weight of the 27 ft. which overhangs the suspension centres, and one-half the weight of the portion which extends between that point and the central support, amounting to about 19 ft.; and as the weight of the structure is about 16 cwt. per foot run, the total vertical load to be carried by each rod is about 18 $\frac{1}{2}$ tons, and the resultant strain upon them in consequence of their inclination is about 53 $\frac{1}{2}$ tons, or 4.4 tons per square inch.

The webs of the main girders are made of $\frac{1}{2}$ in. plates throughout, except at the ends and over the suspension centres, where they are $\frac{3}{4}$ in. thick; they are 3 ft. 4 in. wide, and, like those of the approach, they are stiffened at every alternate joint with T-irons bent round to take hold of the flanges, while at the ends and over the central support there are a number of plate stiffeners of the entire width of the flanges; these latter are 2 ft. wide and $\frac{1}{2}$ in. thick, tapering down to $\frac{3}{4}$ in. at the ends, made of a single layer of plates; the angle-irons are 3 in. $\times$ 3 in. $\times$ $\frac{1}{2}$ in. in section, and the whole of the rivets are $\frac{3}{4}$ in. diameter $\times$ 4 in. pitch.

The clear span of these girders when the bridge is closed and locked is about 63 ft.; and taking into account the horizontal member of the angle irons, the sectional area of the flanges is about 11 $\frac{1}{2}$ square inches; the depth of the girders in the centre of the open space is about 5 ft. 4 in., and the load, equally distributed, which the girders may carry with safety, is

$$W = 2 \times \frac{20 \text{ tons} \times 5.33 \text{ ft.} \times 11.75 \text{ sq. in.}}{63} = 39.76 \text{ tons,}$$

or for two girders 79 $\frac{1}{2}$ tons, which corresponds to about $1\frac{1}{2}$ tons per foot run, or very nearly 1 cwt. per square foot. This calculation, however, does not take into account the suspension-rods, which are quite able to carry 21 tons of a vertical load each. Adding, therefore, twice this amount to the above, we obtain a total load of, say, 122 tons, or about $1\frac{1}{2}$ cwt. per square foot; and as the weight of the structure is fully $\frac{1}{2}$ cwt. per square foot, it appears that, in order to obtain the same carrying capability as in the approach girders, the suspension-rods should be so adjusted as to carry the entire weight of the structure not directly supported by the central pier.

This is a very difficult point in practice, as the following fact will prove: The girders, it will be seen, are very thin, and in fine hot weather, the sun, bearing with his full force upon them, raises the temperature of the iron to such a degree that it may scarcely be touched with the bare hand; the rods, on the contrary, are made of round iron from 4 to 4 $\frac{1}{2}$ in. diameter, whose mean temperature is not raised by perhaps one-fourth the same amount, and consequently the expansion of the girders is considerably greater than that of the suspension rods; now the girders, in pushing upon the rods during the act of expansion, cause these to spring in their body or to swing round their upper centre of suspension, and by thus lengthening their horizontal projection raise the lower centre of suspension from its original level to such an extent as to cause the ends of the girders to rise and fall as much as an inch, between the hottest part of the day and the cool of the night; any very accurate adjustment therefore is quite impossible, and waiving all considerations of architectural appearance, with which, however, the engineer has a perfect right to compound, it is a question with us whether it would not have been preferable to make the girders strong enough of themselves, and dispense altogether with the trussing arrangement. In this view we have no doubt but that we are strongly supported by the contractor, who would have been benefited through it by a good round sum.

The cross girders are similar in every respect to those of the approaches.

The turntable, whose mean diameter is 32 ft., consists of a cast-iron lower tramway fixed to the caissons, and of an upper tramway to which the main girders and the A frames are very firmly bolted; between these, whose faces are turned, there is a wrought-iron live ring fitted with 80 cast-iron rollers 22 in. in diameter, turned to a true cone whose apex is upon the central axis of the turntable; these are bushed with brass, and revolve freely upon radial spindles keyed to a cast-iron centre, and both the upper roller path and the live-ring pivot upon a strong wrought-iron spindle keyed to the centre of the bottom roller path.

No portion of the weight is borne by this spindle, yet the whole mass, consisting of some 230 tons, may be easily set in motion round this axis by one man working at the end of a 7 ft. lever through a pinion and wheel, so as to obtain a purchase of 1 in 36 at the circumference of the ultimate driving pinion, which works into a rack 36 ft. in diameter.

The whole of the turntable and turning gear are hidden by a neat cast-iron coping.

The roadway consists of one layer of 4 in. planks laid longitudinally, and of one layer of 3 in. planks laid transversely, both creosoted; a hard-wood water-way is laid alongside each of the main girders, and longitudinal sleepers are provided for the purpose of laying a pair of rails across when needed.

At each end of the main girders a locking apparatus is provided, consisting of a movable cast-iron wedge, which, by means of a rack and pinion set in motion through a worm and worm-wheel worked from the top of the bridge, is pushed in between two cast-iron shoes, or drawn away from them, one shoe being fixed to the underside of the bottom flange of the girder, and the other to the pier.

The general design of the bridge was supplied by Messrs. Hood and Jacob, and the work was executed and erected by the Regent's Canal Ironworks Company, under the management of Mr. H. Grissell, under whose superintendence also the details of the turntable, turning gear, and other mechanical portions were worked out.

SHEFFIELD.—The iron trade of Sheffield is spoken of as dull and languid. There is, however, a fair demand for steel for manufacturing purposes, and also for steel rails. The demand for other railway material is far from brisk.

PRESTON.—It was recently announced that the Preston town council had matured a scheme for dock improvements. An active opposition to the project is now being organised, the principal ground of objection being the large outlay which is likely to be involved.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig Iron Market.—There is not much to report regarding the state of the local iron market for the last week. Prices have remained much about the same, and there has been comparatively little excitement among buyers or sellers. From 55s. 3d. to 55s. 6d. cash is almost exactly the report from day to day. The following are the total shipments of pig iron from all Scotch ports for the week ending 26th October, 1867:

This year	...	...	10,548 tons
Last year	...	...	18,628 "

Decrease	...	...	8,080 "
Total since 25th December, 1866	...	...	527,077 "
For corresponding period in 1865-66	...	...	494,130 "

Increase ... 32,947 "

Gas Matters.—The following is the last report issued by the local inspector under the Gas Act:

Glasgow Gas Company (average), 28.8 standard candles—the minimum being 27.6 and the maximum 29.7 standard candles. 28.3 @ 4s. 7d. to 1s. 4d. per 10 candles.

City and Suburban Gas Company (average), 26.6 standard candles—the minimum being 25.6 and the maximum 27.4 standard candles. 26.6 @ 4s. 7d. to 1s. 8d. per 10 candles.

Comparative Statement of the Illuminating Power and the Price of Gas in various Towns.

Places.	Average illuminating power in Standard Candles.	Price per 1000 cubic feet.	Cost in pence for 10 Candles.
Aberdeen	32.0	5 10	21.9
Airdrie	30.0	4 2	16.7
Ayr	25.0	5 10	28.0
Dumbarton	23.0	5 0	26.1
Dundee	24.0	5 2	25.8
Edinburgh	30.5	4 10	19.0
Glasgow	30.0	4 7	18.3
Greenock	29.5	4 2	17.0
Hamilton	27.5	5 10	25.5
Helensburgh	28.0	6 3	26.8
Johnstone	23.5	5 0	25.5
Kilmarnock	27.0	5 0	22.2
Lanark	18.0	5 0	31.8
Paisley	28.5	4 2	17.5
Perth	29.9	6 8	26.8
Port-Glasgow	28.5	5 0	21.1
Renfrew	28.0	5 0	21.4

There is a rent charged for the use of the gas meters in all the places excepting Glasgow and Greenock—the gratuitous use of which the Glasgow companies consider equivalent to a concession of 6d. per 1000 cubic feet.

At present the transference of the Gasworks to the Town Council, or (failing an arrangement favourable to the town) the formation of a company under the Corporation, is exciting a good deal of attention in the town, especially in connexion with the municipal elections. The profits made by the Corporation of Manchester in the sale of gas in that city last year is a stock argument, and one of considerable effect. Dundee is further advanced in a similar movement than we are.

State of the Iron and Coal Trades in the Coatbridge District.—During the last two weeks increased steadiness has prevailed in almost every branch of industry in this district, as orders appear to be coming in less reluctantly than they did a few months ago; but slackness is still the characteristic of trade, and there are yet instances of partial employment, while the prices of certain descriptions of material are lower than they have been for a lengthened period. Yet buyers, upon the whole, seem afraid to operate to any extent. The malleable iron trade is making some progress towards a restoration to ordinary healthy action, though exceptional causes are operating to retard complete recovery. Stocks, both with customers and manufacturers, are decreasing; but there is still underselling, and consequently no advance on prices. The pig masters, without an exception, report a revival in their department at somewhat advancing prices; but it is especially desirable that the stocks in the yards shall be kept down, now that the position of the markets gives a comforting assurance of improvement, not founded on speculative contingences. More than one-third of the furnaces remain out. The number of furnaces in Lanarkshire at present in blast is sixty-five. On the 21st current, a new furnace was put in blast, at Quarter, by the firm of Messrs. Colin Dunlop and Co., of Clyde Ironworks. In the oil trade there is still an utter stagnation. The accounts from the coal-mining districts are to the effect that a few more orders have lately been received; but in no instance is a winter season's average amount of work being done. Stocking everywhere takes place. At Rosehall, Newlands, Milnwood, and Braehead the collieries are indifferently off for orders. The reports from Larkhall and Motherwell are unsatisfactory; and at the various pits about the district of Wishaw the dullness of trade is shown by the unusual amount of partially-employed labour. According to the masters' agreement, the colliers in the Hamilton, Larkhall, Motherwell, and Wishaw districts receive an advance of 6d. per day for the three months commencing the 1st November, which will then make their wages 5s. The colliers employed in the Glasgow Sale Collieries have asked their employers for an advance of wages equal to the men in the above districts. The Excelsior Ironworks at Wishaw are about to be doubled in size, while the extensive wagon works belonging to Messrs. Pickering and Co. have just been finished.

City of Glasgow Union Railway.—The statutory half-yearly meeting of the Union Railway Company was held this week; the principal business was the reception of the report from the engineers, Messrs. John Fowler and J. F. Blair. The report mentions that the principal portion of Messrs. Brassey, Kelk, and Waring's contract is well-nigh finished. This includes a length of about 3200 yards, extending from the junction with the Glasgow and Paisley Joint Railway to Port Eglinton, and thence through the

south side of the city to the river, and onwards to Gallowgate-street, about 100 yards east of the Cross. In the course of this section there are various stone bridges, iron viaducts over streets, and, heaviest of all, there is the bridge over the river Clyde. This bridge has seven spans, five of which are over the river Clyde, each with 76 ft. openings between the piers, the others being land spans, each 65 ft. 6 in. wide, over Adelphi-street, on the south side, and East Clyde-street on the north side of the river. The total length of the bridge is 200 yards. The most important work in this bridge has been the construction of the river towers, with their cast-iron cylinder foundations, which are carried down through sand to the solid ground. The whole of the pier towers and both abutments are completed, and the iron superstructures extending over all the spans is now erected, leaving only to be done certain small works in the pilasters and river towers, and the permanent way laying. The contract and specification fix the 1st of January next for the completion of this section of the railway; but this cannot be accomplished, owing to the delays which the contractors have had to encounter, owing to no fault of theirs. The Central Terminus in St. Enoch-square, intended as a point of convergence for all the railways which reach Glasgow, seems to be indefinitely postponed.

Greenock.—Purchase of Garvel Park Grounds for a Graving-dock.—At the last meeting of the Greenock Harbour and Water Trustees, held a few days ago, it was finally resolved to purchase Garvel Park as a site on which to construct a large graving-dock. In a meeting of twenty-three trustees, the proposal was carried by a majority of only one vote. The cost of the ground alone is no less than 80,000*l.* As affording an indication of the great value of ground in Greenock, it may be mentioned that the present proprietors of Garvel Park purchased almost the whole of the ground included in it for 3000*l.* in the year 1832.

Sale of Forth Ironworks.—In the course of last week, the steam-engines, machinery, patterns, rails, wagons, trucks, and other material and plant, connected with the Forth Ironworks and Collieries, at Oakley, near Dunfermline, were brought to the hammer by Mr. Duncan Keith, auctioneer of this city. For some time there was a considerable amount of litigation in connexion with these works, and it was thought better to dispose of them in the way mentioned above. By the stoppage of the works, and the sale of the plant, Oakley has now a deserted and forlorn appearance, while the people of the village have been driven to seek employment in other parts of the country. At the sale which has just taken place, the steam-engines were purchased by Messrs. James Dunlop and Company, of Clyde Ironworks. The establishment at Oakley, now broken up, was, I think, upwards of half a century old.

Dundee and the Whale-Fishing Trade.—The present is said to be the most unlucky year for the Dundee whale-fishers that has occurred within the memory of man, and it will be the more severely felt in consequence of the great amount of capital now invested in the screw steamers employed in the whale-fishing. One of these steamers fully equipped is worth about three of the old class of sailing vessels, and it is computed that the average loss on each steam-whaler will be 5000*l.*, reckoning wages and provisions at 3000*l.*; insurance, 1000*l.*; and wear and tear, 1000*l.* This on ten ships amounts to 50,000*l.* of actual loss; but the difference between an almost total failure and a good ordinary fishing can scarcely be reckoned at less than 100,000*l.* Three whalers, the Polynia, the Alexander, and the Arctic, arrived in Dundee docks on Saturday last without any fish. Fears were entertained that another vessel, the Tay, having a crew of fifty-seven men, had been frozen in the ice. She was seen by one of the vessels just arrived lying in a bight of ice, near Coutt's Inlet, about the middle of August. Since the arrival of the three steamers just named, the Tay has turned up at Dundee all safe, but "clean." The Ravenscraig, another of the steam fleet of whalers, has also come home this week in the same condition.

American Patent Tube-Well.—Under this name a very novel mechanical contrivance was put to a practical test last Saturday morning at Messrs. Muir, Brown, and Co.'s extensive cotton-printing works, Dalmarnock, at the east end of this city. It is an arrangement whereby a sort of miniature artesian well can be made in a very short while, sometimes in a few minutes even. An iron tube, about 1½ in. in diameter, pointed and perforated with holes at the end, is first put into the ground. In this instance it was within the washing or dye house at the Dalmarnock print works, the force employed being a sort of battering ram on a small scale. The shaft first used was about 10 ft. long, and this is generally found to be a sufficient length in favourable ground. That length can generally be pierced in about half an hour. At a depth of 17 ft., the pipe, now increased by addition of another length, struck a bed of clay. Other pipes were screwed on; and at a depth of 24 ft. a stratum of sand was reached where water was found. It was too muddy for use, however, and fresh lengths were added until a depth of 30 ft. was reached, where the water was plentiful. The experiment was quite successful. Something like 2,000,000 gallons of water are used in Messrs. Muir, Brown, and Co.'s works daily; but it is not expected that one of these tube-wells will supply that amount of water. It is proposed to use the water so obtained in some of the special and more delicate washing operations, while the bulk of the work will, as heretofore, be done by water drawn from the Clyde, near which the works are located. The tube-well has been extensively used in America, especially during the late war, when the soldiers carried the tubes about with them, and fixed them in the ground in every encampment where water was not already at hand. This invention has been recognised by the British Government, and a great number of the tubes and the other required appliances have been ordered of the Manchester agent for use in the Abyssinian expedition. Mr. J. L. Norton, Blackfriars-street, Manchester, is the sole agent for the wells in this country.

Shipbuilding News.—The dull prospects which existed in the shipbuilding trade some weeks ago are vanishing, so far as Greenock and Port Glasgow are concerned, where there are signs of considerable improvement. Besides the contracts entered into during the last few weeks, by Messrs. Steele and Company, for four new iron ships, by Messrs. Robertson and

Company, for a new paddle and tug steamer, and by Messrs. Duncan and Company, for a new iron ship, three other new contracts have been fixed by two shipbuilding firms. They are for a composite ship, an iron ship, and a paddle-wheel steamer. Messrs. Kirkpatrick, McIntyre, and Company, of Port Glasgow, have laid down in their new yard an iron sailing ship of 1200 tons. Altogether, there are now fourteen vessels building, or to be built, in the shipbuilding yards in the Greenock district, which will keep the workmen in this branch of business pretty well employed during the next two or three months, thus tiding over the dead of winter.

A few days ago two keels were received from Dumbarton by Messrs. Laurence Hill and Company, Port Glasgow, for vessels to be built by that firm.

This afternoon I learn that Messrs. Randolph, Elder, and Company, of this city, have concluded a contract for another steamship, but I have not yet learned the details regarding the vessel.

Messrs. Robert Steele and Co., the world-famed builders of the China clippers and of pleasure yachts, have just contracted to build, for the Marquis of Drogheda, a splendid composite schooner yacht, of about 160 tons, similar in dimensions to the well-known cutter-yacht Oimara, built by the same firm for Mr. Tennant, of Glasgow. The new yacht will be ready for the next yachting season.

Captain M'Lean, the owner of the favourite old steamer Vulcan, has concluded a contract with Messrs. Barclay, Curle, and Co., Glasgow, for a new river paddle steamer. She is to be fully larger than the Vivid, which was built about two years ago by this firm for Captain Campbell, and is to have all the latest improvements as to comfort and speed. It is expected she will be ready for the Glasgow and Rothesay station by the opening of the season. Next season several fine new steamers will be added to the fleet of steamers trading on the Clyde.

Messrs. Archibald M'Millan and Sons, shipbuilders, Dumbarton, have just launched a handsome composite ship of 780 tons o.m., and 700 tons register, built for John Kerr, Esq., Greenock, and to class A 1 at Lloyd's for fourteen years. She is named the Barbadian. Her principal dimensions are, length, 170 ft.; breadth, 31½ ft.; and depth, 18½ ft. She is the thirty-first vessel built by the Messrs. M'Millan for the same owner, for whom they have at present in hands another vessel of a similar description, as also a large iron sailing ship for a Liverpool firm. The Barbadian having been coppered, and had her rigging nearly completed on the stocks, she was immediately after her launch towed down to Greenock.

Messrs. Dobie and Company, Govan, launched from their building-yard yesterday an iron sailing barque, the Immacina, 680 tons o.m. This is the second vessel built for Messrs. Donaldson Brothers, Glasgow, by the same firm, and a third vessel, similar in every respect to the one launched yesterday, was on that occasion contracted for.

For some years past the iron ship Shandon, built by Messrs. Barclay, Curle, and Co., Glasgow, in 1855, has carried off the palm in the Montreal trade, and, in fact, was the only ship that made the three runs regularly either from the Clyde or Mersey. Last year, Messrs. Barclay built the Gleniffer, an iron ship of similar size to the Shandon, which, during the last two years, has outstripped her old rival. In the early part of this year, Messrs. Steele and Co., Greenock, built for the same owners as the Gleniffer, an iron ship named the Pomona, of 1200 tons, and she has even outstripped both these ships, having made the three trips this season from Montreal and back, and is the first ship home at any port. From St. Paul's she has made the quickest run this season. She left Quebec on the 1st instant, discharged the pilot on the 8rd, and did not reach St. Paul's till the 17th, owing to easterly winds. The run from St. Paul's to the Mersey was made in twelve days.

SHODDY.—Under the name of shoddy an enormous weight of material is now used which once was waste. Shoddy was first brought into use about 1813 at Batley, near Dewsbury. Mungo was adopted in the same district, but at a later period. Shoddy is the produce of soft woollen rags, such as old worn-out carpets, flannels, guernseys, stockings, and similar fabrics. Mungo is the produce of worn-out broad or similar cloths of fine quality, and of the shreds and clippings of cloth. The Pollution of Rivers Commission, which has been visiting Yorkshire, was informed of the origin of the word "mungo." A manufacturer gave some of the materials to his foreman, who, after trial in the shoddy machines, came back with the remark, "It winna go;" when the master exclaimed, "But it mun go." These old woollen rags are collected and imported from India, China, Egypt, Turkey, Russia, and, in fact, all parts of the world where woollen garments are worn. They come to Yorkshire from districts where plague, fever, smallpox, and loathsome skin diseases extensively prevail; they are sorted by human fingers when the bales are opened before being placed in machines which tear up, separate, and cleanse the fibre for manufacture; but the Rivers Commission mention that 50 years' experience has proved that these rags are not in any degree dangerous to the health of those who work among them, although in many of the countries where they are collected they are believed to be peculiarly plague-bearing materials. The lapse of time in collecting, sorting, and transmitting the rags, and the possible destruction of any special poison by friction or otherwise, must be taken into account. The dirt, dust, and fine particles blown out by the machines are collected and sold for manure at from 10s. to 20s. per ton. The shoddy trade is a remarkable instance of the utilisation of waste material. It forms nearly one-fifth in weight of the woollen and worsted manufacture of the West Riding. Mixed with wool, shoddy or mungo is largely used in the manufacture of cheap broadcloths, finer cloths for ladies' capes and mantles, pilots, wintneys, frizzes, petershamas, pea-jackets, and blankets. A considerable quantity is used in the form of flocks for beds. Felted cloth is extensively manufactured with it, and used for table-covers, carpets, druggots, and horse-cloths. From 70 to 80 million pounds weight of shoddy and extracts are used in a year in the woollen trade of this kingdom. The trade could not be carried on to its present extent without shoddy.

"RAILWAY RESISTANCES."

It not unfrequently happens that our contemporary, *The Engineer*, favours its readers—whoever they may be—with articles the composition of which must have required a vast amount of originality and ingenuity, the originality principally displaying itself in the description of things which do not exist, and the ingenuity in the perversion of facts in a manner hopelessly bewildering to the uninitiated. Amongst the more recent productions of this kind is the "leader," bearing the title at the head of this article, which occupied the place of honour in the last number of the above-mentioned journal. The "leader" in question appears to have originated in this way: On the 13th of September last there was read before the Société des Ingénieurs Civils, of France, a paper containing a summary of the results obtained from a series of experiments carried out on the Eastern of France Railway, to determine the tractive resistances of railway rolling stock under various conditions. This paper was, in fact, a kind of abstract of a *mémoire* on railway resistances prepared by MM. Vuillemin, Guebard, and Dieudonné, in answer to a premium for the best paper on that subject offered by the late M. Perdonnet; and as it contained facts of much interest to many of our readers, we have, in recent numbers, published a translation of it. The first portion of this translation was published in our number for the 11th of October last (page 340), and the conclusion appears this week. Having, by the publication of two portions of this translation, been made aware of the value of MM. Vuillemin, Guebard, and Dieudonné's paper, "*The Engineer*" considered that it too should take some notice of it. But here a difficulty arose. It evidently would not do to copy the translation *verbatim et literatim* from our columns, and yet a full translation of the paper, recording all the results, was almost the only thing that could be of use to their readers. In this emergency it appears to have been resolved to "hash up" the paper in question into a leader, and endeavour, by the aid of large type and a prominent place, to give it the appearance of containing as many original ideas as possible. And "hashed up" it has been in every sense of the term; and as to original ideas, or rather statements, it contains them in abundance.

The first portion of the "leader" consists of a description of the methods of experimenting followed by MM. Vuillemin, Guebard, and Dieudonné, and, as far as it goes, it is tolerably accurate. But it does not go very far. By the time that this first portion had been written, the writer evidently felt that he was doing himself an injustice. An accurate statement of the facts contained in any paper, however valuable, was not in his line, and his soul yearned for more lofty flights into the regions of fancy. At last his feelings overcame him, and he commenced a fresh paragraph thus:—"Having thus explained briefly the system of experimenting adopted, we may now proceed to express the results obtained. A single van, weighing 5 tons 1 quarter 34 lb., carried by four wheels, and lubricated with oil, gave a resistance per ton of 7.16 lb. on a perfectly straight and level road; the initial velocity being 16.4 ft. per second; with a velocity of 45.6 ft. per second, the resistance rose to 16.1 lb. nearly per ton. In other words the resistance was nearly doubled by doubling the velocity." These sentences contain some curious assertions. First of all, it is stated that the van upon which the experiments were tried weighed "5 tons 1 quarter 34 lb.," a way of giving the weight which at once leads the reader to wonder whatever the poor unfortunate "1 quarter" can have done to cause it to be isolated in this manner, and makes him wish to know why it could not have 28 lb. of the 34 lb. given to it, so that it might have been transformed into 2 quarters, leaving 6 lb. to be expressed in the ordinary way. But this is not all. The weight given, "5 tons 1 qr. 34 lb.," equals 11,262 lb., whereas the weight of the van stated in the original paper is 5500 kilogrammes, equal, if we take a kilogramme at 2.2 lb., to 12,100 lb. *The Engineer*, in a footnote to its article, states that a kilogramme is equal to 2.205 lb., and, adopting this value, 5500 kilogrammes would equal 12,127½ lb., or 865½ lb. more than stated by *The Engineer*. The writer then goes on to state that with an initial velocity of 16.4 ft. per second the resistance was 7.16 lb. per ton, whilst with an initial velocity of 45.6 ft. per second it was 16.1 lb. per ton; and regarding these facts he states, "In other words, the resistance was nearly doubled by doubling the velocity." We were not aware before that a velocity 45.6 ft. per second was but double one of 16.4 ft. per second, nor did we know that a resistance of 16.1 lb. per ton was nearly double one of 7.16 lb. per ton. MM. Vuillemin, Guebard, and Dieudonné's

certainly stated in their paper that the resistances were nearly doubled by doubling the velocities; but they did not refer to the examples above quoted. Their experiments on the single van included one in which the initial velocity was 21.71 ft. per second, and one in which it was 45.59 ft. per second; and as at these speeds the resistances were 9.1168 lb. and 16.0832 lb. per ton respectively, they bore out the authors' theory.

Returning to the "leader" in *The Engineer*, we find the writer stating that, "The weight of the engine and tender together were, of course, employed in determining the resistance per ton." Were it? Oh, Lindley Murray! Then speaking of the resistances of an engine with four coupled wheels, he says: "At about 24 miles per hour the resistance reached 9.74 lb., and at 37 miles per hour 12.76 lb. per ton; the engine weighed 30 tons, and had drivers 6 ft. 1 in. high, and 16½ in. cylinders. Thirty ton goods engines, with six coupled wheels 4 ft. 3 in. diameter, and 16.5 in. cylinders, gave a resistance of 12 lb. per ton at speeds of twelve to fifteen miles per hour, while at 23 miles per hour the resistance rose to nearly 18 lb. per ton." Now, it so happens that all the speeds above quoted were the initial velocities given to the engine, whilst the resistances were the mean resistances experienced during the time that the speed of the engine was decreasing from its initial velocity to *nil*. The resistances quoted are thus those due to velocities certainly much below the initial velocities to which they are annexed by *The Engineer*, although it would be impossible to say, from the data given, to what particular velocity they properly belong.

When the writer begins to treat of the resistance of trains in general, he blunders more than ever; he says: "The piece of line on which the experiments were tried was not exactly level, but it was found that, as the resistance due to the gradient was just 2.2 lb. per ton for each 1 in 1000, that the line ascended." Now it is well known that the resistance on an incline due to the action of gravity bears the same proportion to the weight of a train that the rise of the incline does to its length, an incline of 1 in 1000 causing a resistance of 1/1000th the weight, and so on. The resistance on an incline of 1 in 1000 would thus be 2.24 lb. per ton, instead of "just 2.2 lb. per ton," as *The Engineer* states; and, in fact, MM. Vuillemin, Guebard, and Dieudonné give in their paper the extra resistance as being 1 kilogramme per tonne (= 2.24 lb. per ton) on an incline of 1 in 1000.

After stating correctly that the total number of trains experimented upon was 139, the writer in *The Engineer* goes on to say that: "The gross loads varied between 152 and 574 tons, and the number of vehicles between twelve and fifty-six. The minimum radius of the curves was 400 metres. The velocities varied between six miles and twenty-four miles per hour." Here are more errors. The total number of trains was made up partly of goods trains, partly of mixed trains, and partly of passenger trains. In the case of the goods trains, the gross loads varied from 152 to 571 (not 574) tonnes, equal to from 149.2 to 560.8 tons English; whilst in the case of the passenger trains the variation was between 30 and 116 tonnes, equal to 29.46 and 113.8 tons English. The total variation of the loads of the 139 trains was thus between 29.46 and 560.8 tons, instead of between 152 and 574 tons, as stated by *The Engineer*. The number of vehicles in the trains also, and the minimum radius of curves above quoted, really refer to the goods trains only, whereas they are applied by *The Engineer* to the trains generally.

The task of correcting *The Engineer's* errors is becoming a tedious one. In the nineteen lines following those last quoted, we have the following series of blunders. A speed of from 10.54 to 16.12 miles per hour is given as "from ten to fifteen miles per hour;" a resistance of 8.84 lb. per ton is said to be "8.7 lb. per ton;" the average resistance of goods trains at average speeds is given as 7.8 lb. instead of 7.95 lb. per ton; the resistance of short passenger trains is given as "15.8 lb. per ton at twenty-nine miles per hour," instead of 16.15 lb. at 28.12 miles per hour; the resistance of 21.44 lb. per ton at 35.96 miles per hour, given in the original paper, is stated to be 21 lb. at 35 miles per hour; and that of 32.57 lb. per ton at 47.12 miles per hour is given as 32 lb. at 48 miles per hour. In the case of the long passenger trains, the resistance at a speed of 30 miles per hour is stated to be "a little over 13 lb. per ton," whereas it was 13.37 lb. per ton at a speed of 27.9 miles per hour. Further, other resistances are given as "at thirty-three miles 14.36 lb., and at thirty-seven miles per hour 17.7 lb. per ton," whereas the resistances given in the original paper were 14.63 lb. at 32.64 miles per hour, and 18.03 lb. at 37.2 miles per

hour. A pretty good series of errors, this, to be contained in nineteen lines of a "leader."

MM. Vuillemin, Guebard, and Dieudonné give in their paper several formulæ for calculating the resistances of trains, and some of these are quoted by *The Engineer* in its "leader," and in order, we suppose, that the writer may have some scope for his originality, the speeds to which they are applicable are entirely misstated. Thus one is said to apply to "mixed trains travelling at speeds of twenty-two to thirty-seven miles per hour," instead of from 19.87 to 31 miles per hour; a second to "ordinary passenger trains, at speeds of thirty-seven to forty-three miles," instead of 31 to 40.36 miles per hour; and a third to "express trains of eight or ten carriages only, at speeds of forty to forty-five miles per hour," instead of 43.47 to 49.68 miles per hour.

Numerous as are the errors which we have pointed out, they are far from being all which the "leader" in *The Engineer* contains. Of the value of such an article—an article which would be perfect disgrace to any journal which had any claim to a professional position—we leave our readers to judge, and we shall conclude with one more extract from it, which, coming as it does from near the end of this "leader," could only have been written in most deeply sarcastic frame of mind. This quotation is, "We believe, however, we have selected all that is likely to prove most interesting or useful to our readers."

NOTES FROM INDIA.

DURING the present closure, it has again been found that the Ganges canal bed is in a satisfactory state. The tax-payers will be glad to learn that Government has been saved half a million sterling, which was the sanctioned outlay on the "remodelling" of the Ganges Canal, and which is now found to be unnecessary.

An interesting report has recently appeared in Ceylon from a sub-committee of the Agricultural Society, containing valuable suggestions to aid the Executive and Legislature in their deliberations on the best scheme for the encouragement and extension of irrigation works.

It is rumoured that it is the intention of the Viceroy to carry out a scheme which he formed some time ago, viz., to send a commission to inquire into all questions affecting the cultivation of tea in Assam and Cachar. It is said that the commission is to consist of a civilian as president, and two non-officials as members.

The site selected for the new opera-house in Calcutta is a garden west of Madge's-lane, reaching from Lindsay-street to Sudder-street. The shape is to be a semi-amphitheatre, accommodating 520 persons, distributed through twenty boxes, stalls, a dress-circle, and pit. The building is to be of brick and timber, roofed with zinc, and great attention is to be paid to its ventilation. The interior arrangements are on the model of the English Opera House.

The *Gazette of India* publishes the following statement of the silver received and coined in the mints of Calcutta, Madras, and Bombay during the month of July, 1867: in the Calcutta mint, the bullion or coin received during the month, valued in rupees, amounted to 2,210,422 rupees; in the Madras mint, to 34,403 rupees; and in the Bombay mint, to 2,596,139 rupees. The amount of silver coined and examined during the month, valued in rupees, was: in the Calcutta mint, 2,460,050 rupees; in the Madras mint, 56,360 rupees; and in the Bombay mint, 4,998,622 rupees.

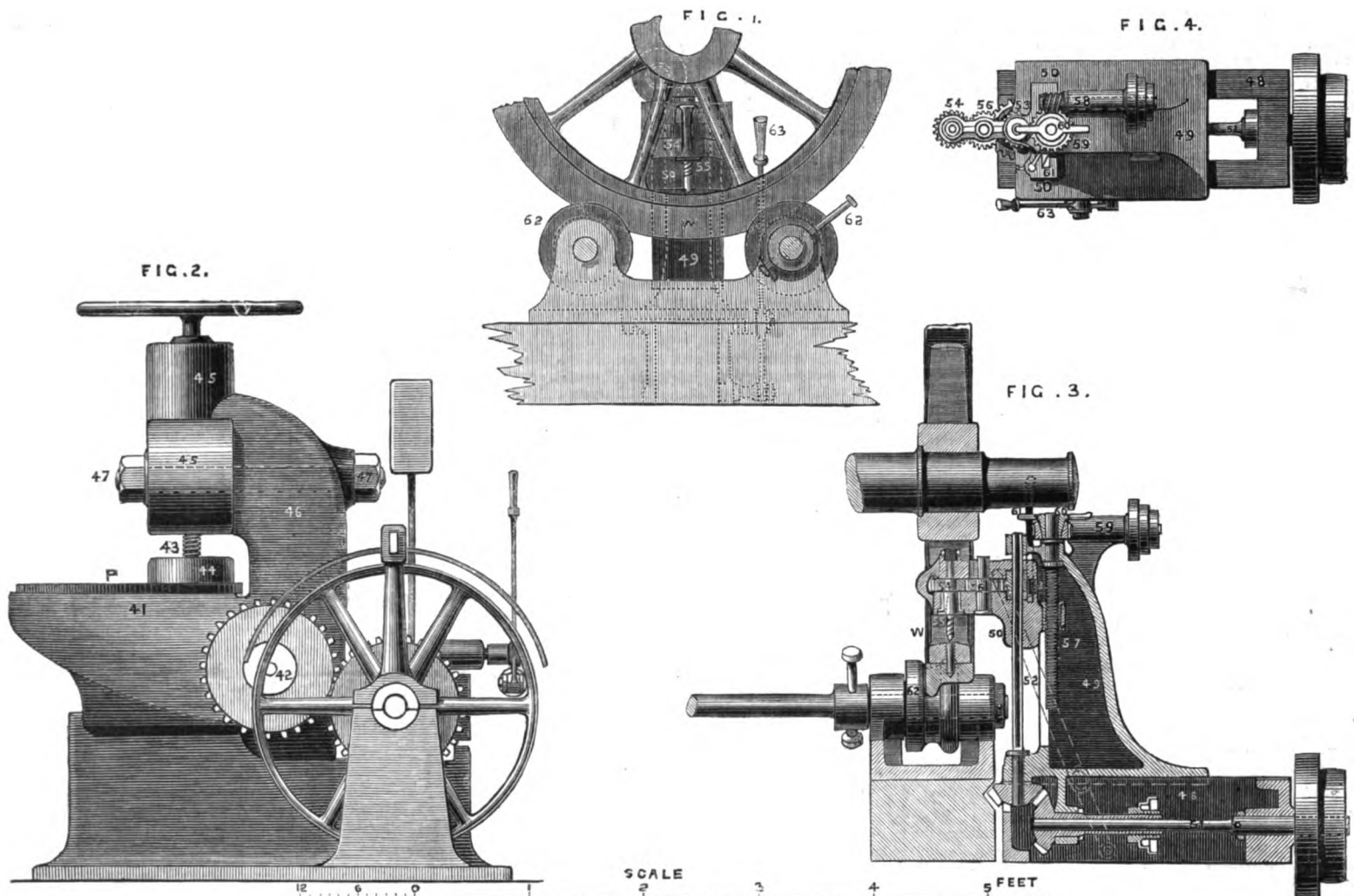
The Madras papers state that the late famine, so far as that presidency is concerned, is quite at an end. Relief committees are now engaged in deliberating what they are to do with their surplus funds, and in reckoning up the amount of temporary and permanent good they have effected. It appears from a return just published, that in Ballary, during the distress, 261 miles of new roads were constructed, and 216 miles improved; several reservoirs were cleared and enlarged, and 41 towns and villages improved, besides other improvements in the matter of wells, irrigation works, chattrams, and other permanently useful works. At one period more than twenty-one thousand men, women, and children were thus afforded the means of subsistence, and all at the cost of less than four and a half lakhs of rupees.

Colonel Crommelin's report on the progress in new military works in India during the past two years shows that the sum of 8,650,836L. has been spent or sanctioned from 1864-65 to the end of the current year. Plans of all the most important buildings, such as barracks, hospitals, &c., have been decided upon after much discussion and consideration, but many more relating to minor buildings have yet to be designed. The actual construction of barracks, hospitals, and some other buildings upon the new designs, has been commenced at almost every military station in the Bengal Presidency, and these buildings are now being vigorously pushed forward; but it will take two or three years before they can be completed in any considerable number. Many projects have still to be submitted by local governments.

In 1854, when the East Indian Railway was first opened to the public, the profits amounted to 35,275 rupees, or about 5 per cent, on the capital expended. In 1866 the profits rose to the enormous sum of 12,260,564 rupees, or 5.7 per cent, on the capital expended, and 5 per cent, on the capital on which the Government guarantee is paid, showing how prosperous this great undertaking is becoming. The number of miles first opened to traffic was only thirty-eight, the profits were therefore 928 rupees per open mile. The number of miles now open is 1129, and the profits have reached 10,857 rupees per mile. Throughout this period the working expenses have almost always been 50 per cent. of the gross earnings; but for the last few years there has been a slight improvement in this respect; and in 1866 the working expenses were reduced to 44.2 per cent. of the gross earnings, showing that the management is now conducted on more economical principles.

PLATE-PLANING AND TYRE-DRILLING MACHINES.

DESIGNED BY MR. STEPHEN ALLEY, ENGINEER, GLASGOW.



We give, above, engravings of two machine tools, recently designed and patented by Mr. Stephen Alley, of the firm Messrs. Neilson Brothers, of Glasgow; one of these machines being intended for planing the edges of plates, such as locomotive frame-plates, and the other for drilling holes in wheel tyres. The first-mentioned tool, shown by Fig. 2, is made like existing machines for the same purpose, with a long table or bed, 41, upon which the plate, P, is fixed, so as to have the edge, that is to the right-hand in the drawing, planed by a tool, not shown, but made to travel along by a screw-shaft, the end, 42, of which is shown. The plate, P, is held down by screws, 43, acting upon blocks, 44, placed upon it; and these screws, 43, are tapped through a massive beam, 45, extending from end to end of the machine, and formed with or attached to massive brackets, 46, which brackets are themselves attached to or formed in the same casting as the bed-frame, 41. In the figure, the beam, 45, is shown as fixed to the end brackets by strong bolts, 47. My improvement in this machine consists in making these brackets, 46, so as to overhang, as shown, from either the front or back of the bed-frame, 41, and so as thus not to interfere with the movement or adjustment of the plate, P, longitudinally, as they do in ordinary machines.

The other machine tool is shown in elevation in Fig. 1, in plan in Fig. 3, and in vertical section in Fig. 4; the section, Fig. 4, being at right angles to Fig. 2. This machine is for boring holes into steel or iron railway wheel tyres, W, from the insides of the wheel rims when the tyres are in place; such holes passing partly through the tyre, and being afterwards tapped to receive holding screws entered from the inside. The tool is represented as in position for operating on a wheel, W, and it comprises a fixed bed-frame, 48, on which there is fitted to slide horizontally a standard, 49, fitted with a vertical slide, 50. In the bed-frame, 48, there is a horizontal first-motion shaft, 51, which by bevil gear drives a vertical shaft, 52, carried by the standard, 49, and passing up through the slide, 50. A spur-wheel, 53, on the vertical shaft, 52, but carried by the slide, 50, drives a spur-wheel, 54, on the drill spindle, 55, either directly or through one or more intermediate spur-wheels, 56. The slide, 50, is shaped to receive the wheels, 53, 56, 54, as between a pair of jaws, as will be easily understood from the engraving, and it is moved by a vertical screw-shaft, 57, in the standard, 49, for adjusting its position vertically, and for feeding the drill down as it operates. The feeding is effected by means of a revolving

worm, 58, gearing with a worm-wheel, 59, which is on a conical boss, 60, screwed on the top end of the screw-shaft, 57. The conical boss is formed with arms, by means of which the worm-wheel, 59, can be jammed between its conical surface and a collar on the shaft.

An adjustable gauge-piece, 61, is fixed on the vertical slide, and is formed with its top end bent over so as to come in the way of the handle of the conical boss, 60, and by loosening the worm-wheel, 59, to stop the feeding motion when the drill point reaches a depth in the tyre corresponding to the gauge-piece. The wheel, W, to be operated upon is supported in the ordinary way on two rollers, 62, and when it is placed with the part to be bored at the bottom, and centrally between the two rollers, the drill standard, 49, is moved horizontally by means of a lever, 63, so as to enter the drill-slide, 50, between a pair of spokes. On a hole being completed, the slide, 50, is withdrawn vertically and horizontally, and the wheel, W, is turned to bring another part of the tyre into position.

THE BROOKLYN BRIDGE.

We gave last week (*vide* page 392) some extracts from Mr. John A. Roebling's report on the great suspension bridge, which he is about to erect between New York and Brooklyn, and we now publish some further extracts describing the piers and foundations. Respecting these important details, Mr. Roebling says:

Towers and Foundations.

"The great features of the work will be the two towers, of which plans and elevations are herewith submitted.

"The base of each tower at the water-line, measured in the direction of the river, is 184 ft. long, and its extreme width will be 56 ft. Below the upper cornice, at the top of the tower, these dimensions are reduced to 120 ft. by 40 ft. This reduction is not effected by a gradual drawing in or sloping, but by sloped offsets at intervals, which leave the intermediate portions of the masonry plumb face. The elevation of the floor is 118 ft. above high water; the height of the roofing above the floor is 150 ft., making a total height of 268 ft. from high water to top of roof, not including the balustrade and ornamental blocks. This large body does not form one solid mass, but is built hollow.

"Two large openings or well-holes, each 81 ft. by 20 ft. wide, are left open in the masonry below the floor, and these openings are continued 120 ft. above the floor in the form of pointed arches.

"It will be noticed that by the above arrangement the lower masonry is divided into three shafts, connected by walls, and that in the plan of the upper work these connecting walls are

omitted. The shafts are provided with projecting buttresses for the purpose of saving masonry, to gain strength, and to improve their architectural appearance. In a work of such magnitude, and located as it is between two great cities, good architectural proportions should be observed. No expensive cutting, however, will be required in this masonry. The character of the facing will be that of rock work below the floor. Above the floor a draft will be cut around the margin of each stone, and the face between will be simply cut down to a uniform but projecting level. The impression of the whole will be that of massiveness and strength.

"It is proposed to face all the outside with dimension stone of granite; the inside or backing will be rubble and concrete. Any kind of stones, provided they are sound and strong, will answer for backing. Limestone, sandstone, gneiss, &c., will answer.

"Starting with the masonry 3 ft. below low water, the cubical quantity in the two towers will be 62,824 cubic yards of 27 cubic feet each.

"The foundations for the support of these large masses of masonry must be unyielding. Solid rock bottom is preferable to any other, but if such cannot be found at a reasonable depth, then other means must be resorted to, to made the bottom secure.

"The cubic contents of one tower is 31,412 cubic yards, equal to 848,124 cubic feet, which at 160 lb. weigh 135,699,840 lb., or 67,850 tons. Add to this the greatest weight of superstructure and load of 4758 tons, and we have a total of 72,608 tons neat. Now the area of base at water-line is 4660 superficial feet, and therefore the pressure upon each superficial foot will be 15.58 tons. It is important that this great pressure should be spread as much as possible over a larger area. This can be done by enlarging the base of the masonry itself, either by solid stone or by concrete. But neither of these methods is as good and as reliable as is a heavy solid timber foundation. I therefore propose to lay down a solid timber platform, with its lower base enlarged to 174 ft. in length by 96 ft. in width, and of a depth of about 20 ft. or more. The area of the lower base will therefore be 16,704 superficial feet, and the superincumbent pressure will be reduced from 15½ tons to 4½ tons per superficial foot. Now a pressure of 3 to 4 tons per superficial foot of foundation is an ordinary and usual weight, imposed upon railroad bridge foundations, with piers of 50 to 60 ft. high, and such a pressure will always be considered safe and secure on a bed of compact gravel or sand, provided there is no danger of undermining or spreading sideways.

"The towers of the Ohio bridge at Cincinnati are supported by similar foundations, but of less extent and depth. The pressure upon each square foot is 3.63 tons. These foundations have proved adequate; they have never shown the least sign of unequal settlement. A slight settlement may be harmless, provided it is uniform. But whatever settlement takes place, it

should occur at an early stage of the work, before the masonry reaches a great height.

"To obtain a correct knowledge of the nature of the strata, borings have been commenced on the Brooklyn side. The bore-hole, now being sunk, had reached a depth of 70 ft. on the 23rd August. So far the material encountered is composed of compact sand and gravel, mixed with clay, and interspersed with boulders, which latter have detained this operation considerably. It appears from the soundings which I have taken, about 80 ft. beyond the pier line, out into the river, that the river bed is composed of the same material, coarse gravel and sand, and very compact.

"The depth of water outside of the coal wharf of Marston and Powers, and in front of the spare slip, near the line of the bridge, averages about 20 ft. at high tide, 25 or 30 ft. out from the pier line. The bed of the East river appears to be composed of a layer of gravel and sand of sufficient compactness to resist the action of the tides. There is no evidence that the bottom is much affected at any time by this tidal current. In the line of the bridge the depth of water in the river gradually increases to about 60 ft., and then diminishes again towards the New York shore. These facts would appear to warrant the conclusion that any foundations which may be sunk inside of the pier lines, leaving, therefore, the tidal flow entirely unobstructed, will be safe against underwashing or undermining from the river side. If, for instance, the Brooklyn foundation was formed by a large timber platform of a depth of 20 ft., its top 3 ft. and its bottom 23 ft. below low tide, this would require an excavation of 12 ft. below the present river bed at the pier line. Now, I am of the opinion that at such a depth, the foundation, if further protected by a promiscuous outside piling, cut off say 5 ft. above the river bottom, and holding a heavy body of large loose rock, thrown in between the piles as a rip-rap, will for ever be safe against undermining on the river side. Now, this danger being guarded against, all that remains to be done is to provide against vertical settling.

"There is little expectation that rock will be found at a reasonable depth, so as to be available as a foundation. And yet an examination of the map of the East river strongly indicates, that the Brooklyn shore near the Fulton Ferry, where the east tower will be located, must be composed of a material which has successfully resisted the tidal current for centuries. I have now before me the geological map of Long Island and New York, published by authority of the State. But any other map shows equally well how the tidal river, in flowing back and forward between the New York harbour and the Long Island Sound, is acting against the projecting part of the Brooklyn shore, and how this current has in olden times been directed towards the New York shore, and hollowed out that sweep formerly known as the Swamp. After flowing around the Brooklyn point, the tidal current has been operating on the Brooklyn shore and excavated the Wallabout Bay.

"A geological section from near Fiftieth Street on the north to the Brooklyn Heights on the south, as published in Mr. Mather's "Geology of New York," 1843, indicates no rock on the Brooklyn shore within a reasonable depth. On the New York side, on the other hand, there would appear to be a better prospect of rock. In Holt's well, near Fulton Market, the gneiss rock is found at a depth of 126 ft. The old rock well near Trinity Church strikes rock at a depth of 26 ft. In the well of the City Hall the same gneiss rock is found at 90 ft. depth. The whole of Manhattan Island appears to rest upon a gneiss and granite formation.

"The results of the boring near the Brooklyn tower are so far favourable to a good foundation. Whether the timber platform spoken of above may be allowed to rest on the bed of the excavation, or whether a pile foundation will become necessary for its support, this question cannot and should not be decided now.

"After the construction of a coffer-dam the pit of the foundation must be excavated to a sufficient depth to make it secure against the encroachments of the river. Experimental soundings by test piling and sinking a number of iron test-bars at various points, all over the pit, will then decide the question whether piling all over or partially is necessary or not. From present indications I am fully satisfied that a good and efficient foundation can be made for the support of the Brooklyn tower, without any unusual expenditure of either money or time. If all the timber is contracted for during this fall, so that it can be got out during next winter and delivered next season, I entertain little doubt that the Brooklyn foundation may be successfully completed during the course of next year.

"No boring has been attempted yet on the New York shore. The boring on the Brooklyn side will be stopped at a depth of 100 ft. to 150 ft., or as soon as rock has been reached. The machinery will then be transferred to near pier No. 29, New York side, and a bore-hole commenced. There a greater depth of water will at once be encountered. From numerous inquiries which I have made, I have learned that the piles which are driven in the construction of docks along the East river on the New York shore take a firm hold in a layer of coarse and solid gravel, which underlies the mud. If this is so, this fact would indicate a similar nature of the river-bed as we find on the opposite shore. But no matter what may be encountered, I do not entertain the slightest doubt that a good and efficient foundation can be obtained on the New York shore as well as on the Brooklyn side.

"Should it become necessary to operate in a depth of water of 30 ft. to 60 ft., then wrought-iron caissons will become necessary. They will prove expensive, but will make sure work.

"As it is proposed in any case to use timber foundations, a few remarks on the ravages of the sea-worm will be in place here. The opinions of those who have had good opportunities to observe the habits of this mollusk about the harbour of New York vary very greatly on this subject. While some well-informed gentlemen assure me that the seaworm has entirely disappeared from the East river, in consequence of the pollution of its waters by the refuse poured in from the adjoining gasworks; others, again, equally well informed, maintain that its ravages are as bad as ever. All agree, however, that the attacks of the worms are never found below the bed of the river, and that timber is safe which is buried below or is otherwise protected.

"The timber foundations will be formed by layers of flat timber, alternately crossing each other, and well bolted together. The sides of the sticks being left rough, they will be laid with wide open joints, and these will be filled with concrete; and every course, after being levelled off, will be thoroughly grouted with cement. The width of the joints, left open, will be determined by the comparative cost of timber and concrete. It is probable that timber will cost more, and in this case I propose to make the joints as wide as the timber is. An impregnation of the timber with cement not only has the effect of hardening it, but it will also afford some protection against the sea-worm. This protection, however, will be rendered more effective and complete by covering the outside of the timber with a heavy layer of concrete, and this again will be protected by a heavy stone filling, intermixed with gravel and sand. In this manner the whole timber foundation will be hermetically enclosed by a heavy body of concrete, and this again protected against the wash of the sea on the river front. It is known that the sea-worm, which bores into wood, does not penetrate mineral substances and stones, and we are also certain that a well manufactured concrete, if left undisturbed, will soon become as solid as rock, and will therefore effectually keep out those dangerous mollusks.

"In Holland, where the habits of these mollusks have been studied for centuries, a long-established practice is to cover the timber with broad-headed iron nails. Iron rust is found to be death to the worm, and therefore proves a protection. On the strength of this fact, I further propose, before depositing the concrete, to cover the wood with a layer of cement, well mixed with roll-scales and hammer-slugs, which will speedily oxidise and form a very hard iron cement. A few tons of scales will suffice.

"In some tropical waters a mollusk is found which will penetrate and destroy rocks, but this creature has, to my knowledge, never been heard of in northern latitudes.

Anchorage.

"No rock will be found available for anchoring the suspension cables on either side of the river. No great saving would result from rock, even should it be found near the surface, because at the point where the anchorage will have to be located, the grade of the bridge is so much elevated above the natural ground that high anchor-walls for the support of the anchor-chains cannot be dispensed with.

"Each of the four cables enters the anchor-walls at an elevation of nearly 80 ft. above tide, and passes through the masonry a distance of 20 ft., at which point a connexion is formed with the anchor-chains. These are composed of ten links, the first one is 18 ft. long, the others are 12 ft. 5 in. long each, measured from centre to centre of eye. Each chain has a total length of 129 ft. 9 in., and forms a curve of one-quarter of a circle, or exactly 90°. The first link, which connects with the cable, occupies a horizontal position, while the last one is placed in a vertical line, and is attached to a massive anchor-plate, which supports the superincumbent masonry, whose weight must be great enough to balance the greatest tension to which the chain can ever be exposed.

"By this curvature of the chain a portion of its tension is converted into pressure directed upon the wall. This pressure will be supported at each knuckle by case-iron plates, which are to be bedded upon large blocks of granite.

"The greatest weight which the cables and stays will ever have to support was stated at 4753 tons.

Allowing six times, we get 4753 × 6	28,518 tons.
Deduct supporting power of stays	15,000 "

Leaves for the cables to support	13,518 "
The tension resulting from this weight is	
13,518 × 1.64 = ...	22,170 "

Tension of one cable	5,542 "
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And this will be the tension each chain will have to support.

"Now estimating the ultimate strength of good steel bars at 50 tons per square inch, the section of each chain will be 5542 ÷ 50 = 111 square inches.

Allowing 40 tons	189 square inches.
" 30 " for wrought iron 185 "	
" 25 " " " 222 "	

"Whether steel or iron bars should be employed, and of what qualities, will be decided by their relative strength and relative cost. We want the greatest amount of strength for the least amount of money, let it be iron or steel, home made or manufactured abroad. As the anchor links descend, their tension diminishes. It is safe to estimate the tension of the two last or vertical links at two-thirds of the tension of the first or horizontal link. So far as the cables and chains are enclosed in masonry, they will be protected against rusting by a thorough grouting with cement. The location of the anchorage on the New York side will be in the block bounded by Cherry, Water and Dover-streets, one side facing the latter. The Brooklyn anchorage will be located in James-street, and part of an adjoining block.

"The anchorage will not form one solid mass, but there will be two large open spaces left in each wall. I will add here a few remarks, explaining how these spaces can be improved and utilised to an excellent purpose, so as to bring a higher rate of rent. By arching and iron flooring, eight rooms may be formed, in each anchorage, each over 70 ft. deep, 15 ft. to 20 ft. wide, and about 20 ft. high. By being converted into treasury vaults for the safe keeping of all kinds of treasures and securities these vaults will possess unequalled claims, not only for the city of New York, but for the whole country and the whole continent. No city in the world would possess treasury vaults of equal strength, safety, and security against fire as well as burglary. By a small additional expenditure, absolute safety may be obtained in every respect. Although the cost of this masonry will be about \$600,000, I feel satisfied that, if my suggestions are carried out, the eventual rent of safes will pay more than ten per cent. upon the above cost.

Approaches.

"The approach on the New York side from Chatham-street to the anchor wall will be 1336 ft. long. On the Brooklyn side

this distance will measure 836 ft. All this ground is valuable, and should not be sacrificed, but on the contrary utilised. Most of the railroads which pass over the City of London are supported by brick arches, and the ground thus occupied is to a great extent valueless. My plan contemplates no sacrifice of the kind, but on the contrary involves, on the New York side at least, a decided improvement of all the blocks which will be passed over, west of the anchorage. This includes all the ground from the entrance to the anchor wall.

"If authority can be had, I would propose to open out a new street from Chatham or William to Cliff or to Franklin-square, running alongside of the bridge on the north side of it. This Bridge-street, as it might be properly named, would present two new fronts. The south front would be formed by the buildings underneath the bridge.

"The iron girders, which support the floor, will rest upon small pillars of cut stone or brick masonry, which will at the same time form parts of the enclosing walls. The intermediate supports may be built up in the same way; but a better plan will be to put up iron columns in connexion with the different iron floors and division walls. An inspection of the plan shows how the bridge front of the new street may be made very imposing and attractive in its architectural features, and how all the ground can be utilised.

"It is desirable that the construction of the bridge and of the improvements underneath should be carried on simultaneously, and upon one and the same plan. The bridge floor will thus form the roof of the houses underneath, and must be made fire and water proof. My estimate includes the necessary pillars for the support of the bridge floor, but no more. The balance of the work must be charged to the improvements of the ground, which will pay for themselves. For this same reason have I not included an estimate of real estate, because its value will not be destroyed, but on the contrary it will, in connexion with the contemplated improvements, be considerably enhanced.

Estimate of Cost.

"The proposed bridge over the East river will cost from six to seven millions of dollars. My estimate sums up \$6,675,357."

ENGINEERS' TOOLS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your article on "Engineers' Tools," on page 379 of your last number, you notice and illustrate a method used in Glasgow of varying the speed of machinery to the utmost nicety by means of a pair of cones.

This plan was adopted by the late J. G. Appold, Esq., the inventor of the centrifugal pump which bears his name, to regulate the amount of air which was driven by a fan (worked by the engine used in the adjoining factory) under the floor of his dining-room, for the purposes of ventilation. This floor was perforated with small holes, so that the air might enter uniformly over its whole surface, and ooze through the carpet without creating a draught. Under the end of the table a small metal rod projected through the floor, and was connected by a series of levers with the band which passed over the two cones. When the room became too hot, or *vice versa*, which was shown by a metallic bar thermometer, also of Mr. Appold's invention (the index moving about an inch for every degree), Mr. Appold had merely to move this rod with his foot to bring the room back to its normal temperature. I myself saw this in operation six years ago, and Mr. Appold spoke to me of it as having then worked for many years without a single hitch.

I could fill a page of your journal with a description of the various contrivances which this wonderful mechanical genius applied to his house. Doors opened as you went towards them, and closed noiselessly behind you. This latter object was effected by the use in some cases of air in compression, in others in tension.

There was one door in the hall which opened as you approached and disclosed a basin, which rapidly filled itself with water, and, when you had washed, emptied itself, and the door again closed as you retired. The hall and staircase were warmed by a gas-stove, the supply for which was regulated by a thermometer, about 3 ft. long, and containing many pounds of mercury. This instrument was suspended horizontally by a pin through its centre of gravity, when at the required temperature. When the temperature rose or fell, one end of the thermometer became heavier, and the supply of gas was altered accordingly. There was also another gas-stove, of peculiar and beautiful construction in the library.

There were numerous other inventions of equal interest in the house and factory, and all were self-regulating. But I have already trespassed too much on your much-sought-for space, and, besides, as Mr. Appold was the friend of all our leading scientific men, many of your readers must themselves have seen what I could so poorly describe.

If Mr. Appold had been a professional engineer, he would have left a name second to none among the benefactors of his species; but even as it is, his public inventions, to which I need only allude, as they were so fully described by you at the time of his death, place his name high in the lists of honour.

I enclose my card.

I am, Sir, your obedient servant,

G. B., Assoc. Inst. C. E.

Engineer's Office, Railway Works, Surrey,

October 28, 1867.

[We print our correspondent's letter because of its interest, but we must add that conical pulleys were employed, for the nice adjustment of speed, long before the late Mr. Appold could have employed them. We must also observe that Mr. Appold died about three months before this journal was established, and that we did not "fully" describe his public inventions at the time, nor afterwards, as our correspondent supposes.—Ed. E.]

LITERATURE.

The Roorkee Treatise on Civil Engineering in India. Edited by Major J. G. MEDLEY, R.E., Principal, Thomason Civil Engineering College, Roorkee. Printed at the Thomason College Press, Roorkee. 2 vols. 8vo. 1866-67.

THIS is a useful and creditable work. It does not offer any pretensions to originality, and Major Medley says that it is chiefly built up of manuals of different branches of engineering which have for some time been in use in the Roorkee College, and which, in their turn, are for the most part compilations from European authors. But Major Medley has here brought together the more important doctrines which ought to regulate the construction of engineering works in such a country as India, and he has also given descriptions of such Indian works as are most remarkable or most successful. There is a tone of diffidence and deprecation discernible in these volumes, indicative of a consciousness of the want of that practical grasp of the subject which is manifested by engineering authors, and, in fact, the work is little other—and pretends to be little other—than a compilation reflecting the opinions of others, and with little title or claim to independent authority. Nevertheless, it is a work calculated to be of much service to the students of the Roorkee College, and, indeed, to all students of engineering, especially if looking for employment to the East, as it presents a *résumé* of the best European and Indian experience, filtered through the mind of a competent judge of what is relevant and advantageous. The first volume is devoted to the principles of engineering construction, and comprehends dissertations on building materials, strength of materials, masonry, carpentry, and earthwork. It ought also to have embraced the principles of mechanics and of hydraulics, which are in reality more important than all the rest. The second volume is devoted to an explanation of the method of embodying these first principles in actual works as exemplified in buildings, bridges, roads, railways, and irrigation works, and this explanation is illustrated by a reference to Indian structures, such as churches and barracks, bridges for roads and railways over Indian rivers and canals, aqueducts, dams, and canals of irrigation. In most of these Indian works the features exhibited are rather those of mediocrity than of excellence, almost the only exceptions to this character being the works upon the railways, which manifest the possession of competent attainments. Of the other engineering works carried out in India chiefly by officers of the military engineers, the highest praise that in most cases can be fairly given is that they are clever examples of amateur engineering, in which the native idea shines through the varnish of European classicality that has been laid on. In the railway works, we see for the most part the operation of this law, that the directing head, understanding his business, and having confidence in himself, has controlled the execution throughout, and, in general, the result is a structure of an efficient character, and such as would be esteemed adequate in any other part of the world. In the works executed under the direction of Government officers, on the contrary, we see everything working in an inverted order, and the misteree, or native foreman, inspires the designer, and the native workmen the misteree. We have consequently, at the best, a sort of half-caste structure without the virtues of either parentage, and much money may thus be spent, while little efficiency is secured. To take an example, the bridges on the grand trunk-road, over 900 miles long, and extending from Calcutta to Delhi, are in all easy cases perfectly satisfactory works, but are only such as we should imagine might have been built in the Highlands of Scotland some hundreds of years ago as efforts of untutored genius, and they are not such as would be erected in any civilized country at the present day. It is true the viaducts on one of the Indian railways have lately shown faults still more glaring, as they have given way altogether. But there is no doubt that this is imputable wholly to the omission to keep the mortar wet in a hot and sickly season for a sufficient time after it was used to ensure its perfect consolidation, at a time when the superintending Europeans had either died or become unable to look after the work. A fault in the design is, of course, indicative of incapacity in the designer. But a fault in the execution may arise from accidental circumstances over which he had no control. There are no doubt many engineer officers in India who, from natural aptitude, and by dint of the experience which has been forced upon

them, have now attained to respectable proficiency. But their proficiency would have been greater if they had received a better training, and in view of the great engineering wants of India, looking to the great works which have to be carried out there, and the wide area over which they must be spread, the question is whether we shall restrict the selection of the directing minds to a class of men who are confessedly without the latest modern knowledge, and only a better class of amateurs, or whether it is not the cheapest and best course to select the highest measure of practical ability wherever it can be found? There is no doubt the objection that European engineers know little of the people, the language, or the climate of India, and in former times much was made of this objection as warrant for an exclusion which had no other justification. But, however plausible this plea may once have been, it has lost all semblance of cogency now, since numerous properly trained engineers have for the last twenty years been resident in India, and have successfully constructed the greatest works now to be found in that country. It is not sufficient, in a country like India, to be content with old methods. We want the importation of European talent and enterprise to deal with the circumstances there arising, and to subdue the powers of nature as effectually in that climate as they have done in this. Thus, in the matter of barracks, there is not a barracks in the whole of India that is properly planned. For the most part, they are spread over far too great an area, and are thereby more injuriously heated by the sun, whereas they ought to be constructed as a hollow cube, with a central court, over which a *velum* or awning should be drawn in the day-time; and all proper expedients of refrigeration should also be adopted. Thus, in the North-West Provinces, and in the Punjab, where the hot winds prevail during the summer months, it is easy to obtain any desired reduction of temperature by the evaporation of water alone; and the air is there sent into apartments by a large revolving fan of wood, called a *thermantidote*, turned slowly, usually by two men, and drawing the air through a thick matting, called a *tally*, which is kept wet with water. In Calcutta, and other localities where the air is already loaded with moisture, this expedient is not available. But in every part of India there is no difficulty in keeping residences cool and comfortable by the introduction of suitable arrangements. In the Punjab, and in many other parts of India, it is the habit of the more opulent natives to have cellars constructed in the ground, in which they may find refuge from the heat. But, by properly constructing the houses, all the surfaces which are now heating may be made cooling, and the sun, instead of being a source of heat, may be made a source of cold. A common way of cooling a bottle of wine in India is to wrap it in a wet cloth and hang it in the sun, when the rapid evaporation abstracts heat from the enveloped liquid to supply part of the heat requisite for vaporisation. So also a house may be cooled, as well as a bottle, by placing a flat water-tank on the roof, from which the water will be suffered to trickle down over venetians or awnings placed upon the sides. Unfortunately no town in India is yet properly supplied with waterworks, except Bombay, those for Calcutta being only now in preparation. But where such works exist—and they should exist everywhere—it is a very simple problem to refrigerate a house; and the water escaping from the pipes into the tank may be made to work the punkahs of the dwelling. On the whole, there is no internal expedient of refrigeration more satisfactory than the punkah, which is a great board or fan hung by cords from the ceiling, and moved to and fro to give a gentle current of air. The punkah is generally suspended over the table in a room, and its motion should not be so rapid as to displace papers or any light objects laid on the table beneath, which would be a source of inconvenience. Barracks which are not provided with water and gas-works should have such works attached specially for themselves, which could be done with a vast increase of comfort, and without any heavy expense.

The stations of India, by which is meant the residences of the European part of the population, are uniformly spread over far too large an area of ground, whereas it would be vastly better if they could be contracted into such structures as large hotels, whereby there would be less surface for the sun to act upon, and they could be cooled, lighted, and supplied with every European comfort and luxury with the greatest facility and at the smallest expense. At present it is work enough for Europeans, at many of the Indian stations, to continue to exist. Thus, at Moultan there is a great range of most expensively constructed bar-

racks spread over a very wide area, and heated by the sun all day with unremitting ardour. The consequence is that the bricks and tiles absorb so much heat during the day that they radiate a great deal of heat during the night, and thus maintain a painfully high temperature without intermission. Such structures should be shielded from the sun, either by trees or by some species of awning. But the best method to pursue is to build the barracks in the form of a hollow cube, with a water-tank on the roof, and wetted venetians on the sides, and a wetted awning over the central court. At Umballa the barracks, instead of being tiled, are thatched, which is cooler. But thatch harbours scorpions and other vermin. At Mean Meer, a few miles from Lahore, the barracks, which are of recent and expensive construction, are built on the usual vicious Indian plan, and every tree has been removed from the vicinity, in the idea that trees were detrimental to health, whereas the fact is precisely the reverse, as they are effectual generators of the powerful antiseptic ozone. The fact however is, that in no part of India should large numbers of soldiers be kept inactive in the plains. Residences should be provided for them in the cool and bracing atmosphere of the hills; and easy means of communication by road and railway between the hills and plains should everywhere be provided. For persons stationed at Umballa, the natural retreat is Simla; Lahore, Kanyra or Dalhousie; Delhi, Nynsee Tal; Calcutta, Darjeeling; Bombay, Poonah; and Madras, the Neilgherries. Each presidency should have its summer and its winter capital, with duplicate sets of offices and duplicate records, and the whole of the officials and of the soldiers, except those required for urgent local needs, should migrate like the swallows or like the court of the Moguls. The question of the proper site for the capital of India has lately attracted consideration, as people are becoming alive to the fact that there is no necessity and no advantage in conducting the business of that great empire in an unhealthy swamp, like Calcutta. But, in point of fact, there should be no capital, in the usual sense of the term, but each presidency should have its own summer and winter capital, and the governor-general and his council should spend some time in all of them in rotation. He would thus have an opportunity of personally surveying every part of the empire, and he would be emancipated from the guardianship of a clique so narrow and overweening as that of the Bengal officials. One year he would devote to Bengal, another to the Punjab, with which Scinde should be incorporated, another to Bombay, and so on, by which means during the period of his incumbency he would have made the whole round of India. Another benefit of the proposed arrangement is that the officials would be kept in such health and comfort, that they would be able to work during the whole year, whereas now, during a great part of it, it is labour enough to exist.

We hope to see colleges and schools of art for imparting technical instruction established all over India, but we also hope that effectual precaution will be taken to prevent them from degenerating into governmental factories seeking by indirect means to establish a monopoly of their productions—an evil which the zeal or the selfishness of their administrators is likely, unless checked, to generate. Thus, on the Ganges the Government at one time established trading steamers, on the ground that no one else was willing to do so. But when other parties came into the field, the vessels were still run in opposition to private enterprise, and the persons concerned in the management of the vessels strained every nerve to perpetuate their existence. The same thing happened on the Indus, and in some of the southern districts of India it is said that good pressed cotton cannot be obtained, from the impediments thrown in the way of persons who would establish presses by the officers of a Government establishment which was some time since set up. These things should be looked to; else measures of amelioration, which were at first a boon, soon became a curse. In the jails of India and in the army workshops much has been done to promote the cultivation of the useful arts. But the grand measure of improvement must be to encourage immigration by emancipating the capabilities of the country from the gripe of a jealous and exclusive clique, who secretly dislike interlopers as much as in the days when the "Company" effected their deportation as intruders on their monopoly. Such a policy is of course denied in words, as it cannot be justified. But it is continually asserted and exemplified by facts, and, in fact, it constitutes the secret spring by which the whole of our existing Indian policy is moved. It remains to be seen

how long, in these days of sweeping change, a policy so oligarchical, so selfish, and so mischievous will be endured.

How to Develop Productive Industry in India and the East, with Estimates and Plans of Factories. Edited by P. R. COLA, late sole Proprietor of the Arkwright Cotton-mills, Bombay. London: Virtue and Co., 1867.

THIS is a volume advocating the extension of European modes of manufacture to India and other countries of the East, and containing plans and estimates of factories for spinning and weaving cotton, for bleaching, dyeing, and calico-printing; manufacturing jute, silk, sugar, and paper; for foundries, timber, and corn-mills; for making bricks, producing engines and boilers, and with remarks on working coal-mines. The prices of agricultural machinery suited to India are also given.

The question of the expediency of importing European modes of manufacture into India is one that raises many important considerations. The rudiments of most of the arts we have received from India. But the processes have been much improved in our hands, and Mr. Cola says that it is now incumbent upon us to render back these improved methods in supercession of the native processes. There is certainly no reason why a bad method of manufacture should continue to be pursued in India or anywhere else when a better method is known. But in most cases these improved processes are only possible of successful prosecution under the factory system, and the existence of that system presupposes a condition of internal improvement to which it is doubtful whether India has attained. No industry can receive large development in a country in which good roads and other aids to easy communication do not exist; and supposing a factory of any kind to be established at such places as Delhi or Lahore, the question is, who would become the purchasers of its productions. In Bombay, indeed, and also in Calcutta, cotton-mills have been established with a fair measure of success. The natives of India have the delicacy of manipulation suited to such employments. The temperature of the atmosphere is also appropriate for this manufacture, and it seems to be a great waste of effort to carry cotton half round the globe to be spun in Manchester, and to be afterwards carried back to the place from which it was exported. Nevertheless, such are the natural advantages possessed by England in more abundant skill and capital, and in a large market in which to buy and sell, that it is only in exceptional cases that the mills of India can compete with those of England even in producing cotton fabrics for the East. Then the price of labour in India is rapidly rising; and Bombay and Calcutta have become among the dearest places in the world. While, therefore, it is very desirable that the native processes of India should be improved as much as possible by the aids afforded by European science, and while it is further desirable that the factory system should be imported into that country to as great an extent as is consistent with its otherwise undeveloped condition, it appears to be tolerably certain that the rash or wholesale adoption of the factory system there would lead to disastrous failures, that would operate as a discouragement to subsequent enterprise, when the circumstances had become more propitious. The first and most promising capability of India is its agriculture. By the simple expedient of irrigating the land from the rivers, or by water collected in reservoirs during the rains, the productiveness of the land may be increased threefold; and as there is more land to irrigate than there is water to irrigate with, the measure of the country's productiveness is WATER—every pint of which represents so much grain or sugar. Yet of this fertilising element the greater part is now lost by being discharged into the sea; whereas every drop of it should be retained and spread over the land. There are greater facilities now for the introduction of a comprehensive system of irrigation into India than at any former period of its history; as, instead of being broken up into a number of conflicting states, the whole region is under the dominion of one paramount power, possessed of the requisite engineering skill to carry out a great system of hydraulic works in the best manner, and also of the requisite capital to pay for such reproductive improvements. The only hindrance to the practical realisation of this enormous boon is the India Council, which, like the dog in the manger, will neither carry out the works themselves nor permit independent enterprise to do so; and while all our other colonies are advancing to greatness with giant strides, India—the most important of them all—is strangled by official

cobwebs. If irrigation were to be largely introduced, the irrigating channels would form valuable water-roads to bring down the produce to a sea-port or other mart at which it could be profitably disposed of; and the population would then be sufficiently enriched to become such large consumers of manufactures that the factory system might be established at the more important centres with every probability of a remunerative issue. To begin with manufactures, however, is to begin at the wrong end. First, irrigation should be carried over the whole face of the country; and next, agricultural machines should be introduced to perform the heavy parts of agricultural labour, and to thoroughly turn up and pulverise the soil. There is no country in the world better suited to the action of such machines. From Calcutta to Delhi, and from thence to Lahore, Moultan, and Kurrachee, is a vast alluvial plain, with little broken ground, and requiring only water—which the rivers will supply—and cultivation of an efficient kind, to convert it into a great garden. Then the sunderbunds, now a pestilential jungle, extending eastward from Calcutta, five hundred miles along the head of the Bay of Bengal, is suited, when cleared, for the growth of the best Sea Island cotton. But the clearing should be effected by proper machines, which would pull up the trees and bushes by the roots—the present mode of clearing being so tedious and expensive that the cleared land hardly repays the expense of reclamation. These are the measures upon which enterprise should be chiefly concentrated, as they are the most promising investments and the most pressing wants. But the ghost of the East India Company in the shape of an India Council stops the way, as it inherits all the narrowness, inertia, and selfishness of its prototype. The Indian Government has supreme power over the land of India, and hinders the prosecution of important works of irrigation by pretending that it will undertake them itself, which it either never does or languishes so long over them that enormous present detriment is necessarily sustained. Instead of fostering immigration into India, the Government does all it can to hinder it; and, in fact, India is still regarded as a great preserve, maintained for the benefit of the civil service, and interlopers, instead of being welcomed as in the other colonies, are viewed with dislike and jealousy, and are prevented from acquiring the possession of land. A system so monstrous and suicidal was never before tolerated in any country, and the question of the proper administration of India must now attract the serious attention of Parliament. The India Council has been tried and failed. The country remains in the same stagnant state in which it rested while under the rule of the East India Company, and, in fact, the India Council is only the old company in disguise. There is far too much of the old civilian element in it. It does not, and will not, move with the times, and while this conclave of elderly gentlemen repels the enterprise and loyalty of their own countrymen, whom they hinder by their discouragements from settling in India, they permit without any controlling effort of statesmanship Russian armies to march nearly up to their doors. These considerations, however, are leading us away from Mr. Cola's work; but they really lie at the root of any effectual expedient for developing the resources of India. English enterprise must be let in there. It must be courted, and not repelled. This point once gained, and the restrictive incubus of the Government taken off, adventure will flow there, as elsewhere, into the most productive channels. The day, we believe, will come when factories of the kind Mr. Cola describes will take wide root in India; and it would be a miserable and unworthy policy in us to discourage their establishment because they will compete with our own factories at home. But we are confident that, before manufactures can flourish largely in any colony, its agriculture and other resources must first be largely developed, and there must be cheap communication between the different parts of the country. Mr. Cola has performed a useful service by affording so much information about the cost and arrangements of small factories suited for such a country as India; and such details will be specially useful to those who meditate the establishment of factories in that country, which in certain exceptional cases may even now be successfully done. The lights he affords may also aid in the improvement of native processes. But we feel persuaded that, before manufactures can prevail largely in India, its agriculture and internal communications must be largely improved; and before there can be much hope of carrying such improvements out, the policy of the Indian Government must be entirely altered, and the India Council must be swept away.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1867; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 477, 10d.) William Riddell, of Crosby Hall-chambers, patents a machine for disintegrating wood, or reducing it to filaments. In this machine the wood to be cut up is placed upon a reciprocating table, and is acted upon, as it moves in either direction, by a series of cutters or plane-irons, each cutter being preceded by a number of "scorers," which score the wood and causes the shavings removed by the plane-irons to be divided into filaments.

(No. 482, 8d.) James Roger Crompton, of Elton Paper Mills, Bury, patents making the rolls and bottom plates of "rag-engines," or pulping-machines, with cutters consisting of bars or strips of steel, of uniform or almost uniform thickness, these strips being adjustable for wear.

(No. 484, 1s.) John Harrison, of Liverpool, patents an apparatus for cleaning ships' bottoms, which could scarcely be described without reference to drawings.

(No. 485, 8d.) William West, of Tredenham House, St. Blazey, and John Darlington, of Moorgate-street-chambers, Moorgate-street, patent arrangements for counterbalancing the pump-rods in mines, and for communicating motion from one rod to another when the two rods are not in the same straight line. The arrangement for counterbalancing the rods consists of a pair of hydraulic cylinders, each fitted with a plunger. One of these plungers is connected to the rod to be balanced, and the other carries a counterweight. The two cylinders being connected with each other by a pipe, and being partially filled with water, it follows that as the pump-rod descends, and with it the plunger attached to it, the other plunger and the counterweight will be raised, and *vice versa*. A similar arrangement is employed for transmitting motion from one pump-rod to another, the two plungers being in this instance attached to the two pump-rods, instead of one of them being connected to a counterweight. This arrangement will no doubt be found an exceedingly convenient one in many situations, as the hydraulic cylinders can be placed at any distance apart, and may be inclined at any desired angle to each other. One of the main plungers is connected to the plunger of a small feed-pump, which supplies to the hydraulic any water which may be lost by leakage, and a safety-valve is provided for discharging any excess of water thus injected.

(No. 486, 10d.) Charles Colwell, of Gorleston-cum-Southtown, distinguishes himself as the patentee of a perpetual motion, disguised under the title of "improvements in apparatus for obtaining motive power." This apparatus is as complicated and ridiculous as such arrangements always are.

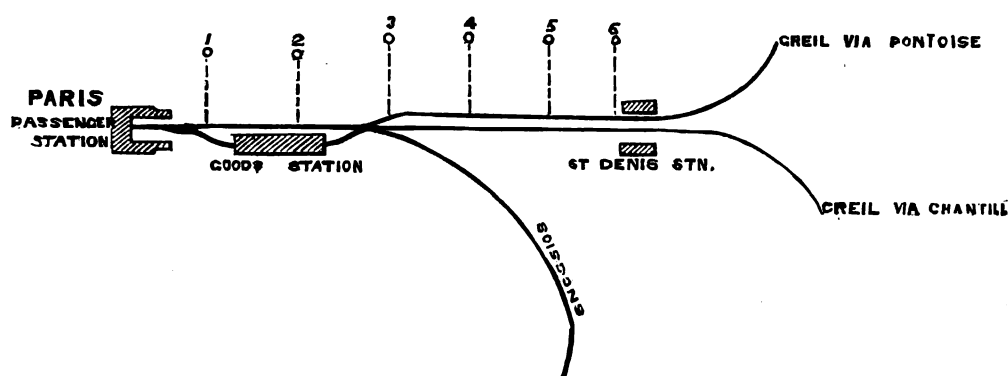
(No. 488, 8d.) Alice Isabel Lucan Gordon, of Prince's Gate, Hyde Park, patents a coupling for connecting wires employed for transmitting electric signals on railway trains. This coupling consists of two parts, united by spring clips in such a manner that, although securely connected under ordinary circumstances, they would become detached in the event of the carriage becoming uncoupled. When two parts of the coupling are pressed together, springs carried by each of them, and connected with the wires, are brought into contact with each other, No. 1 wire on one carriage being brought into electrical communication with No. 1 wire on the next carriage, and so on; whilst in the event of the coupling becoming disconnected, a T-headed spring comes in contact with two of the springs carried by each part, and, by bringing them into electrical communication, causes a signal to be transmitted to the guard's van.

(No. 496, 1s. 8d.) Thomas King, of Brick-lane, Spitalfields, patents a method of washing casks by passing them through a machine which is kept continually in motion. The washing-machine itself, although not very complex, could scarcely be clearly described without reference to drawings.

(No. 497, 1s. 2d.) John Phillips-Smith, of Hereford, patents the steam ploughing and cultivating machinery described by us on page 126 of the present volume.

THE SAMARA-ORENBURG RAILWAY.—The works on the Samara-Orenburg Railway are being energetically pushed forward. The completion of the line, which yet cannot be expected in less than a year and a half, will supply Russia with steam communication between her central cities and the town considered as the portal to Turkistan.

THE LINES OF THE NORTHERN RAILWAY: PARIS.



We represent on the present and following pages the apparently complex arrangement of lines which the peculiar requirements of the traffic have rendered it necessary that the Northern Railway Company of France should lay down in the neighbourhood of their Paris terminus. The plans on page 428 extend for a distance of nearly 3 kilometres from Paris, and a general outline of the company's lines for a distance of about 8 kilometres from Paris is given in the small plan at the head of the present notice. The general arrangement of the lines is altogether a very peculiar one, and we have no doubt therefore that an account of it, and of the system upon which the lines are worked, will be interesting to those of our readers who are "railway men."

The Northern Railway is divided, on its departure from Paris, into three distinct lines, namely:

1st. Upon the left, the line from Paris to Creil, by Ponttoise, this line serving the suburbs of Paris and the valley of the Oise as far as Creil.

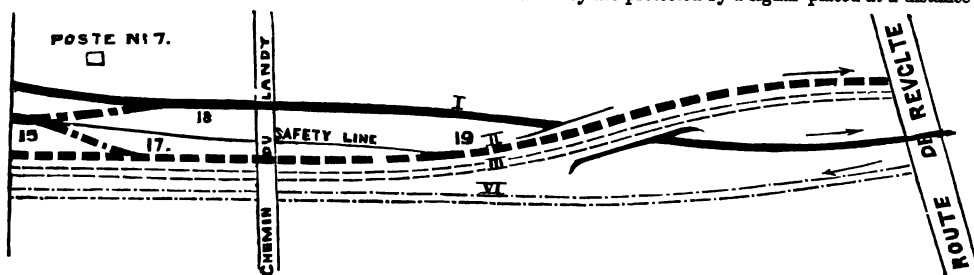
2nd. Upon the right, the line to Soissons.

3rd. In the centre, the direct line from Paris to Creil, by Chantilly, this being the line over which are despatched the quick trains serving the Northern system, and those to England, Belgium, and Germany.

It is necessary, for the convenience of the traffic, that in the Paris terminus the trains traversing the line to Chantilly should be led close to the luggage-offices, &c., situated on the left for the departure, and on the right for the arrival trains; whilst the lines serving the suburbs, on the contrary, are conducted to the central platform. Further, at La Chapelle, near Paris, all the goods traffic—both the arriving and departing trains—has to be taken over the lines upon the right.

It follows from this arrangement that, if the lines were all maintained at the same level, the goods trains forwarded from La Chapelle would necessarily cross one or more of the return lines, whilst all the trains leaving Paris for Chantilly or Soissons would, in a similar manner, cross, on a level, the whole of the lines situated on their right. The arrangement represented in our engravings has been carried out to avoid these level crossings, and to keep the various arrival and departure lines clear of each other.

The arrangement of the lines, as they now exist, is as follows:



The departure line for Chantilly is kept on the extreme left until near the level crossing of the road to Landy, where it descends, and, passing under the Ponttoise line, takes its place on the right of the latter, which is maintained on its former level and almost in its former position.

The Soissons traffic leaves Paris by a special line, which, on leaving the fortifications, is raised so as to pass over the return Chantilly line, and which then regains its original level a few hundred yards further on.

The line for the departure goods trains is raised parallel to that of the passenger trains to Soissons, and, crossing the return line used in common by the trains arriving from Chantilly and Soissons, it joins the Soissons departure line, as shown on the plans. A short distance further on it again leaves the Soissons line, branching to the left, crossing over the departure and return Ponttoise lines, and descending between the departure lines to Ponttoise and Chantilly respectively, is joined to them both by branches near the crossing of the road to Landy.

The return lines are maintained at their original level, and are reduced to two in number between Paris and the third kilometre post, near which point the return line from Soissons joins that from Chantilly.

The goods trains arriving from Chantilly are turned, near the third kilometre post, on to the return line from Chantilly, whilst at a distance of about five-eighths of a mile from Paris a pointman diverts them on to a special line, over which they pass to the goods station of La Chapelle.

From the description that we have given and an inspection of the plans, it will be seen that no "up" line crosses a "down" line on the same level, and thus any collision between trains running in opposite directions is rendered

impossible. In cases where lines over which trains pass in the same direction are united, the junction is not effected until the two lines have run side by side for some distance, so that trains approaching the junction on different lines are within sight of each other. Besides these precautions, there is a very complete system of signals for regulating the traffic. The whole of the works required for completing the arrangement which we have described were executed without interfering with or interrupting the transit of the trains.

The following are some of the particulars of the signalling arrangements under which the network of lines is worked:

The pointman at the signal station marked Poste No. 5 has charge of the points 11 and 12, together with the signals protecting them, and he is also able to work a "correspondence signal," by which he is enabled to communicate with the man at Poste No. 7, as will be explained presently. The points marked 12 are habitually kept open for the line leading to Soissons, and in the case of trains which have to be despatched by that line, the man has nothing to do but to work the corresponding signals. When a train arrives which is to be despatched by the left-hand line, No. IV. (the line which eventually joins those leading to Ponttoise and Chantilly), the pointman has, before allowing it to pass, to make sure that no trains will be on the way on lines Nos. I. or II., and to see that the distance signals placed near him on those lines are placed at danger.

The signalman at Poste No. 6 regulates the passage of all the trains over the return or "up" lines, and he is stationed on a platform raised so that it is about on a level with the departure line to Soissons. He works the points numbered 14 and the distance signals which govern the trains approaching by the three lines, from Ponttoise, Chantilly, and Soissons respectively. He, in general, allows the trains to pass in the order in which they present themselves; but a goods arriving by the Chantilly line has to wait if a passenger train is in sight, or is signalled either on that line or the line from Soissons.

The signalman at Poste No. 7 has charge of the points marked 15, 16, 17, and 18, and of the signals belonging to them. The points 15 and 16 usually stand, so that any approaching train would be turned on to the *voie de sûreté*, and they are protected by a signal placed at a distance of 60

metres from the points 15. The points 17 and 18 are always open, so that they permit of the passage of trains by the lines I. and II., their counterweights holding them in this position. All trains arriving by line No. IV. are stopped at the signal belonging to points 15, and their direction demanded. If the train thus stopped has to proceed by the right-hand or Ponttoise line, the signalman lowers the distance signals corresponding to points 17. If at this moment there is no train upon the Ponttoise line between the distance signals and the points 15, the signalman at Poste No. 5 informs the man at Poste No. 7 of the fact by working the "correspondence signal" belonging to the Ponttoise line, this signal being situated near Poste No. 7. The man at the latter station then opens the points 15, for the Ponttoise line, and the train having past, replaces them in their normal position. He also, after the appointed delay, sets at "clear" the distance signals which he had altered to protect the points.

If a train has to be sent over the left-hand line, to Chantilly, the signalman places at danger the distance signal which covers the points 18, consults his colleague at Poste No. 5, and upon obtaining a reply through the working of the "correspondence signal" belonging to the Chantilly line, he opens the points 16, and places at "clear" the signal which protects them.

The points 15 and 16 being habitually placed so as to direct trains on to the safety line already mentioned, it follows that if a train is not sufficiently under command to be brought to a stand at the proper place, before arriving at the points 15, it will merely pass on to the safety line, where it can be stopped without fouling the lines to Ponttoise or Chantilly. A train which has thus run on to the safety line, and been

brought to a stand, is not allowed to start again until the signalman at Poste 7 gives orders to that effect. Before giving these orders, he takes the precautions above described as being necessary when a train is to be sent by the Ponttoise line; and on his receiving a reply by the correspondence signal from the man at Poste 5, he allows the train to pass from the safety line to the Ponttoise line, through the points marked 19. If the destination of a train, which has thus overshot the mark is the Chantilly line, it is still turned on to the Ponttoise line in this manner, the change from the Ponttoise to the Chantilly line being subsequently effected at the St. Denis station.

The whole system of lines and signals which we have described was represented at the Paris Exhibition by a model in relief.

CAST IRON IN SEA-WATER.

SOME time in the early part of the present year a specimen of cast iron (piece of an iron pile) used in the construction of the Bombay, Baroda, and Central India Railway bridge over the Nerbudda, which for some considerable time had been immersed, was submitted to the chemical analyser to Government. Dr. Lyon first gives the analysis of the water, and next, after carefully examining the iron, considers that this particular specimen had not undergone any material change, but at the same time points out that cast iron under similar circumstances may undergo certain changes, which as long as they are slight are not detectable by analysis. The water was found to contain, per gallon:

	grains.
Chloride of sodium	139.40
Do. of magnesia	8.64
Sulphate of zinc	11.34
Do. of magnesium	7.84
Carbonate of magnesia	9.37
Silicia	1.34
Organic matter	.56
Suspended matter	178.69
Sp. gr. of clear water	1.00206

Total solids dried by evaporation at 280° F. ... 178.64

In June again two pieces of cast iron and two wrought-iron bolts were submitted to Dr. Lyon. These specimens had been four and a half years immersed in the Bassein creek, the water in which is pure undiluted sea-water, having a specific gravity of 1.028, and containing per gallon 3000 grains of solid matter, of which 1604.75 consists of chlorine in combination with sodium, magnesium, &c. Here the cast iron had undergone a change to a depth of one-tenth of an inch from the surface, resulting in a small solution of the iron forming this portion of the pile. The wrought iron, which was not in contact with any cast iron, bore no evidence of deterioration.

The action of sea-water on cast iron in Dr. Lyon's opinion consists in the gradual solution of the cast iron, leaving the carbon undissolved, and as the percentage of iron in cast iron varies within certain limits in different specimens, it follows that, unless the percentage of iron be reduced below these limits, such change must remain undetected unless the iron has been analysed before immersion. Dr. Lyon also considers that cast iron immersed in water of the composition of the Nerbudda, at the point where the first mentioned specimen was immersed, and which by the analysis it will be seen contains a large quantity of sea-water, will, in process of time, deteriorate from this cause, and it is, he thinks, a question whether it would not be advisable to guard the iron from corrosive action of the water by coating it with some protective material, or by rendering it electro-negative under the influence of some more oxidisable metal, such as zinc.—*The Bombay Builder*.

REMUNERATION OF ENGINEERS UNDER GOVERNMENT IN INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—As you always advocate the interests of young engineers, allow me to make a few remarks relative to the remuneration of civil engineers under the Government in India. That the salary of this body is totally inadequate there is not the slightest doubt, viz., 177. per month during probation, and increased to 201. when placed on the permanent staff. The course of education which a young engineer has to undergo before he can present himself for the examination with any hopes of success can readily be judged from the fact of his having to make 60 per cent. as qualifying marks, irrespective of the competition that comes in afterwards—no easy task, considering the ever-varying style of the examination. The generality of the candidates are both civil engineers and graduates of some university, and consequently they must have obtained a very liberal education, besides their professional course. Now that Government requires such a number of engineers to assist in carrying out important works of irrigation, &c., to further develop the resources of India, which are certain to yield them a large return on the money invested. Surely it is not too much to expect them to increase the pay of the engineers to 301. per month at the start. They will then get men in any number—men competent and willing to discharge the duties intrusted to them. I am thoroughly cognisant of the fact that engineers are at a discount at present, but I am also convinced that good men will always fetch their price; and if the latter class who now go up for this examination could hold out for a time, I have no doubt that some change would be made with a view to ameliorating both the remuneration and position of engineers under the Government in India—a change which sooner or later must take place under existing circumstances. Hoping that you will give this space in your influential paper,

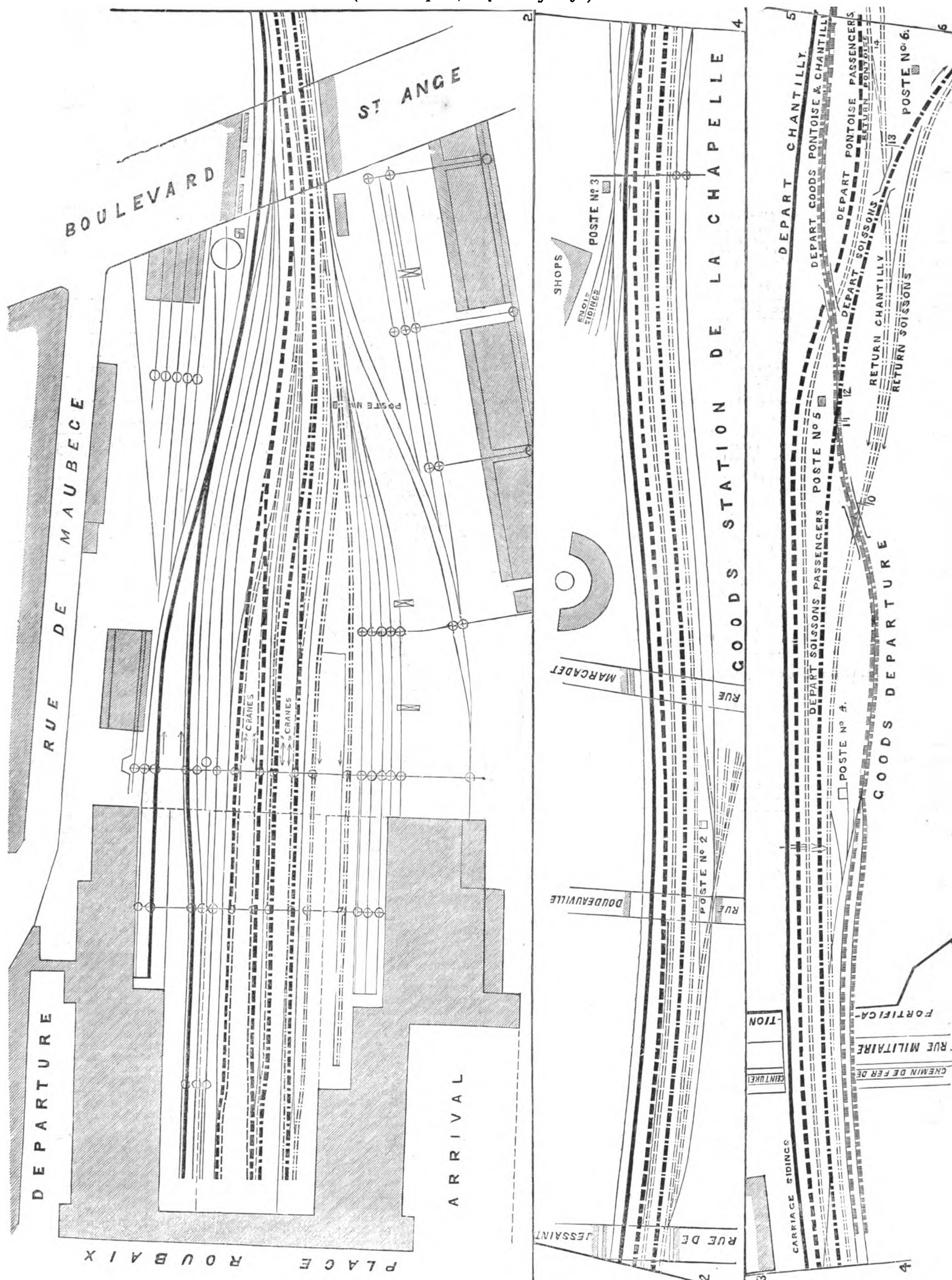
I am, Sir, your obedient Servant,

A YOUNG ENGINEER.

London, November 4, 1867.

LINES OF THE NORTHERN OF FRANCE RAILWAY: PARIS TERMINUS.

(For Description, see preceding Page.)



STEAMBOATS FOR THE DUSSELDORF AND COLOGNE STEAM NAVIGATION COMPANIES.

CONSTRUCTED BY MESSRS. L. SMITH AND SON, KINDERDYK AND ENGINEERED BY MESSRS. RAVENHILL, HODGSON AND CO., ENGINEERS, LONDON.

FIG. 1.

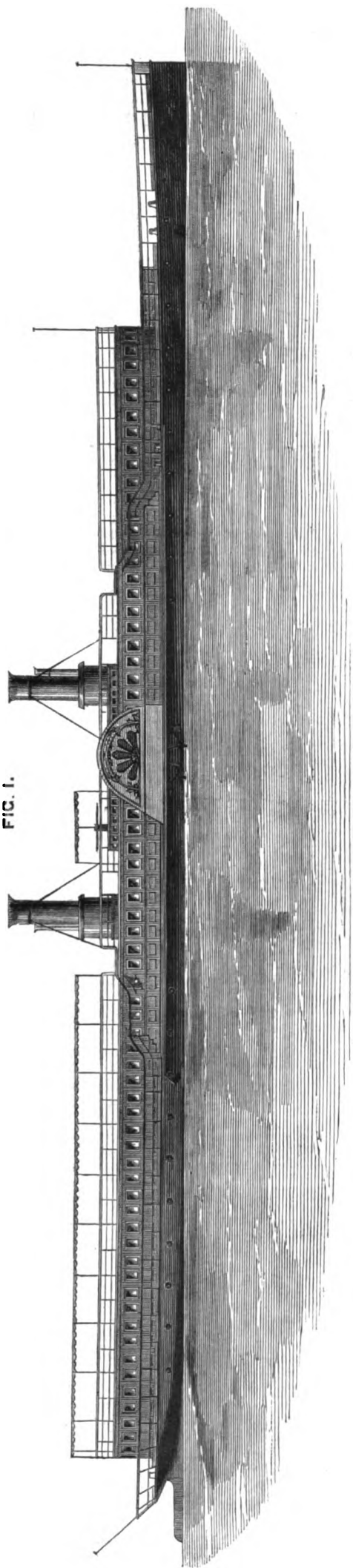
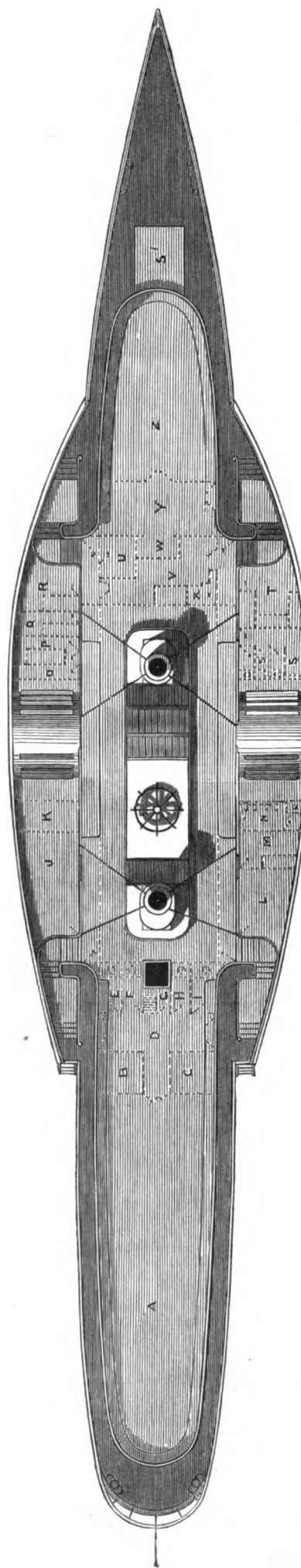


FIG. 2.



We give, above, engravings showing an elevation and plan of one of a couple of new steamers lately built for service on the river Rhine. These steamers were ordered by the Dusseldorf and the Cologne Steam Navigation Companies, with a view of offering further facilities to those travellers or tourists who chose to follow their route to the interior of Germany, and they have been constructed so as to combine a high speed with spacious accommodation. The vessels have been built from the designs, and under the immediate superintendence of Mr. Hide, of Fenchurch-street, the vessels themselves having been constructed in Holland, at the yard of Messrs. L. Smith and Son, of Kinderdyk, and the engines having been made by Messrs. Ravenhill, Hodgson and Co., of London.

The vessels are provided with all the usual accommodations of a Rhine steamer, but on a very much larger scale than has previously been attempted for that river; and the chief difficulty to be met in designing them was the smallness of the draught to which they had to be limited to enable them to pass safely over the numerous shallow places with which the parts of the Rhine, over which they have to work,

abounds. This required shallowness of draught has, however, been very successfully obtained, the vessels only drawing 36 in. of water, whilst, by the judicious use of iron and steel, combined in their construction, a large amount of accommodation of the class required for passenger traffic has been secured. The principal dimensions of the vessels and engines are as follows:

Length on water-line	240 ft.
Beam	25 "
Draught of water	3 "
Length of main saloon	60 "
" fore "	35 "
Engines:	
Diameter of cylinders	46 in.
Number	2
Length of stroke	4 ft.
Diameter of paddle-wheels at centre of motion	13 ft. 6 in.
Length of floats	10 ft.
Width	2 ft. 8 in.

The references to the letters marked on the plan are as follows:

A, saloon.	O, fresh provisions.
B, buffet.	P, maids.
C, wardrobe.	Q, mates.
D, gangway.	R, captain.
E, ladies' toilet.	S, 2nd class W. closets.
F, ladies' W. closet.	T, firemen.
G, steward's stores.	U, restaurant.
H, gentlemen's W. closet.	V, kitchen.
I, gentlemen's toilet.	W, buffet.
J, smoking-saloon.	X, sailors' galley.
K, ice-room.	Y, gangway.
L, conducteur.	Z, fore cabin.
M, 1st and 2nd class engines.	S', sailors.
N, 1st class W. closet.	S'', steering-wheel.

The steamers above described have attained a high rate of speed, and we have no doubt that the liberality of the companies in ordering such vessels will be amply repaid by a large increase in their receipts, whilst there will also be a corresponding increase in the comfort of tourists.

THE KINGSTON FLOATING DOCK.—The Windmillcroft Dock—a new tidal harbour which has been for the last two or three years in course of construction, for the purpose of relieving the harbour proper to some extent—now named the Kingston Dock, was opened on Thursday last. Contrary to expectation, the opening was attended with a good deal of ceremony, including the entrance of the Clyde Trustees and many public citizens on board one of the trustees' tug steamers, the towing into the dock of several ships laden with grain, and toast-drinking and speech-making in a spacious marquee on the quay. The sheds and some other things are not yet completed, nor is the bed of the dock dredged sufficiently deep yet; but the demand for harbourage is so very great that the trustees were compelled to call the dock into requisition so soon as its conveniences justified them in doing so. One of the most notable things about the Kingston Dock in the engineering is the iron swing bridge over the entrance to the dock, a width of about 100 ft. The whole length of the bridge is about 180 ft. The work of constructing the bridge was performed by the well-known engineering firm, Messrs. John Yule and Company, of Glasgow.

KRUPP'S STEEL ORDNANCE AND PROJECTILES.

THE illustrations on page 433 show some further details of the construction of steel ordnance and shot, as made at the celebrated steel works at Essen. Figs. 1, 2, and 3 represent the breech-loading arrangement, invented and patented by M. Krupp, and adopted by him for guns of larger sizes, say up to 9 in. bore. The breech-piece is cylindro-prismatic, and in principle this breech arrangement is the same as that adopted for the smaller guns, and described in our number of the week before last, page 387. The difference between the two systems consists only in the details of the mechanism for opening and closing the breech, since the simple and quick working arrangement used for the smaller guns could not be conveniently handled if applied to large guns, on account of the insufficiency of the muscular power of the gunners. The wedge-piece is in this case moved in and out of the gun by a flat-threaded screw, H, Fig. 1, which runs across the breech, and works upon the thread of a half-nut, S. The end of the screw is held by a collar, R, so as to be attached to the wedge-piece, while the half-nut is attached to the solid breech of the gun. A handle being attached to the end of the screw, H, at F, and turned, the screw will bring the wedge-piece out of the gun, or move it back into its seat, according to the direction in which the loader is being turned. This movement is used only for the quick removal and insertion of the wedge, and a second contrivance is required for giving the final pressure, so as to bring the wedge home to its seat, and close the gun gas-tight. For this purpose a second more powerful screw is provided, and sunk with its nut into the body of the wedge-piece. It is shown in section at F and G, Fig. 1. This screw comes into action after the wedge-piece has been so far brought home into its seat as to allow of the insertion of the stop-pin, B, by means of the handle, D, working the screw, C. The stop-pin passes into the groove provided in the steel piece, F, which forms the nut for the screw, G. As soon as the nut is arrested in its movement by the stop-pin, B, the action of the screw, G, can be brought into play, and this screw pushes the wedge-piece home into its seat, using the stop-pin as a fulcrum for the thread of the nut. The same handle is used for working the two screws, G and H, since the two never work simultaneously. The operation of opening and closing this breech is quicker than may at first sight be supposed from examining these drawings. The two screws are moved one after the other by the same man who keeps the handle in his hand, and sets it on to the end of either screw as required. Another man attends to the insertion and removal of the stop-pin at the proper moment, and after a short exercise the gunners work together with great precision and rapidity. The largest kinds of Krupp's guns have another breech arrangement, yet similar to those two in principle, i.e., the cylindro-prismatic wedge. We illustrated M. Krupp's large gun at the Paris Exhibition on page 480 of our third volume, where this breech arrangement is shown.

Figs. 4 to 10 show different sizes and constructions of projectiles made by M. Krupp. Figs. 4, 5, 6, and 7 show solid shot of cast iron covered with lead for the 4-pounder, 6-pounder, 12-pounder, and 24-pounder guns respectively. The weights are as follows:

Shot.	4 lb.	6 lb.	12 lb.	24 lb.
	lb.	lb.	lb.	lb.
Solid iron core ...	7.0	11.9	26.6	52.3
Lead casting ...	3.1	5.5	10.5	16.3
Total ...	11	17.4	37.1	68.6

Fig. 9 shows a flat-fronted steel shell coated with lead for an 8 in. gun (English measure); the front is not made quite plain, but rounded to a large radius, as shown in the drawing.

Fig. 8 is a shell with a sharp point somewhat similar to Major Palliser's construction. This is 8 in. (Prussian) diameter; the steel body weighs 143.3 lb.; the lead coating, 44 lb.; the bursting charge is 2.7 lb., making the total weight of this projectile 190 lb.

Annexed are the results of some experiments made with M. Krupp's guns:

These trials were made at Essen on the 25th of November, 1866, and the following days, ending 2nd of December, 1866, in the presence of General Major Neumann and of several other officers. The guns tested were three 4-pounder steel guns with breech-loading arrangements of three different constructions. They were selected from a number of 400 guns of the same kind now in course of manufacture for the Prussian Government. The principal dimensions are, length of barrel, 74 in.; length of rifled bore, 47.85 in.; length of cylindrical chamber, 18.20 in.; diameter of bore, 3 in.; diameter of chamber, 3.16 in.; number of grooves, 12; pitch, 137 in.; thickness of metal at chamber, 1.72 in.; at the mouth, 1.25 in.; diameter of trunnions, 3 in.; weight of each gun, 516 lb.; weight of the breech-pieces 40 lb., 60 lb., and 55 lb.; weight of loaded shell, 8.6 lb.; charge of powder, 1 lb.

The breech arrangement of No. 1 gun consisted of double wedges, both of square section, and closed by means of a screw fixed to the wedge placed at the back; the gun No. 2 had a double wedge, consisting of a square front wedge and one of half-round section at the back; and No. 3 was arranged with Krupp's patent single wedge, opened and closed by means of a quick-threaded screw having its nut in the solid portion of the breech. The weakest section of the breech at the seat of the wedges was about 26 square inches in each of the guns. All other details were alike in all the three guns. The trials were made for the purpose of ascertaining the strength of the guns and breech-pieces with increasing charges. For this solid shot of 10½ lb. each was employed also for testing the tightness of the breech arrangement with small charges and with imperfect materials for the packing-discs inserted with each charge. For the former point, shell of 8 lb. weight has been chosen, and for the latter some plates made purposely of brittle cast iron were employed instead of the proper discs. Some cylindrical pieces of 3 in. diameter, 12 in. long, of 20 lb. weight, and 2 ft. long, weighing 40 lb., were also kept in readiness.

The charges fired from each gun are shown in the following Table:

Number of rounds.	Charge of powder.	Projectile.	Cylinder.
10	2.	lb.	
10	0.3	solid, 10½	none.
10	0.2	shell, 8.6	{ for testing the packing with small charges.
10	0.2	solid, 10½	{ none
10	0.2	"	"
10	0.2	"	"
10	0.2	"	"
150	0.2	"	"
1	0.2	"	{ with cast-iron packing-disc.
1	0.2	solid, 11	{ cylinder, 12 in. long, 20 lb. weight.
1	0.2	"	{ cylinder, 24 in. long, 40 lb.

The above was the extreme test of the programme, and the further trials were made to ascertain the final strength of the guns.

Number of rounds.	Charge of powder.	Projectile.	Cylinder.
1	3	lb.	lb.
1	3	solid, 11	60
1	3	"	80
1	3	"	100
1	3	"	20
1	3	"	40
1	3	"	60
1	3	"	80
1	3	"	100

With the last charge the powder filled the entire space of the chamber, and the projectile with the cylinders completely filled the barrel, and the latter even projected 17 in. in front out of the muzzle of the gun. With this extreme charge all three guns showed very nearly equal signs of destruction, viz., a widening of the chamber by about ¼ of an inch in diameter. The breech pieces did not show the same equality of resistance. No. 3 proved the best in every respect, and remained in perfect working order after the tests. No. 2 also remained intact, but showed an inferior degree of lightness towards the end of the trials, and No. 1 commenced to give way with the 3 lb. charges of powder. The screw and nut required to be exchanged for continuing the trials, but they failed a second time. Still, it was possible to conclude the experiments with No. 1 gun, same as with the others. The cast-iron packing discs used in some of these trials broke as intended when the respective charges were fired, yet the damage done to the breech-piece or wedge was so unimportant that it did in no way affect the continuation of its functions. The conclusions arrived at were, that the guns are of sufficient strength, and that all three modes of breech fastenings are sufficiently good for military purposes, preference being given to the breech-piece No. 3.

TRADE OF THE MERSEY.—The export trade of the Mersey appears to be temporarily depressed. The value of the exports from the great river in September was 6,355,990£, presenting a decrease of 1,482,746£ when contrasted with September, 1866. The exports from the Mersey in the nine months ending September 30 this year were valued at 57,938,049£, against 67,149,487£ in the corresponding period of 1866.

DONCASTER.—Mr. Rawlinson, C.E., has delivered a report on the sanitary condition of this town. He suggests that the town should obtain its water supply from the springs at Horton Roberts, and that it should be conveyed thence in pipes along the turnpike road. Mr. Rawlinson further proposes that the sewage of the town should be applied to irrigation purposes.

ROYALTY AND RAILWAY SIGNALS.—Messrs. Saxby and Farmer, who have so successfully upheld the supremacy of our English system of railway signals at the Paris Exhibition, where they have been rewarded by a gold medal, and received the personal commendation of the Emperor Napoleon, have likewise received a royal compliment from the court of Berlin. By permission, Messrs. Saxby and Farmer presented to the Queen of Prussia a set of beautiful photographs, illustrating their system of signals in use at Cannon-street, Charing-cross, and other important places, and have been honoured by the following gracious and flattering letter of encouragement from the Queen's private secretary: "Her Majesty the Queen of Prussia has ordered me to express her thanks to you for the photographs you sent her; she congratulates you on your ingenious invention, which excited her interest on her last journey to England, and of which these photographs give so good an idea."

RAILWAY EXTENSION.—**OPENING OF THE DENBURN JUNCTION.**—The junction line of railway connecting the Caledonian line with the Great North of Scotland system at Aberdeen has just been opened for public traffic. Hitherto the only means of communication between the two railways named has been by a line of rails along the quays at Aberdeen, and as the companies had no authority to use locomotive power, which indeed would have been impracticable, or at least dangerous, on crowded quays, only goods carriages were run between the two stations, through passengers having to go by "bus a distance of over a quarter of a mile. The junction now opened goes through the heart of the city by the valley of the Denburn. The works, which were undertaken by the late Scottish North-Eastern Company, the Great North of Scotland contributing, under the Act, a considerable proportion of the cost, include two short tunnels, and also a magnificent joint station, south of Union Bridge, where all the passenger traffic reaching Aberdeen will now be concentrated. The station is 500 ft. in length and 202 ft. broad, and the roof alone cost 90000£. The line of railway newly made and now opened is only a mile and a half in length; but as a good deal of house property had to be bought, its construction has been very expensive. By means of this short line there is now an unbroken communication between the extreme north and south of the kingdom. The Denburn Junction line, short as it is, has been about two years and a half in course of construction.

MANUFACTURE OF GUN-COTTON.

(Continued from page 408.)

THE pulping machinery at Messrs. Prentice's works is, as we have already stated, driven by a water-wheel. The pulping machines, of which there are two, are similar to those employed in paper-mills. Each machine consists of a kind of trough of O form in plan, this trough having a central longitudinal partition of a length about equal to its parallel sides. On one side of the partition, at the centre of the length of the trough, is placed a cylinder, or drum, revolving on a horizontal axis, this drum carrying the beaters or cutters, which, acting in conjunction with the cutters fixed at the bottom of the trough, tear the cotton to pieces, and reduce it to pulp. The drum is placed so that as it revolves, its cutters come almost in contact with those fixed at the trough bottom; and the fixed cutters being inclined to the direction of the axis of the drum, the latter, as it revolves, draws the cotton over them, and gives rise to a kind of combined cutting and abrasive action. The trough is nearly filled with water, in which the cotton is placed; and on the drum being started, its action causes a sufficient current to be set up round the central partition to keep the cutters supplied with material, the mixed water and cotton being, however, kept stirred up by an attendant.

The process is continued until the material is reduced to the required pulpy consistency, when it is ready either for being formed into mining charges, or being made into paper, which is afterwards used for cartridges for small arms. For the latter purpose, however, the pulp is not made of gun-cotton solely. Paper made entirely of gun-cotton would burn too rapidly, and, in consequence, have too violent an explosive action, to be used advantageously for making small-arm cartridges, and to avoid this violent action the pulp for this paper is made partly of gun-cotton and partly of ordinary cotton, the proportion of the latter being varied according to the amount of "retardation" which it is desired to obtain. This method of regulating the rapidity of combustion of the "gun-paper," as it may be called, is due to Professor Abel, and it is an admirably simple and effective one, and what is more, it gives as good results when the explosive is contained in a gun as when it is burnt in the open air. This was not the case with Baron von Lenk's plan for obtaining the same end. The Austrians endeavoured to moderate the explosive power of the gun-cotton in their cartridges by subdividing the material into a greater or less number of portions, which it was intended should be fired successively, the cotton being in some cases, for instance, disposed in a series of concentric cylindrical coils separated from each other by paper tubes. These plans were very ingenious, and when the cartridges were ignited in the open air appeared to give tolerable results; but in practical use the case was different. When confined in a gun, the explosion of the first portion of such a cartridge was liable to destroy the whole of the arrangements for insuring the successive ignition of the other portions, and the consequence was that, practically, but little, if any, moderation of the explosive power of the cotton was effected. On the other hand, in Professor Abel's "retarded paper," as it is termed, the particles of gun-cotton are separated to a greater or less extent by the intervening particles of ordinary cotton, the extent of this separation depending upon the amount of ordinary cotton contained in the pulp. This subdivision of the explosive material is effected throughout the whole of the paper of which the cartridge is composed, and it is evident that it is effected in such a manner that the explosion of the portion first ignited can in no way affect the remaining portion.

Altogether, this system of making "retarded" paper—or we should rather say pulp, for the latter need not necessarily be made into paper—appears, theoretically, to afford the means of regulating with the utmost nicety the explosive power of the gun-cotton, and this theoretical deduction seems to be fully borne out by the practical results obtained. Of course, a great deal of experimental research has been necessary to ascertain the best proportions of ordinary cotton to be mixed with the pulp for different purposes; but Messrs. Prentice have spared no trouble of this kind, and we believe that they have now definitely settled upon the strength of "retarded" paper which it is best to employ for different classes of small-arms.

The pulp for making the retarded paper is reduced to a finer consistency than that used in the manufacture of the mining charges, and to prevent mistakes, a small quantity of colouring matter is mixed with it, and the paper produced has thus a pink tint. The paper is all made by the ordinary hand process, the

sheets being, perhaps, about 20 in. by 15 in. Of the subsequent treatment which these sheets receive we shall speak presently, when describing the manufacture of cartridges.

We have said that the cotton after conversion is, in addition to the first "drench-bath," subjected to eight successive washings and dryings, and when besides these the effect of the subsequent pulping process is considered, most persons would imagine that the cotton had, by the time it was made into pulp, been thoroughly cleansed from the slightest trace of acids. The importance of completely freeing the cotton from any acids is so great, however, that at Stowmarket the pulp is, at the suggestion of Professor Abel, as an extra precaution, finally treated with an alkaline solution containing about 1 per cent. of carbonate of soda. The special object of using an alkaline solution in this way is as follows: The cotton used in the manufacture, notwithstanding the great care bestowed on cleansing it, generally contains a small proportion of foreign matters, and these matters, when acted upon by the nitric acid, produce organic (nitrogenised) impurities of comparatively unstable properties, the amount of these impurities depending, to a great extent, upon the care with which the cotton has been cleansed previous to conversion. When the gun-cotton is exposed to the action of heat, these impurities give rise to the development of free acid, and this acid in its turn exercises a destructive action on the cellulose products, and establishes decomposition. By treating the finished gun-cotton, however, with an alkaline solution, the free acid, developed in the way above explained, is neutralised as it becomes nascent, and it is thus prevented from exercising any injurious influence. The introduction of the alkaline carbonate in no way interferes with the effective action of the cotton as an explosive, although it is possible that it may very slightly retard its combustion, and may cause a trifling addition to the amount of smoke given off whilst its combustion is taking place.

We have said that two kinds of pulp are prepared at Stowmarket, the one being that employed for making the "retarded" paper, and the other being used for manufacturing mining charges. We shall describe the subsequent treatment of the latter description of pulp first.

For making the mining charges, the pulp is first placed in a centrifugal machine, and as much water expelled as is possible by such means. When removed from the machine, the pulp is not completely dried; but the proportionate quantity of water which it contains is known, so that it can be weighed up into charges as accurately as if it was dried perfectly. The weighing of the dried pulp is effected by a number of girls, the weighing scales being situated in a light wooden building. Each charge on being weighed is placed in a small tin vessel, in which it is conveyed to the pressing-house, where the charges are again moistened with water. The sole object of temporarily drying the pulp is, in fact, to enable it to be accurately weighed out into charges, and after this weighing has been effected it is kept moist in all stages of its manufacture until it is subjected to the final drying process.

The charges are first hand-pressed, and are then subjected to a more severe pressure by the aid of machinery. The hand-pressing is effected by boys as follows: Each charge, after being moistened with water, is transferred from the tin cup containing it into a cylindrical mould or tube, the internal diameter of which is equal to the external diameter of the intended charge. At first these tubes were made solid at the lower end; but it was found that the gun-cotton or pulp charge, when introduced into them, formed a kind of piston, below which the air contained in the tube became compressed, and under these circumstances it was found impossible to get the charges fairly home to the bottom of the tubes. This difficulty has been got over in a very ingenious manner. Instead of the tubes being made completely closed at the lower end, the latter is perforated, and the solid bottom on which the charge rests is formed by a piston, with which each tube is fitted. This piston is furnished with a rod, which passes up through the centre of the charge, forming a hole through the latter, which enables the charge to be ignited from end to end by the flash of the portion first lighted. In the case of charges, the diameter of which exceeds about 1½ in., the pistons of the moulds are furnished with two rods, one of these forming the central hole, and the other a hole nearer the circumference in which the end of the igniting fuse can be placed.

To return, however, to the process of pressing, the piston being first placed in the mould, and pushed in a small distance, the charge is rammed in on the top of

it, and then on the piston being forced down to the bottom of the mould by the aid of its rod, the atmospheric pressure on the top of the charge causes it to be carried down in close contact with the piston. A hollow plunger, perforated at the bottom and sides, is next placed in the mould, the end of this plunger having a hole, or holes, in it, through which the rod, or rods, of the piston can pass; and the whole is then placed under a hand-lever, by which the plunger is forced down on the charge, and the latter compressed to some extent. The charges, on being removed from the moulds above described, are next subjected to a more severe pressure by steam power. Two machines are used for this purpose, one of them, which is used for the larger charges, being a specially fitted-up hydraulic press, and the other somewhat resembling a slotting-machine in its general appearance. The slide of this latter machine, however, instead of carrying a cutting tool, is fitted with three plungers, which act upon each charge successively. The charge to be pressed is placed in a cylindrical mould carried by a horizontal circular table, having an intermittent rotary motion. By one movement of this table, the mould is brought under the first plunger of the slide, which partially compresses the charge, and, on the return stroke of this plunger, the further movement of the table brings the charge under the second plunger, which on making its next stroke completes the compression. A third movement of the table brings the mould under the third plunger, which on its descent forces the charge out of the mould, the latter having, by this third movement of the table, been brought over a hole through which the false bottom of the mould and the charge can pass. A fourth movement of the table brings the mould into a position where it can receive a fresh charge. The moulds and plungers are formed so as to allow of the escape of the water expressed from the charges, and the revolving table is supplied with several moulds, so that the processes of partial compression, complete compression, and the expulsion of the charges are carried on simultaneously, there being always three charges under operation.

For effecting the compression of the larger charges, an entirely different apparatus is employed. This consists of a horizontal hydraulic cylinder, the main plunger of which is furnished with a head carrying a number of small plungers for compressing the charges, these plungers being arranged in parallel rows one above the other. Facing the plunger, is the fixed head of the press upon which the pressure is received, and between this and the press cylinder is placed a block of zinc perforated to receive the charges, and also another block, the use of which will be explained presently. Both these blocks are capable of being slid on one side, the lateral movement enabling the uncompressed charges to be placed in the zinc block. The second block, which is of iron, has, we should mention, a number of pieces of zinc let into it, at the points at which the charges directly bear upon it. The method of using this apparatus is as follows: The charges to be compressed having been placed in the holes in the zinc block, the latter is brought into its proper position in front of the plungers with the second block behind it, and secured by a simple contrivance provided for the purpose. Water is then forced into the press by pumps worked by a small steam engine close at hand, when the plungers enter the holes containing the charges, and compress the latter to the required extent. The water-pressure is next removed, and the plunger allowed to recede to a sufficient extent to leave the second block loose. This block is then run on one side, and a box furnished with as many shelves as there are rows of charges being substituted for it, the water-pressure is again put on, and the plungers, advancing, force the charges out of the holes in the zinc block into the box placed to receive them. The press is, of course, furnished with a number of zinc blocks and sets of plungers corresponding to charges of different diameters, and the arrangement is found to be a very efficient one.

The next process undergone by the charges after pressing is that of being covered with a peculiar kind of paper, termed "artificial vellum." This "artificial vellum," which is manufactured by Messrs. Prentice on their own works, is made by laying sheets of blotting-paper for a few seconds on the surface of strong sulphuric acid contained in a suitable bath. The paper, after being subjected to the action of the acid, is immediately washed by plunging into troughs containing water, and on its removal from these troughs, it is ready for use. The process of manufacturing this material is a very interesting one to witness, the "artificial vellum" being a tough semi-transparent substance so entirely different to the blotting-paper from which it is produced, that it is almost difficult

to believe that the transformation could be effected by such simple means. The artificial vellum is cut into strips, rolled around the charges, and secured by paste, the operation of covering the charges being performed by girls.

After being covered, the charges are ready for the final process of drying; and this drying is effected by the aid of steam, the drying stove being situated at some little distance from the sheds in which the other processes are carried on. The stove consists of a small brick erection enclosing the steam-pipes, the top of the brickwork being fitted with a number of vessels in which the charges to be dried are placed. The vessels are separated from each other by division walls carried up between them, so that, in the event of the contents of one vessel becoming ignited, the flame will not be communicated to the other vessels, and they are protected from the weather by light hoods placed over them. The charges are dried at a temperature of about 140°, and efficient means are provided for ensuring that the temperature shall never rise above a perfectly safe limit.

(To be continued.)

THE GRAND TRUNK RAILWAY.

CAPTAIN TYLER and Mr. Eborall, who went over to America at the beginning of September, on the invitation of Mr. Watkin, to inspect the Grand Trunk Railway Company, were met in New York by Mr. Brydges, the managing director, upon their arrival. They visited Baltimore and Washington, making an inspection of the lines in that direction, and arrived at the Falls of Niagara on Saturday, the 5th October. There they were met by Mr. Waite, of Foster and Braithwaite, and Mr. Shaw, of Shaw and Thompson, of London, who accompanied them as far west as Chicago, the Illinois Central Company giving them a car to go fifty miles into the prairies. At Detroit, on their return, the work of inspecting the Grand Trunk system began, and Captain Tyler and Mr. Eborall only reached Montreal on the 17th October. On the 20th, they proceeded to Portland, and will return to England about the middle of this month. The report of two gentlemen so well conversant with railway plant and railway policy cannot but be of great importance to the shareholders, and it will be looked forward to with great interest. The public of Canada complains loudly of the impaired state of the line, and it is to be hoped that a railway of so much importance to the new dominion of Canada may be thoroughly equal to any other line on the American Continent. In Canada, jobbery, the system of granting passes without adequate reason, and continual irregularity in the arrival of passenger and goods trains are the chief causes of the disfavour with which the line is at present regarded.

CONTRACTORS' LOCOMOTIVE.

We give, on the next page, an engraving showing a longitudinal section and plan of the tank locomotive exhibited by Messrs. Ruston, Proctor and Co., of Lincoln, at the late Paris Exhibition. It is an outside cylinder engine, with four coupled wheels, intended for contractors' purposes, and it is adapted for coal-burning. The principal dimensions are as follows:

	ft. in.
Diameter of cylinder	0 9
Stroke	1 4
Diameter of wheels	2 9
Wheel-base	5 0
Distance from centre of leading axle to inside of leading buffer-beam	4 1
Distance from centre of trailing axle to inside of trailing buffer-beam	6 2
Distance from centre of trailing axle to front of firebox casing	0 6½
Transverse distance between centre lines of cylinders	6 0½
Inclination of cylinders 1 in 12	
Length of barrel of boiler	7 0
Diameter of " " inside largest plate	2 10
Thickness of barrel plates	0 0½
Length of firebox casing, outside	3 0
Width	2 10½
Depth of " " below centre line of barrel	3 0
Length of copper firebox, inside	2 4½
Width	2 3½
Height	3 4½
Height of centre line of barrel above rail level	4 2½
Length of smokebox, inside	1 10
Diameter of chimney	0 8½
Diameter of blast-nozzle	0 2½
Diameter of tubes, outside	0 2
Number of tubes, 64.	
Heating surface of tubes, outside	242.5
" " firebox	32.5
Total heating surface	275.0

CONTRACTOR'S LOCOMOTIVE AT THE LATE PARIS EXHIBITION.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR AND CO., ENGINEERS, LINCOLN.

FIG. 1.

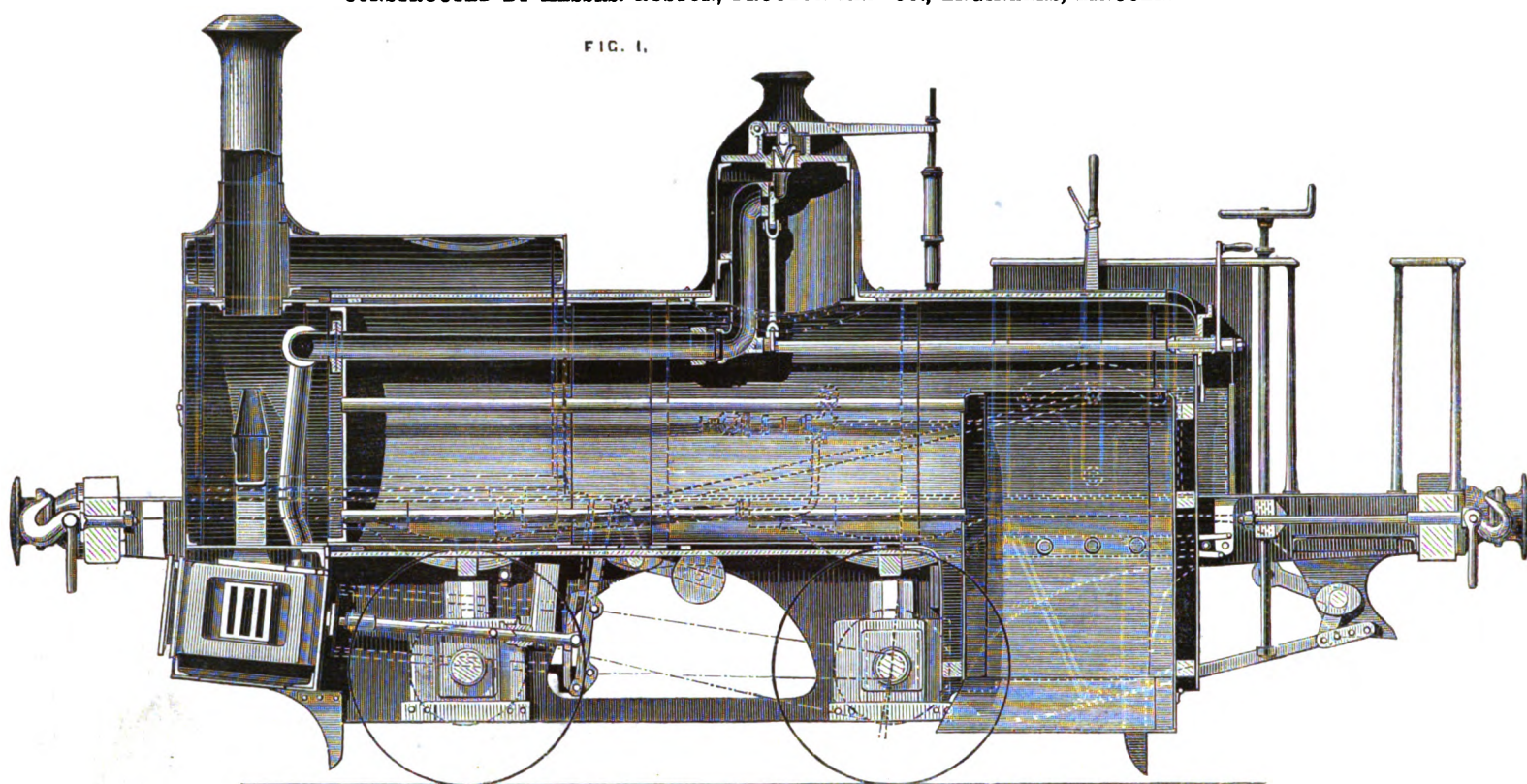
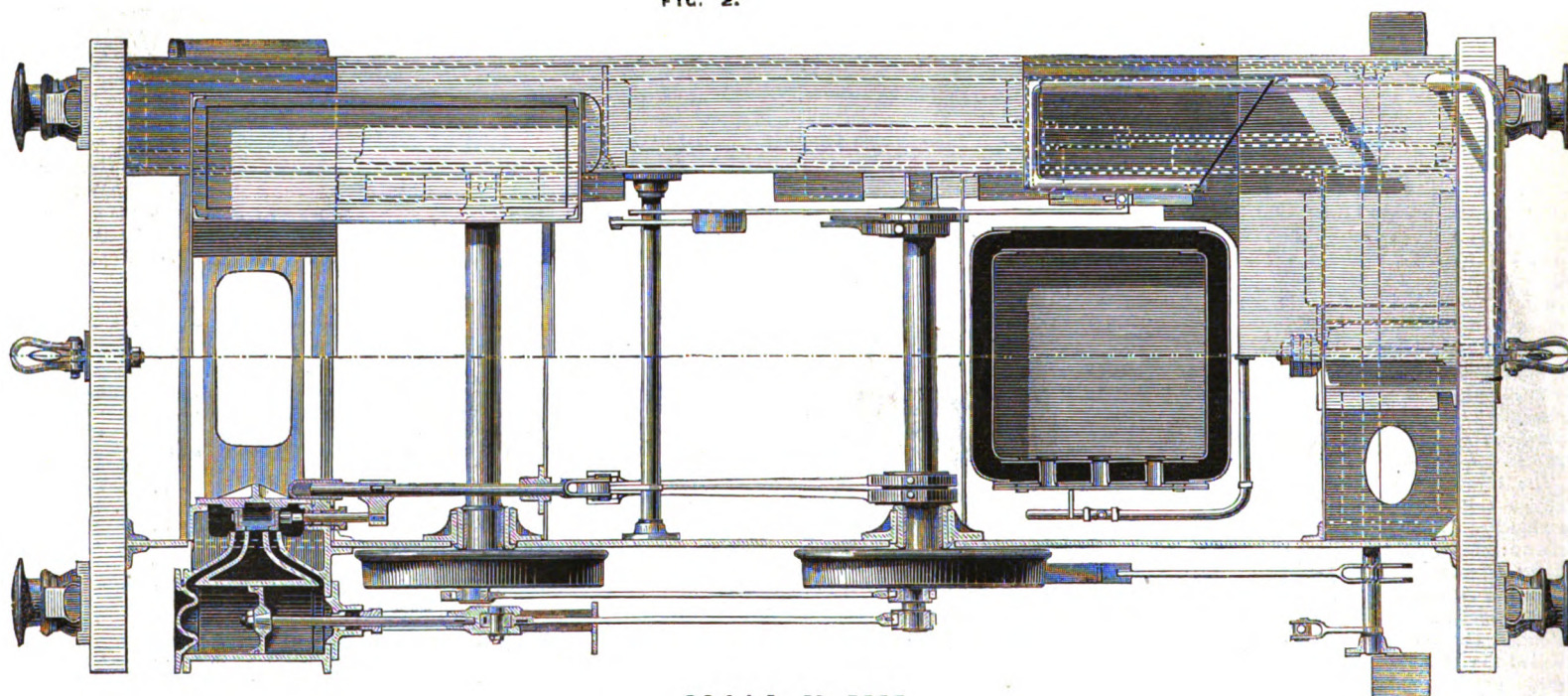


FIG. 2.



SCALE OF FEET.

12 0 1 2 3 4 5 FT.

Area of firegrate ...	5.5 sq. ft.
Transverse distance between frames ...	4 2½
Thickness of frames ...	0 0½
Extreme width over footplates ...	6 10
" " buffer-beams ...	7 3
Capacity of water-tank, 250 gallons.	

The firebox shell and smokebox are flush with the barrel of the boiler. The copper box is comparatively large, and is fitted with Clarke's smoke-consuming apparatus. With a view of increasing the efficiency of the latter, the air-holes on opposite sides of the firebox are arranged alternately, and are also provided with double regulating-slides. Each pair of slides has holes in it corresponding to those in the firebox, and, by moving the slides in opposite directions, the admission of air can be varied considerably without interfering with the steam-jets. The fire-door has an air-slide, and an inclined deflector plate, and there is a steam-jet in the chimney.

The saddle-tank is placed over the smokebox, and rests on the foot-plate on either side. This forward position prevents an excess of weight on the hind wheels, the common fault of

four-wheel engines. There is an equal weight on each wheel when the tank is three-quarters full, notwithstanding the large firebox and ample footplate.

The boiler is fed by a pair of Sellers's patent self-adjusting injectors, with Gresham's patent self-closing overflow valves; and conical valves are cast on the steam spindles, so as to render separate steam-valves unnecessary. The injectors are attached to the barrel of the boiler, and internal steam-pipes lead from them to the steam dome. The overflows return to the tank.

The slide-valves are Adams and Parsons's patent balanced valves, and the valve-spindles are worked from guide-rods, in order to reduce the length of the steam-ports. The valve-gear is of the shifting-link kind, and the distribution of steam given by it, as measured from a model, in percentages of the stroke of the piston, is as follows:

Notch.	Front Stroke.		Back Stroke.	
	Suppression.	Release.	Suppression.	Release.
1	75½	90½	76	91½
3	53½	79½	53½	80
5 mid gear	15	5½	17½	55½

Backward Gear.

Notch.	Front Stroke.		Back Stroke.	
	Suppression.	Release.	Suppression.	Release.
1	76½	91½	78	93½
3	50½	79	50½	82
5 mid gear	13	4½	13	46

The side frames are cut out of single plates, and the piston-rods, valve-rods, connecting-rods, coupling-rods, crank-pins, axles, and tyres are all made of Bessemer steel. The engine is, in fact, made of the best materials throughout.

THE AGES OF NATIONS.—Lord Bacon says in his essay on Vicissitudes of Things, "In the youth of a State, arms do flourish; in the middle of a State, learning; and then both of them together for a time; in the declining age of a State, mechanical arts and merchandise." Certainly mechanical arts and merchandise have somewhat pushed aside arms with England; but we refuse to believe that the old spirit is dead. It sleeps, perhaps, only too soundly, and the shaking given us by European wars close beside us, and an Abyssinian expedition to defend our honour, may have the good effect of rousing us to a sense of the danger incurred by the unready, whether Saxons, Romans, or Austrians.

LOCOMOTIVE WORKSHOPS.

OTHER things being equal, the greatest economy of production in factories is secured where the cost of labour, the interest on capital, and the maintenance and working of the machinery and plant are, when taken together, a minimum. A single workman, however, at 36s. a week, or 93*l.* 12s. a year, represents the interest, at 5 per cent., upon 1861*l.* of capital, and if the power required, the attendance, and the depreciation and repairs of a machine which shall save the labour of only one such workman amount to but 50*l.* a year, it will be cheaper to expend at least 500*l.* or even 750*l.* upon it, and to dispense with the man.

There is now but little difference of opinion among locomotive engineers as to the desirability of placing all the machinery of a locomotive workshop, whether for construction or repair, upon a ground floor, both because of the value of the overhead light, which may thus be admitted through the roof, and because the lifting of weights from one floor to another is thus avoided. A workshop, however, of which from one-third to one-half its width, along the middle, is open from the roof to the floor, and having galleries along each side, presents some advantages. The heavy tools are then ranged along each side, on the ground floor, the engines in course of construction or repair occupy the middle space, under the travellers, which span the distance between the galleries, and upon the latter the lighter tools and vices are placed, and which require but little head-room and short belts, but which need abundant light, both from the sides and from overhead.

Every locomotive shop, whatever its size, should be provided with gasworks of the kind made by Mr. Porter, of Lincoln, Mr. Bower, of St. Neot's, or Mr. Holmes, of Huddersfield. No other artificial lighting is so cheap, so cleanly, and so safe. Owing to the necessarily irregular mode of working small gasworks, the economy of clay retorts cannot be taken advantage of, as these require to be heated more gradually and carefully than is possible in such works. But even with iron retorts, the expense of distribution being nothing, gas is still the cheapest illuminating agent, and the coke produced is of ready value in every engine factory.

An excellent flooring is made, as at the Yorkshire Engine Works, Sheffield, of blocks of larch, of almost every diameter, sawn to 6 in. lengths, and placed on end upon a bedding of sand and gravel. This is more durable than bricks, and is more comfortable and healthy for the workmen who have to stand upon it.

With tolerably good water and proper attention, locomotive boilers, or else the Howard or the Field boiler are preferable to Cornish boilers, inasmuch as they can be put down almost anywhere so as to suit the excellent system of small independent engines to each principal line of shafting. The Howard boiler is preferable to the locomotive boiler, as being absolutely safe from explosion, and as maintaining a perfect circulation of water. Messrs. Howard's own extensive works at Bedford, now draw all their steam from these boilers; and Messrs. Clayton, Shuttleworth, and Co. are arranging to adopt them at their still larger works at Lincoln. Of the Field boiler little precise information appears to be accessible, although it has been heard of for a long time. It is a form of boiler designed many years ago by Jacob Perkins, but with the single peculiarity that the internal circulating tubes are flared at their upper ends. Although not less safe than locomotive boilers, the Field boiler is, probably, not more so, as it requires the usual diameter of barrel, or one even greater than would be given to a locomotive boiler. The grate area, too, is necessarily somewhat restricted, whereas, with Howard's boiler, any size of grate may be employed, so as to burn the finest slack coal.

As already said, the best system of engines for the scattered and rambling shafting of a locomotive factory, when laid out upon a single floor, is that of a separate engine, or pair of engines working direct upon each principal line of shafting, as at Messrs. Beyer, Peacock and Co.'s works. Such engines, with proper oil-cups, fitted with wicks and trimming wires, and with suitable lubricators to the slide-valve chests, work with practically no attendance at all, and they are hardly ever out of order. Being generally of small size, the economy by condensation hardly pays for the additional complication of air-pumps, and often there is no sure supply of water for condensation.

As far as possible, the shafting should be carried by brackets fitting to slotted iron wall-plates. The fastening is thus cheap and strong, and a bracket can be readily moved whenever required. Rogers's wrought-iron pulleys, as made by Messrs. Hudswell and Clark,

of Leeds, are the lightest and best, and they may be readily fitted to, or removed from, any part of a shaft. They were fully described on page 13 of our second volume.

For out-door hoisting and traversing, Henderson's derrick crane, not yet known as it deserves to be, will be found the cheapest and most convenient of working. For the travellers, in-doors, the clip drum and steel rope system of the Steam Plough Works, Leeds, possesses advantages over that of the "flying rope," whether of cotton or hide, which is worked elsewhere at speeds of from 15 to 60 miles an hour. We lately illustrated the clip-drum traveller, the steel rope of which works at but three miles an hour, so that there is no gearing up to obtain speed, to be got down again afterwards, and the wear of the rope is almost nil.

A system of water-pressure machinery is of great service in a locomotive factory, and, indeed, in every engine works. It is true that it has the disadvantage that exactly as much power is expended when doing very light work as when doing the heaviest of which the machinery is capable; but its great recommendation is its convenience, and the saving of power in working counter-shafts, &c., of machines when they are not in use. Hydraulic power, whether derived from an accumulator or from a reservoir at a much higher elevation than the factory, as at the River Don Works, Sheffield, is applicable to a multitude of purposes, to cranes, to punching and shearing machines, to stamping-presses, to hauling piles out of the scrapping furnace, &c.

In the foundry, Woodward's steam-jet cupola appears to be now the best in use. Although it may appear a wasteful application of live steam to obtain draught by a jet in a cupola flue, the consumption of coal for raising the steam is found to be but 2 cwt. per ton of iron, and this coal is equal in value to but from $\frac{1}{3}$ cwt. to 1 cwt. of the coke used in the cupola itself. When the cupola is once charged, the consumption of coke is as low as in any other in use, and we hear it said by practical foundrymen who have used the steam-jet cupola that a stronger metal is obtained by reason of the more thorough action of the blast on the iron, but this we will not vouch for. It is certain that much is saved by dismissing the engine and high-speed fan commonly employed, and the steam-jet cupolas now in use deserve to be carefully watched upon all points of working. The steam-jet, like the best varieties of other cupolas, has a drop bottom, and no one who has once worked a cupola with this common-sense provision for convenience and the comfort of the workmen would ever dispense with it.

All the iron should be tapped, not directly into the ladles, but into a receiver lined with fire-clay, and in which a thorough mixture of the metal is obtained. The receiver should tilt upon trunnions in filling the ladles.

Where the steam-jet is not used in the cupola, blast is best obtained for melting, and also for the smiths' fires, by a pressure-machine, instead of a centrifugal fan. Among the best blast-pressure machines are the ordinary direct-acting blowing-engine and Roots's blower, the latter made by Thwaites and Carbutt, of Bradford. The cost of working a Roots blower is far less than that of a fan, the power required not being more than half as great, while, as it works at a low speed, the wear of belting is but trifling.

The "heat-conductors," or hot-water pipes, introduced by Messrs. Perkins, of Seaford-street, Regent-square, London, promise to come into favour for heating core ovens, and they have been already applied to that purpose. They are strong pipes partly filled with water, and are welded up at both ends. They are laid in an inclined position, with one end in a small furnace, and the steam, as it is generated, is again condensed by the radiation of heat, from the surface of that part of the pipe out of the fire, into the core oven. In this way the pipes, under enormous pressure, go on with the original supply of water for years, or as long as they themselves will last. With a sufficient number of pipes and size of furnace, the full heat requisite for core-drying is obtained, and, when properly planned, there is no danger of explosion. There is, of course, rather more waste heat than where the fire is made within the core oven, but the oven is kept clean within, and may be white-washed, and even lighted through thick double windows.

In the smiths' shop a variety of processes and appliances not used in the older works have established themselves in general favour within the last few years. One is that of stamping in dies. At the Yorkshire Engine Works and at the fine works at Fives-Lille, in France, stamping is carried to

a great extent, and the stock of dies is very large. The saving in smiths' labour is very great. Lately a considerable saving of labour has been found to attend the use of Davies's steam-striker, as illustrated in our former volumes, and made by Kennard Brothers at the Viaduct Works, Crumlin. From what we have seen of the working of this machine, we are disposed to regard it as a necessity in every engine-shop. It will strike a regulated blow either vertically or at any angle, and a single machine is available for four anvils.

For certain purposes, like that of forging copper stay-bolts, Ryder's forging machine, although a noisy affair, surpasses all other appliances. For cutting off bar and angle iron in a smith's shop, especially of considerable section, the circular saw, driven by a small independent engine, is the cheapest means, just as it is in a rail-mill. Among the few places where we have seen the saw thus used in locomotive works was at Fives-Lille, France, and the manager would not do without it on any account.

As a matter of course, every locomotive works of any extent will have scrapping-furnaces and steam hammers, wheel-making plant, and thoroughly built case-hardening furnaces, and upon all these we have nothing to say here.

A branch of smithing which deserves general attention, which it has not yet received, is that of welding boiler rings. At all first-class works steam domes are welded up, hemispherical top and all, and at a few works the longitudinal seams of the boiler have been welded. Mr. Bertram brought out a convenient arrangement of double gas fires, a few years ago, whereby plates could be rapidly welded, and he made a Cornish boiler at Woolwich, welded all in one piece, without a rivet in it. In the late Paris Exhibition, Eugène Imbert, of St. Chamond, exhibited a beautifully made tubular boiler with internal firebox, having apparently not a rivet in it. If engineering opinion would but support this superior style of construction, we should soon see the end of the clumsy and even dangerous system of rivetting. Let any one call upon Mr. Woodcroft, at the Great Seal Patent Office, and he may learn how much the workmen of the last century were ahead of us in these matters. He may see two mandarin's helmets, one of polished, the other of blued steel, apparently transparent or translucent, yet perfectly opaque, and weighing each but one pound. There must, one would say, have been welding here, but it is impossible to detect it. Let us try and do a little of this sort of thing in iron plates from $\frac{3}{4}$ in. to $\frac{1}{2}$ in. thick, as we now do in steam domes of greater thickness.

We will not speculate here upon the possibility of forging screw-threads instead of cutting them. We have some specimens of small screwed bolts with threads rolled in while the iron was hot, and the thread is beautiful, only the pitch is not exactly uniform. The average pitch is about 11 to the inch.

The good results attained with the Wilson furnace, at the works of the Bolton Steel and Iron Company, make it worthy the attention of managers of locomotive factories as well as of ironworks. It makes no smoke, and burns all that is combustible of the fuel, no matter whether this is lump-coal or slack.

In the boiler-shop we now expect to find steam-rivetting machines, stay-bolt setting-machines, machines for planing the edges of plates, and, in the best practice, drilling-machines for all rivet-holes. These and the plate-welding furnaces already noticed, and complete appliances for handling boilers so as to bring them, wholly or in their parts, to the machines with the least manual labour, make up the differences between the boiler-shop practice of 1867 and that of 1847-57.

(To be continued.)

THE EUPHRATES VALLEY RAILWAY.

In the last number of the *Practical Mechanic's Journal* there is an article, subscribed by the editor, commending to public favour the scheme known as the Euphrates Valley Railway, as calculated to give new life to our Indian empire, to curb the ambition of Russia, and to checkmate France, who, by the construction of the Suez Canal and otherwise, is sowing the seeds of empire in the East. Undoubtedly it is proper to watch and, if necessary, to counterwork Russia; and we have on former occasions pretty strongly expressed the conviction that our Government has been too supine in this matter. But in what way the Euphrates Valley Railway would subserve this object, or indeed answer any useful purpose whatever, does not by any means so clearly appear, and the editor of the *Practical Mechanic's Journal* does not

contribute any new light towards the elucidation of this topic. The Euphrates Valley Railway is a scheme for carrying a railway from Scanderoun or some other point at the end of the Mediterranean to the banks of the Euphrates, and from thence down the valley of that river to the Persian Gulf. But even if the line had been placed there, it would be completely isolated—communicating neither with the European system of railways at the one end, nor with the Indian system at the other. Nor could the proposed railway ever be made a link in the chain of railway communication between England and the East; for not only is the route ineligible to reach the upper parts of India, but at the bottom of the Euphrates the dreadful deserts and formidable mountains of Beloochistan interpose between that point and India, and even the adventurous projectors of the Euphrates Valley Railway do not propose the continuation of the line through that impracticable country. Then does any one suppose that, if Russia proposes to operate against India, it will be through the valley of the Euphrates that the attempt is made? Most of the tract through which it is proposed that the railway should pass is desert, without traffic, and without population except migratory bands of marauders.

Would passengers commit themselves to such a line? Would merchandise be transmitted by it, especially after the Suez Canal has been opened? We concur in the sentiment that unbroken railway communication between England and India is highly important to the well-being of both countries. But, to serve any useful end, it must be carried through Constantinople, Teheran, and Herat, and must not run down the valley of the Euphrates. Such a railway as the one we have indicated would, indeed, be a bulwark against Russia; whereas the proposed Euphrates Valley and Indus Valley lines are merely Utopian schemes of Mr. Andrew, which pretend to commend themselves to public favour on political grounds, as they have none other to offer. Their political benefits, however, are wholly imaginary; and it is only by an abiding faith in the popular ignorance that the effrontery can be collected to advocate such schemes at all. The Glen-Mutchkin Railway was quite as respectable, and had the advantage of being nearer home.

ANTIDOTE FOR WHITE ANTS.

NUMEROUS have been the attempts made to supply some ingredient which, when applied to timber, should effectually protect it from the ravages of white ants. The destructive effects of these little insects must tell seriously upon the permanent-way maintenance account of the Indian railways; for, contrary to all expectation, it has been found that the vibrations caused by passing trains are not sufficient to make them leave when once they have established themselves in a sleeper. Several trials have been made to prevent their attacks by boiling the timber in poisonous liquids, but to little or no effect. To see the stack of railway sleepers eaten away by these insects is astonishing. The new sleepers are coal-tarred; but that, it has been found, is no preventive against the ravages of white ants, proved by trials made by the telegraph department. The Government of St. Helena, through the Government of Madras, invited remedies, and a reward of 50*l.* was offered to the successful competitor. It is not known who the successful candidate is; but by letters from the Secretary to the Government of Madras, in the Department of Public Works, it rests with Mr. Brown. That gentleman's specific is "teak oil." The oil is extracted from chips which can be procured at any carpenter's yard where teak timber is used. The chips are put into a pot buried in the ground, with a small hole at the bottom. A small pot to receive the oil is placed below, and a brisk fire laid on; the chips will be found charred, and in the lower pot a small quantity of strongly scented oil. It makes a capital varnish. Timber coated with this varnish, as reported to the Secretary to the Government of Madras by the several executive engineers of the Public Works Department, even when placed in a nest of white ants, was not touched, though timber coated with other specifics was eaten away. In large timber-yards this oil would not cost more than ordinary oil. The ends of beams which are embedded in walls should be kept open with a flat tile perforated, to shut out any sparrows from making a residence in the apertures. Timber painted hastily before the sap has dried rots rapidly, and some attention should be given to this by all builders. The cost of this oil in certain experiments made by order of the Madras Government, in 1866, was reported to be 6½ annas

for 1½ ounce—a price which would be prohibitory to its general use; but Mr. Brown stated, at that time, that its cost in the general provinces was only one anna per quart. At this latter rate, teak oil would probably prove the most economical, as it also now appears to be the best antidote to white ants that has hitherto been discovered.

AN IRONMASTER'S VIEW OF STEEL.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with great interest your recent articles on the price of steel rails and on steel-laid railways, and whilst agreeing with some of your remarks respecting steel rails, I think your condemnation of iron rails too sweeping, and your advice to railway engineers and directors respecting the immediate adoption of steel rails in place of iron ones open to question.

Having had some experience in rail-making, and many opportunities of noting the durability of various kinds of rails on some of the principal railways in England since the time you speak of, when the Stockton and Darlington Railway was laid with cast-iron rails (over which I have many times ridden) up to the present time, I trust you will allow me to offer a few suggestions which may tend to the further ventilation of this question.

First, as to the price of steel rails, I think it is quite probable that, as you state, the price will be increased rather than lessened in the future, through the increased cost of raw material, and when the suicidal policy of selling below cost price, which has undoubtedly been pursued by steel rail-makers, is ended, as ended it must of necessity be before long. The published balance-sheets of the Mersey Steel and Iron Company for the last two years, the present position of the Lancashire Steel Company, and the figures at which shares in other steel rail works stand in the share lists, sufficiently indicate that the prices obtained of late for steel rails have not been remunerative. Admitting, then, the great likelihood of higher prices having to be paid for steel rails, I think it is open to question whether railway directors and engineers will, in the present state of railway finance, act wisely in making such great additions to their expenditure by substituting steel rails for iron to any great extent, without a careful consideration of the question as to whether we have arrived at the greatest perfection that can be attained in the manufacture of iron rails. This is a point that should not be lost sight of. I believe it will be admitted that much improvement has taken place in the manufacture of rails during the last few years; proper mixtures for producing a close, compact, and hard material for forming the head of the rail and improved methods of manufacture have done much to lessen the difference in strength and durability between steel and iron rails. The specifications of some of our leading engineers, the discarding of the old squeezers (except in some of the Welsh works), and the introduction to a greater extent of steam hammers, and improved machinery for making rails, have done much to bring about this result, and I think it is possible still further to improve the quality of iron rails, if engineers will issue specifications calculated to produce rails of the best quality, and directors will pay manufacturers such a price as will enable them to work strictly and honestly to such specifications. As regards the strength of the rails, I submit that iron rails of the sections and weights used on our principal railways are, if made of good material, sufficiently strong for all practical purposes, and that it would not be safe to use steel rails of any lighter section on account of the uncertain quality of the material. It is true we have heard of one of two broken rails, but these are very exceptional occurrences, and bearing in mind that but a very small percentage of our railways are laid with steel rails, it is quite fair to assume that, had we the same mileage of steel rails that we now have of iron rails, we should hear of quite as many broken rails of that material as we now hear of in the case of iron ones, for the regulation of the amount of carbon in the manufacture of Bessemer rails is not quite such an easy matter as you state. This many steel-rail makers know to their cost, and the number of rails broken in punching is a proof that mistakes are occasionally made in this respect. The practice of heating the rail-ends to bring them to a proper temper for punching is not altogether unknown in some of the steel rail works, thus leaving the middle portion of the rail of such a quality as to render a breakage under certain circumstances as not at all an unlikely event. I have seen steel rails sent from one of the first houses in the trade, and within the present year, break in unloading from the truck. I of course admit that this was from some fault inherent in the identical rail so broken, and that it might not be a fair sample of the average quality; but the same reasoning ought to be applied to the case of a broken iron rail, and, so far as our experience goes, I think it will be admitted that rails of a more uniform quality can be produced from iron than have hitherto been produced by the Bessemer process.

Admitting that steel is better adapted for a wearing surface than such iron as has hitherto been used for rails, is it necessary that the whole of the rail should be of steel? Patents have been taken out for steel-topped rails, and I think our railway engineers and iron manufacturers have not given sufficient attention to this method of making rails. There has, I believe, been some difficulty in getting a perfect weld between the steel hitherto used, and the iron in the rail pile; but surely our metallurgists of the present day can overcome this difficulty; and, if a rail with a sufficient thickness of steel in the head for practical wear, and the remainder of the rail of good wrought iron, can be produced, as I believe it can, for 30 per cent. less cost than Bessemer rails, I see no more necessity for making a rail all steel than for making our engine wheels all steel instead of with steel tyres only.

As to the question of a yielding roadway causing increased resistance to traction, the difference between a good iron rail

and a Bessemer steel rail in yielding to a weight passing over at a high speed will, I think, be found in practice to be so infinitesimal that any advantage obtained in that respect will be more than counterbalanced by the slip of the wheels in wet or moist weather. I am informed by some experienced drivers that this is very perceptible in running over steel rails.

Without going into the question of compound interest on the extra capital required for lines laid with steel rails, I think I have stated sufficient to show that railway engineers and directors will do well not to act too precipitately in a matter of this kind, and that it would be no unwise policy on their part to try the effect of good specifications and fair prices, and thus enable our iron manufacturers to make quality, and not quantity, the grand desideratum.

Pendleton, Manchester.

J. B.

FOREIGN COMPETITION.

TO THE EDITOR OF ENGINEERING.

SIR,—I noticed your remarks in a recent number on the progress of Continental engineering, and the loss of a large portion of this branch of industry to this country.

Being one of the oldest engineers in London, and having many years studied this subject, I have taken upon myself to answer your question of "How is it the French engineers can beat us even on our own ground?" I have long foreseen and prognosticated the decay of our engineering business which is now beginning to be so widely felt and acknowledged.

I consider it has been produced by three causes, viz., exhibitions, trades' unions, and bad government.

From the general tenor of your remarks, you will not, I think, endorse my views of exhibitions; but whatever benefit they may have been to the world at large, and they are unquestionably very great, they will prove a great disaster to England. Even their advantages are very questionable, if considered in the gross. They were of necessity too circumscribed. It was not possible that one in fifty of the industrious manufactures of the country could be represented therein; no building or space could have contained their works; those, therefore, who did show had an unfair advantage over their neighbours, who either had not the means or failed to obtain space for their works (I have myself witnessed several instances of serious injury), although the non-exhibitors had to bear an equal share of the expenses of the country. This fact alone ought to have been well considered by the executive, and should, undoubtedly, have prevented the scheme being fostered by Government, either directly or indirectly. Even if our administration were more akin to that on the Continent, the race would not be so unequal. For it is well known that neither in France nor Germany could such combinations of workmen have existed, nor such atrocities have been perpetrated, without their authors meeting their just reward. The fact is that, in this country, we have too much liberty for evil—not only in the workshops, but also in the classes above them; witness the swindling schemes of every description, bad bankruptcy laws, &c. A paternal and vigilant Government would have corrected these evils before they had attained their present magnitude. The fact is beginning to be widely acknowledged by many thinking men, that in this country we have not only the dearest, but, for all practical usefulness, the most indolent and ineffectual Government in Europe. Our natural advantages are very great, and ought to enable us to hold our own against all comers; but it is altogether impossible that trade can flourish when men of capital and energy, and industrious and intelligent workmen, dare not carry out their plans and improvements without danger to their lives or destruction to their property. Some men suppose that in a short time the price of labour will equalise itself here and on the Continent. I confess I see no grounds for such hope during the present generation. The last winter witnessed the shipbuilders of Deptford allowing their trade to die and leave the district, and themselves to starve rather than take the offer of 6*s.* per day, which was made by a philanthropic employer, but which was refused, as it did not come up to the union requirements. I have just heard that one of our large locomotive builders has just lost a contract for 150 engines and tenders, some Germans having taken them at 15*l.* per ton below the English price.

The fact is only now beginning to be felt and recognised that the '51 Exhibition was a mistake. We there threw away the fruits of the labours of two or three generations of such men as Boulton and Watt, Arkwright, Stephenson, and hosts of others. We there not only showed them what goods we made, what tools we used, and who made them, who used the tools, and how to use them; but we gave them drawings, and then threw open all our workshops for their inspection.

Could we expect otherwise than that, after all this defiant boasting and show to find ourselves first copied and then beaten by such plodding and ingenious people as the French and Germans?

It must not be forgotten also that their workmen are better educated than ours; this their Government takes care of; and in their habits also they are more docile, thrifty, and simple than an English society man; this gives their employers enormous advantages over us.

I believe this to be a full answer to your inquiry, and, as an Englishman, I am sorry to believe is a true one also.

Yours, &c.,

R. WAYGOOD.

Roberts-place, Brunswick-street,
Great Dover-road, S.E., October 15th, 1867.

KRUPP.—The Essen establishment, which has been in existence forty years, now employs 10,000 workmen. In 1866 62,500 tons of cast steel, valued at 1,500,000*l.*, left the works. Essen has now delivered 3500 cast-steel guns, valued at 1,050,000*l.* The cast-steel production of the Essen works last year involved a daily consumption of 1000 tons of coal.