

"MOLECULAR DETERIORATION."

TO THE EDITOR OF ENGINEERING.

SIR,—When I read in *The Engineer's* columns that the Chalk Farm Bessemer steel rail had been broken, I looked for an explanation, but found none. This explanation, however, you have given, and it amounts to this, viz., that the rail in question, after enduring for years an amount of traffic which wore out the bearing surfaces of repeated relays of iron rails, required at length the impact of a railway collision to bend and break it, affording in its very destruction overwhelming proof of the entire trustworthiness of a sound steel rail. That steel should become brittle in its structure from vibration and concussion is a metamorphosis that I have never yet beheld, and I should esteem such a molecular change as the eighth wonder of the world, or as the fifth wheel of a coach. When a cast-steel borer, say 4 ft. long, has been struck by a boring hammer daily for some years, until worn down to a few inches in length, we might reasonably expect that if the molecular-alteration theory be correct, the remnant of the original borer would be found as brittle as glass. Such, however, is not the case, and the much battered fragment retains all its original toughness, and, as far as my judgment goes, the toughness has been actually augmented by the enormous amount of percussion the borer has necessarily received. The hardness of soft steel may be increased by cold hammering, but the steel is not thereby rendered brittle, but merely stiff and stubborn, and even this does not occur, unless the cold hammering is sufficiently severe to cause a permanent set, or alteration in the substance of the steel, or, in other words, when the force of impact is greater than the elastic resistance of the steel. Now will any one contend that the rolling of loco-wheels over steel rails bears any analogy to the sudden impact of hammers upon these rails, given with such force as to crush the very substance of the rail? It is a certain fact that cold short crystalline bar irons are invariably poor in carbon, as compared with fine tough bar irons; in other words, richness in carbon is a guarantee against cold shortness; therefore Bessemer steel rails, which are, in effect, iron rich in carbon, or semi-steel, are a guarantee for the safety of the lines of railway where they are laid down. Who has ever heard of a bar of Swede iron, rich in carbon, becoming cold-short and brittle? and Bessemer steel rails are similarly rich in carbon, but which is more evenly diffused throughout the mass. In fact, those who would distrust a good tough Bessemer rail, for fear it should become brittle, would doubt their own existence. It will be most unfortunate should such groundless apprehensions deter railway companies from adopting their best friend in need, the Bessemer steel rail. In my recent letter on this subject in *The Engineer*, I expressed my belief that steel rails would most probably become tougher by exposure to vibration and to the atmosphere, and this opinion I perceive has been confirmed by the result of the experiments you have detailed, where the most used rail proved to be the toughest. It is, moreover, a well-known fact that steel is improved in quality by simple exposure to the atmosphere for a long period.

Out of many thousands of Bessemer steel rail ends which I have worked up, not one could be found which was not fully as tough as Krupp's fine steel, but, as a rule, the bulk were far tougher. Not one of the rails from which those ends had been cut could have given way in the manner described by your correspondent "J. B.," and yet these rails were purchased from various manufacturers of steel rails, affording to my mind, and no doubt to any unprejudiced mind, a positive proof of the perfectly reliable quality of commercial Bessemer steel rails. As to the breakage of the steel shaft mentioned by "J. B.," it took place, as he says, at a new steel works, where, in all probability, from want of experience, the steel had been too highly carburised, or was possibly red short. It is certain that both very bad iron and bad steel can be produced. Now bad iron rails are largely manufactured, simply because the price of iron rails is so low in many instances that a good quality of iron cannot be employed in their manufacture. On the other hand, it costs not one penny more to produce the best steel rails than to produce the most inferior, therefore the maker of steel rails is not driven, like the ironmaster, to use inferior materials, and it is contrary to his interest to do so; besides which, he can always be certain that each rail he makes is throughout its length of sufficient and uniform toughness, whilst the ironmaster can never be sure that no faulty place exists in his iron rail. Therefore, even were steel rails no better in other respects than iron rails, they would be safer than the latter. That by giving a proportionate price for iron rails we should obtain iron rails as good, or nearly as good, as steel rails is a delusion such as Mr. Tony Weller laboured under when he intimated that for 25,000l. per mile coaching could be made to outdo railway locomotion.

ROBERT MUSSET.

Cheltenham, November 26, 1867.

THE AMERICAN TARIFF.—When we stated, some few months since, that Mr. David G. Wells, the United States Commissioner of Revenue, had personally expressed himself opposed to the excessive import duties levied by his Government, we were accused by the protectionist journals of New York of having "calumniated" him. We now find that the *New York Times* Washington correspondent says: "There promises to be a strong pressure upon Congress to secure a large reduction upon the tax on cotton and woollen fabrics. It is understood that Commissioner Wells will favour a reduction, if accompanied by a corresponding reduction in tariff rates on the same articles. Most manufacturers own that the increased tariff has done damage to their interests. Commissioner Wells also recommends the repeal of the cotton-tax."

A 1227-MILE WALK.—Weston, the American pedestrian, who is now, or very lately was, engaged to walk from Portland to Chicago in 26 week-days, has on two occasions attempted to walk 100 miles in 24 hours, but failed on both occasions. On one he walked 67 miles in 16 h. 45 m.

COLD-HAMMERED STEEL.

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me to draw your attention to a leading article I accidentally discovered in your contemporary, *The Engineer*, and to ask you a few questions in reference to it. It appears that the editor of *The Engineer* knows something about steel; he has heard that people, who know how to do it, can make a steel bar brittle by what he calls "prolonged cold hammering," and he immediately jumps upon the conclusion that "somewhat similar changes" will take place in steel rails, which may be "rendered brittle by impact and vibration." Now I wonder whether the steel pen of this profound writer became brittle under the weight of his arguments? For this seems to be the only piece of steel he ever handled, to judge from what he says about this material. Now I would advise this authority to try for once and make a steel bar brittle "by prolonged cold hammering," taking care to mount the bar in the same way in which a rail is placed in its chairs. I will allow him to select the size and power of his hammer, but I would place two wooden cross sleepers upon the anvil, say 3 ft. apart, with proper cast-iron chairs upon them, and have the steel rails secured to the chairs by wooden keys in the usual way. I propose to pay him by the quantity of brittle rails he will produce in this manner by "prolonged cold hammering." You need not protest that it is *infra dig.*; for to deteriorate steel by cold hammering is fully as honest a job as to deteriorate the knowledge of professional men by coolly hammering false statements into their brains. The fact of the matter is, if you want to condense the grain of a steel bar, you must put it dead flat on the anvil, and let the hammer, or rather the tilt, come down upon it without its having a chance to "play" or spring. Give a chance to elasticity, and you lose all chance of condensing the grain. It is the pressure, and not the concussion, that does it. Moreover, you must be very quick in tilting, the blows must follow each other rapidly, so that the steel gets very warm during the operation. Small pieces of steel become red-hot by this treatment, and, of course, the heat assists in that process of condensing the grain.

How now about the rail supported on elastic ballast and sleepers, and fixed with a wooden key in the chair? Hit it between supports, and it will spring and yield and send the tilt back by its reaction, or hit it just over the chair, and you will smash the chair, but never hurt the grain of the steel rail. So much for my remarks, and now to my questions. I read in that article of your contemporary that "the use of steel in shipbuilding continues to be very limited indeed; steel guns are things of the past, Herr Krupp's doings to the contrary notwithstanding. We have little hope from steel in the shape of armour-plates. Girders, boilers, and loco-motives continue, and apparently will continue, to be made of iron, though steel has been fairly tried." I want to ask you what becomes of all the steel crank-shafts, piston-rods, and other parts of marine engines which are annually made in this country, and of which Herr Krupp continues to send us some few every now and then? What is the name of the material which the Clyde shipbuilders find named in their specifications for the principal parts of our new ironclads? How many times could the whole British army and navy be armed with the steel guns that Herr Krupp has turned out, and which are now in active service on the Continent? Why does Sir William Armstrong order the internal tubes of his large guns from Herr Krupp? Are railway tyres made out of the consolidated formula which your contemporary has recently given for estimating their weight? Since boilers "continue to be made of iron," what are all the steel boilers made of which Mr. Adamson, Messrs. Platt Brothers, and hundreds of other firms make and use, to say nothing of the Continent and the Paris Exhibition? I need not ask you about piling steel and iron for armour-plates, but I cannot resist the temptation to ask what is a "slight" railway collision? I might have contented myself with the answer "one by which an Irishman is 'slightly' killed," but I hope for a better one. In conclusion, can you or any of your intelligent readers tell me what is the difference between the "great deal of nonsense which was at one time written about the effect of vibration in altering the molecular constitution of a metal" and the nonsense which *The Engineer* has written upon this subject just now?

Your very obedient Servant,

Sheffield, Nov. 25, 1867.

TILT-HAMMER.

STEEL RAILS.

TO THE EDITOR OF ENGINEERING.

SIR,—Permit me to make a few observations on an extraordinary article that appeared in your contemporary, *The Engineer*, a week or two since, on the above subject.

After a long and rambling preface, the writer makes the astounding assertion that "there is no evidence that those engineers who are adopting steel most freely are perfectly well acquainted with its peculiarities." Then, after admitting that "all that can be known about steel rails is no doubt known by such men as Mr. Ramsbottom," he goes on to state, probably with a great degree of truth, that "our knowledge of the behaviour of steel is as nothing compared with our knowledge of iron." Now, it appears to me that "there is no evidence" that the writer is at all acquainted with his subject, for, lower down in his lengthy article, he asserts that "until every variety of Bessemer rail in the market has been used for years with the most perfect safety, no prudent engineer will accept Bessemer metal as a reliable material for the construction of permanent way." "This knowledge," he adds, "will certainly be acquired within the next four or five years, but not much sooner."

I am at a loss to discover the meaning of this latter revelation of Messrs. Bottom and Snug; for it is impossible that they can be ignorant of the vast mass of evidence which you have so ably brought forward, from time to time, in connexion with this important subject; but, if they are, your articles in *ENGINEERING*, of November 22, ought to enlighten

their benighted minds, and teach them a lesson they should not readily forget.

Do these estimable gentlemen hail from the "sister isle"? It would appear so from the following quotation from the tail end of the article in question:

"The progress of deterioration is slow, and track may remain sound and serviceable for years, and then BEGIN to 'fail WITHOUT WARNING!'"

Surely if the failure is incipient, warning is given; but if the writer means that they "fail without warning," that is quite a different thing from "beginning" to do so.

The oracle closes with the announcement that "it will not do to commit mistakes under the influence of manufacturers who really know as little of the quality of the material they make as those who buy from them."

This is highly complimentary to the skill and talent of our manufacturers and railway engineers, and would, no doubt, were the scribes worthy of it, be visited with condign punishment; but as no one with a grain of sense now takes notice of the eccentricities of your contemporary, they will probably escape Scot free, for, as was well expressed by a correspondent in your journal some time since, "the impertinences of a poodle can never ruffle the temper of a St. Bernard."

I have thus noticed those passages in the "Revelation" that were overlooked in your excellent article, and, knowing the value of your space, will not trespass further upon it, but

Remain, Sir,

Your obedient Servant,

Birkenhead, November 23, 1867.

D. W. THIRLWALL.

TOOLS AND TOOL-HOLDERS.

TO THE EDITOR OF ENGINEERING.

SIR,—As Messrs. Smith and Coventry, in your impression of the 22nd inst., have again preferred their claims as the original inventors of the system of employing independent cylindrical cutting tools and iron tool-holders in the lathe and planing machinery, it is only fair to point out that a plan of tool-holders, identical with that they advocate, is described in full detail in Holtzapffel's "Mechanical Manipulation," ii., pp. 635, 636, and 987 to 998.

The system was old even in 1830, and the small extent to which it has been carried out is only another example of the conservatism of our so-called practical men. Holtzapffel also describes and figures a variety of guides (similar to that employed by Messrs. S. and C.) to determine the exact angle at which the tools should be applied, in grinding, to the revolving lap or stone (*op. cit.*, iii., pp. 1156 to 1163).

I am, Sir, yours obediently,

W. HACKNEY.

Westminster, November 23, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad to see Messrs. Smith and Coventry's account of the transaction between them and Mr. Zimmermann, in reference to this subject, and also to find that my information respecting the wheel-dividing and cutting machine was correct. The fact is, that on the very morning when I set out on this last journey to Paris, I received my quarterly number of the proceedings of the Institution of Mechanical Engineers, containing Mr. Smith's paper, which I leisurely read in the railway carriage, and when, two days after, I went in search of the wheel-dividing machine, the tools and tool-holders being still very fresh in my mind, I was surprised to find their facsimiles in the Saxon quarter of the Exhibition; the resemblance was so great that I walked away with a latent conviction that they had been copied. The angle, of course, I could not so accurately measure with the bare eye as to be able to note any difference; but, judging from the facts disclosed, I should say it was not wanting in sharpness.

These facts, however, illustrate one of the unlooked-for results of international exhibitions, and in so far justify the conclusions of your correspondent, Mr. Waygood.

"Z," the brother-engineer abroad, is aware that there is going to be an exhibition, and, knowing his deficiencies, he bethinks himself about sharpening up his wits. To that effect he takes a short trip to this country, and makes a small purchase from a respectable house, which will serve as an introduction to any other house, on the plea of prospective business intercourse; a few tracings are easily obtained for the purpose of seeing what accommodation for space is required, and, what with a few verbal explanations and a few personal observations, the plundering expedition is successful.

"Z," then goes home, reproduces that which he has either bought or pretended to buy, and being perhaps a little more favourably situated than his brother of England, perhaps even a little less charge of expense, he appears in the Exhibition with flying colours, and walks away with a "grand prix" or a "gold medal," as the case may be. This fact is then duly noised abroad with every available trumpet, and his reputation henceforward is established, at the expense of whom? Why, of his brother of England, who either could not get admission into the Exhibition, because, forsooth, if everybody were to be admitted, there would be room for nobody, or else who did not think that the chance of gain in view was sufficient to justify the great expense which he would incur by sending to the Exhibition.

Can anybody say that the English locomotive trade was represented there this year? Or, if so, where were Beyer, Neilson, Dubs, Hawthorn, Slaughter, England? or else the tool trade? Then, where were Greenwood and Batley, Fairbairn, Neilson Brothers, Collier, Hulse, & Co., and your friends Smith and Coventry, with a host of others, all well known and respected both at home and abroad? The same thing occurs in other branches of our national industry, and in the face of such absenteeism, whether forced or voluntary, what becomes, I ask, of the value of the prizes distributed and obtained, about which such a fuss is made in a correspondence only published in your last issue? Why, Sir, to my mind, they are mere empty wind-bags; and the paper quarrel between Ransomes, Sims, and Howard reminds me very much of

They do.—Ed. E.

the quarrel between two friends over a nutshell, while the party who had to pronounce upon the merits of the case alone benefited by the substantial element attaching to it, namely, in the case under consideration, the information conveyed by the articles exhibited.

It strikes me, Mr. Editor, that we yet shall learn something from international exhibitions which we did not know before. Meanwhile, I remain,

Yours very truly,

November 25, 1867.

J. J. BIRCKEL.

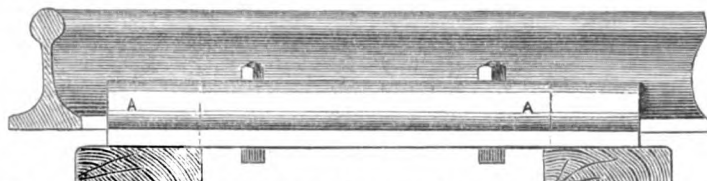
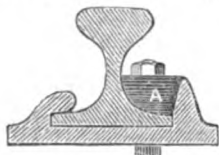
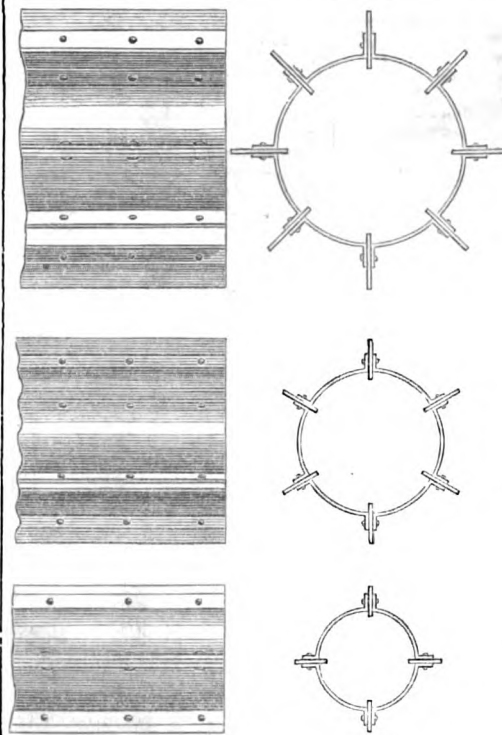
ENGINEERING IN NEW YORK.

We reprint the following interesting "New York Letter" from the last number of *The Journal of the Franklin Institute*.

"New York, August, 1867.

"Gradually our American roads are adopting steel rails, and with such satisfactory results that there is now a positive confidence in their use, such as test and experience alone can give. One of our leading roads, we understand, is buying no more iron rails at all, so satisfied are its directors with the proved superiority and economy of steel ones. The road (the Hudson River) has now in use some thirty miles of steel rails, made by Charles Cammell and Co., of Sheffield, weighing about fifty-six pounds per yard in 30 ft. lengths. Between Thirtieth-street and Spuyten Duyvil Creek, a distance of ten miles, there have passed over these rails, from November 1st, 1866, to August 1st, 1867, 445,000 wheels, independent of 4175 engines. The wear caused by this heavy traffic is unappreciable, and the rails appear as good as when first laid down. The ends of the rails are barely flattened where the bolts of the chairs had not been screwed down tight enough to hold them in place. The pattern of chair now in use along the whole line of this road was one devised by Mr. A. F. Smith, the able superintendent of the line and well-known mechanical engineer. The annexed drawing shows the arrangement. An end and side view are there presented. The chair itself is really a long Phoenix chair, so as to rest upon two ties and thus distribute the bearing. The left side is turned over to fit the base of the rail, leaving about a sixteenth of an inch play to allow of crowding, which is effected by means of the splice bar, *a*, and the two screw-bolts, as shown. The right-hand lip is slightly inclined outwards to aid the

and how completely it is taking the place of cast iron. In the way of girders, cast iron is hardly thought of any more, although it is not many years since Mr. Hodgkinson elaborated the proper economical forms, with the idea that they were to be a permanent construction. From the failure of



wedging action of the splice, besides giving great rigidity in its action as a girder. The web of the rail, it will be noticed, is *not turned*, as is the case with most other suspension joints, which would weaken the weakest part of the rail, the base being merely cut, as for an ordinary spike-hole.

"The above rails are laid, perhaps, in the most unfavourable manner, the joints being laid on the same tie, instead of being broken. I am aware that engineers differ as to this; but my own experience and observation go to show, that where one tie catches the whole force of the joint blow, an increased settling in the ballast results, reacting upon the machinery as well as the wood-bed, to a much greater degree than where the train sways from one side to the other, as it would do in the case of breaking these joints. While on the subject of steel rails, I might mention that the New York and New Haven road is also trying them on a portion of their line; but they have not been down long enough to exhibit their superior economy over the iron rail.

"The borings to determine the character of foundation for Mr. Roebling's East River Suspension Bridge are now going forward on the Brooklyn side, under the direction of George W. Plympton, Esq., C.E. The site of operations is just above the Fulton Ferry. The distance reached about this time is 50 ft., and the material presented is a mixture of hard pan gravel and boulders. As rock does not occur near the surface much under 100 ft., it will be considered perfectly safe to found the abutments upon the first well demonstrated stratum of coarse gravel. I understand that Mr. Roebling has about completed his full plans for the work, and that they will soon be on exhibition.

"That monstrosity, the 'Harlam Bridge,' which I noted in a former letter, is 486 ft. between abutments, and has a width of 52 ft. The abutments are of expensive cut granite, and the piers are cast-iron columns filled in with concrete masonry. The piers for the permanent spans are two in number, and are composed of five columns each, two of 8 ft. in diameter, and the remaining ones 6 ft. They are sunk to a depth of 33 ft. below the bed of the river, and 61 ft. below high-water mark. The swing span is a bowstring of 21 ft. in length, and weighs 330 tons, supported on 96 rollers. The pivot pier has a diameter of 80 ft., and is composed of twelve cast-iron columns, 6 ft. in diameter, and a thickness of metal of 1 in. Croton water is used to operate the draw mechanically. This work has cost over one million dollars. It is difficult to say what character of bridge this is; perhaps it comes as near a clumsy bowstring girder as anything. The panels of the bowstring are filled in with perpendicular gothic mullions and cusps, and beneath the roadway of the permanent spans, an imitation cast-iron arch is formed, the spandrels elaborated with the same style of architecture, only 'more so.'

"A building will shortly be started in this city, which will be quite a novelty in the way of fire-proof construction. It will be an iron building throughout, the supporting principle being a wrought-iron frame of columns and girders. The external facing is of cast iron, but three-eighths of an inch thick, and the projectors claim to have the cheapest permanent building yet devised. It is surprising to contemplate the various applications of wrought iron at the present day,

the Dee Bridge, the public have gradually been losing confidence in cast iron as a constructive material, except under certain conditions, and it has certainly been replaced by wrought-iron beams of various forms. Cast-iron columns, one would think, could not be improved upon, but even they are undergoing mutations even more striking than the innovation noted above. Perfection of wrought-iron working is so nearly attained, that almost any work devised can be made from it. A peculiar case in point is wrought-iron columns now being introduced under patent by the Phoenix Iron Company. The accompanying cuts fully illustrate their mode of manufacture. It will be noticed that there are three sizes, the four, six, and eight segment columns, and by ranging the thickness of the radial pieces and segments, a range of resisting areas is presented that will meet any required case. The columns, as will be noticed, are made from rolled segments of cylinders with flanges, which flanges are brought together and rivetted, or they may have filling pieces introduced, as shown in the woodcut, to attain greater resisting power. They are more economical in every way, than the cast columns, both in regard to the amount of metal used and the superior facilities for the fitting of girders in fire-proof work. The exact theoretical thickness being attained, their insuperable value for the posts and chords of bridges is apparent; for the weight is reduced to a minimum, and there is no risk of fracture from cross-bending. Most columns do not yield by absolutely crushing, but by bending or buckling, and it seems almost superfluous to dwell upon the superior merits of wrought iron under such circumstances. Cast-iron columns have to be made with a great thickness of metal (far beyond theoretical requirements) to insure a sound casting as far as possible, and to allow for uneven thickness, unavoidable bubbles, cinder, &c., as well as to compensate for inequality of strain in the metal itself while cooling. It will be at once perceived that the advantage of these wrought-iron columns in cheapness alone, over the cast-iron ones, arises from the fact of their being so much lighter, not having an ounce of superfluous metal. The magnificent white marble and fire-proof building of Brown Brothers, on Wall-street, is filled up with these columns, and they have been most artistically treated by the architect, Mr. Potter. A light cast-iron band, with fillets, forms the capitals, while an appropriate base of the same material gives a finish to the whole. No effort is made (except on the first floor) to conceal the wrought-iron construction, and the rendering is completed by bronzing the whole column. The whole effort is one giving confidence to the beholder, and the educated aesthetic is satisfied in a truthful rendering of a correct construction. These columns weigh but 45.5 lb. per foot, and the segments are of $\frac{1}{4}$ in. metal. In your own city the rear walls of the imposing new Ledger Building are supported on eight-segment wrought-iron columns, weighing 185.4 lb. per foot. The thickness of these segments is only $\frac{1}{4}$ in., and the filling pieces are only $\frac{1}{8}$ in. These columns are 20 ft. high, and were tested in the Phoenix Iron Company's hydraulic machine up to 180 tons, the maximum capacity of the apparatus. There was no effect produced whatever; and as they had but 140 tons to carry, they were deemed perfectly safe. The area of this column was

55.6 square inches. It is to be regretted that there is no reliable data upon the resistance of wrought iron in the form of posts, columns, &c.; for what little experimenting has been done has shown most surprising results."

HOW TO DRAIN A WELL.

TO THE EDITOR OF ENGINEERING.

SIR,—Truly this is a wonderful age! Who, on reading the letter of your correspondent, an "Economical Utilitarian," can fail to be impressed with the brilliant future that awaits our hydraulic engineers? That truth which has lain hid so long at the bottom of a well has at last been brought to light by the vulgar sons of Cerberus from the underground railway workings at Victoria Station, and in future all drainage operations will be attended with little difficulty and expense: marshes will be reclaimed, and large cities supplied with water, without the aid of steam power or pumps. The only operation necessary, according to your correspondent, will be to sink a well at a certain depth in any wet ground, and from this well to carry up an hermetically sealed pipe to any height above the surface; this done, the water will flow into the well from the surrounding district, and having no other vent will be compelled to ascend this pipe, and discharge itself into some neighbouring sewer. This mode of raising water, or rather of water raising itself, is a marvellous improvement upon the slow method of pumping, and must, if successfully carried out, prove highly remunerative to the projector.

By what train of reasoning could our "Economical Utilitarian" have arrived at this profound discovery in hydrostatics? Has he been studying the theory of boiling springs or artesian wells? As these phenomena do not abound in the neighbourhood of Victoria Station, I would suggest to the "Economical Utilitarian" the necessity of a more careful inquiry into the laws of nature before introducing his improved mode of drainage to the notice of engineers, and holding out such promising hopes of relief to your overworked Servant,

November 23, 1867.

CHAIN-PUMP.

TO THE EDITOR OF ENGINEERING.

SIR.—T. SQUARE is certainly very amusing; he ought to try his hand at light literature. He must be a great acquisition to an office in these dull times, when T. Squares are not very busily employed. T. Square has been prevented by the exuberance of his wit from understanding the subject not, probably, very clearly expressed. T. Square, like all great men, is very condescending to the ignorance which he laments, and doubtless is desirous of removing, for which purpose he has given the following illustration:

"We may compare the condition of the . . . station, with 'its retaining walls all round, to that of a tube with a perforated bottom, or with, say, a sieve fitted on to its open end, 'plunged sieve downwards into 10 ft. of water. . . . In 'future we have only to fix a pipe in one of the meshes of 'the sieve, and the water will run out at the top.' And that is really all that is necessary, with this little additional item, do not let the water run out at any of the other meshes of the sieve, and that is all that was intended by the delightfully innocent E. U. Let T. Square give a satisfactory answer to the question, 'Could no means be devised by some of the 'scientific engineers or contractors connected with this work 'to dispose of the water without so much pumping?' Unless an answer can be given to this question, it must be admitted that there is no remedy in a case of this kind but to commence pumping when the work of constructing the station is commenced, and continuing the expensive operation for many months after the building has been roofed in. If this constant pumping process be the best possible, some innocent parties may be still of opinion that there is some room for improvement in the art of construction.

Will the witty and the wise T. Square be kind enough to send his few grains of *wheat* to ENGINEERING, and his *chaff* to a more appropriate quarter?

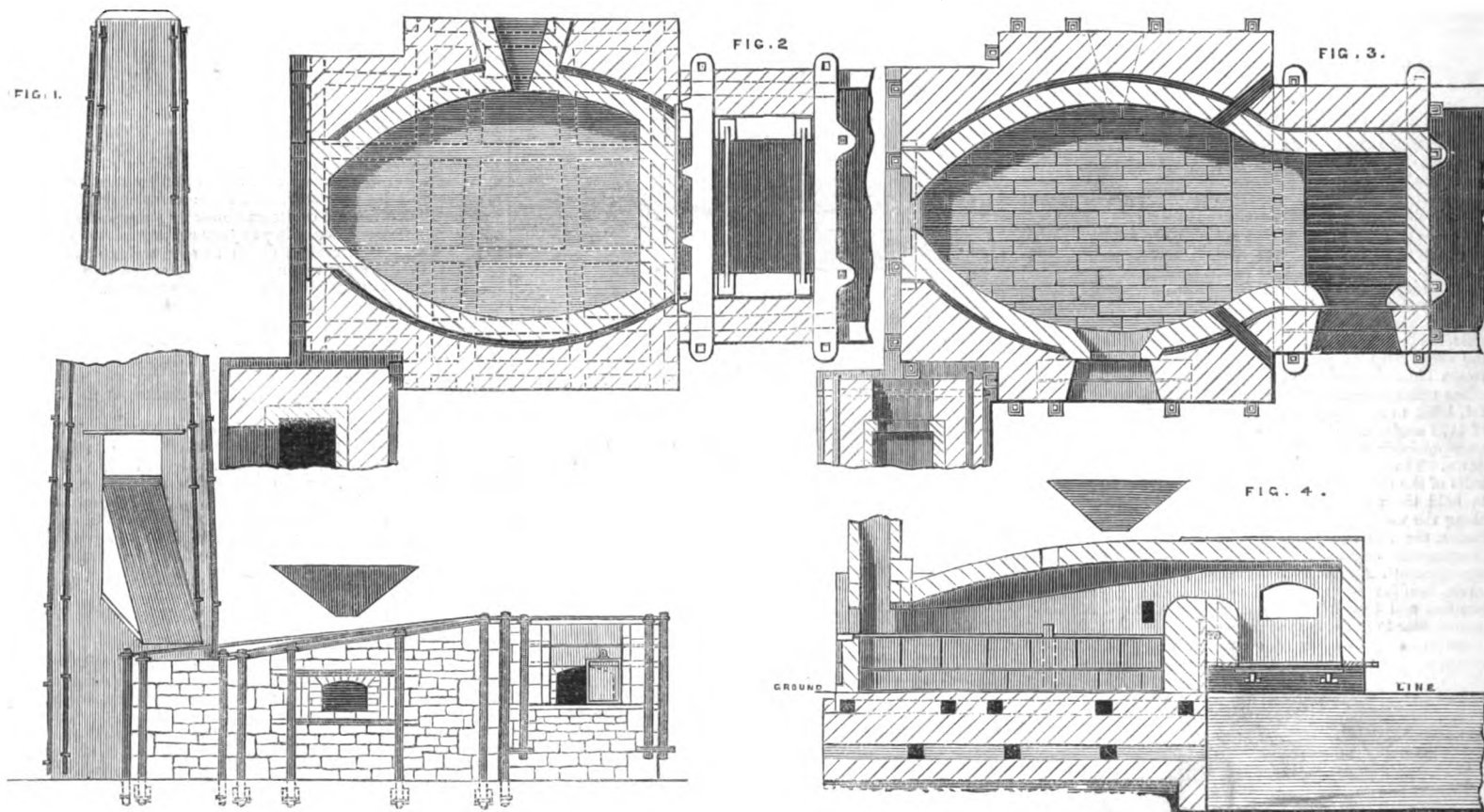
E. U.

"LIMITED AND REDUCED."—Messrs. Sharp, Stewart, and Co. (Limited) have applied for power to reduce their nominal capital of 400,000*l.* to 312,000*l.*, and to divide each of their 3500 shares of 100*l.* each already issued into four equal parts, three of which are to represent 25*l.* each, while the fourth is to be compensated by a money payment of 25*l.* In order to do this they are to deposit 10,000*l.* in court as security for creditors, and the name of the company is to become "Sharp, Stewart, and Co. (Limited and Reduced)." It is a pity that the inventiveness of officials can find no other distinctive term less capable of perverted, not to say ridiculous, construction.

THE ROAD LOCOMOTIVE ACT.—At Greenwich, on Tuesday, Mr. James Maynard, of Croydon-common, the owner of a locomotive steam-engine, and Robert Deadman, a man in his employ, were summoned at the instance of Sir R. Mayne, Commissioner of Police, charged with allowing a locomotive engine to proceed along a certain highway in the parish of Lewisham, contrary to an order made by the Metropolitan Board of Works. Sergeant Churcher, 26 P, produced a copy of the order in question, prohibiting the passing of locomotives along roads in the metropolis between the hours of 6 a.m. and 10 p.m., and deposed to seeing the engine belonging to Maynard, and driven by Deadman, passing through Lewisham at half-past 5 in the afternoon. The defendant Maynard pleaded ignorance of the order in question, and said that the makers of the engines supplied purchasers with a copy of the Act of Parliament, which contained nothing as to prohibitory hours. Sergeant Churcher said the order had only recently been issued, but a copy was posted at every metropolitan police-station. Mr. Maude said the Act of Parliament gave the Metropolitan Board of Works and other local authorities power to prohibit the travelling of locomotives along public roads during stated hours; but in consequence of this being the first case under the order in question, a nominal fine of 5*s.* and costs only would be imposed.

COPPER-SMELTING FURNACE FOR WOOD FUEL.

AS USED BY THE OPHIR COPPER MINING COMPANY, AUSTRALIA.



THE Ophir Copper Mining Company have mines at Lewis Pond Creek, in the Bathurst district, about 140 miles west of Sydney, and owing to the heavy cost of the inland carriage to the port of Sydney, and the subsequent freightage to the works at Swansea, they have been compelled to smelt at their mines all ores of low percentage. The mines are, however, at a considerable distance from any coal-field, whilst they are situated in a thickly timbered district, and this led to the use of wood for fuel. A melting furnace of the class used in Peru was first erected; but, from the low-class ores at the Ophir mines being very siliceous and containing little iron or other matter favourable for forming a liquid slag, they were found to be very refractory, and the attempt to smelt them in such a furnace, with wood as fuel, was unsuccessful. After some discussion, however, it was decided to renew operations, and the furnace shown in the annexed engravings was erected; but before this was accomplished many difficulties were encountered. Fire-bricks for the roof and sides of the furnace had to be obtained. There were on the section of land belonging to the company several reefs of quartz—refractory, of course, as far as fire was concerned, but not less so when any attempt was made to shape it for the bricklayer. This quartz, mined as best it could be, was put into the old furnace, kept red-hot for forty-eight hours, and then raked out into “boshes” of cold water. It was now easily pounded into particles small enough to be moulded into a brick, when mixed with a proportion of clay wash. Material for the bottoms was also required. Pounded quartz would not avail here. Five miles away, a quarry had been opened on a bed of sandstone, lying in the Silurian system—the geological feature of the district. This stone was, fortunately, discovered to be capable of withstanding a white heat, and was, moreover, when quarried, easily dressed; and with this the false and working bottoms were made. In order, when constructing the furnace, to be certain that sufficient heat should be obtained, the area of the grate was made equal to the ordinary Swansea melting furnace, and the body of the furnace considerably smaller. These precautions proved to be unnecessary, for as soon as the peculiarities of the combustion of timber were ascertained, a more intense heat was obtained than would have been the case from first-class coal; and as no clinker was produced, the additional labour of more frequently replenishing the furnace was less than is ordinarily expended in keeping the firebars of a coal furnace clear and bright. The chief peculiarity, which had not hitherto been observed, was the tendency of the cold air to form pipes, or passages, between the ends of the logs and the sides of the fire-chamber, which allowed so much cold air to get into the body of the furnace, without passing through the fuel, as greatly to diminish, and occasionally almost to neutralise, the heat produced from the legitimate combustion of the fuel. To obviate this, dead plates or shelves of cast iron, were placed round the fire-chamber, at the level of the firebars, and projecting fully 6 in. into the area. There was now no chance of air passing but through the burning fuel, and the effective heat in the furnace was increased in a degree greater even than was anticipated. The ore, although subjected to this increased heat, continued nevertheless most stubborn and intractable. Limestone was added, with partial success, but the main element (iron), of a practically good slag, was still wanting. After searching in various localities, a deposit was found, evidently the back of copper lode, and, when added in proper proportions to the charge, produced the desired effect—a fluid slag, from which the copper separated itself without further difficulty. There was

not the slightest trouble in maintaining a very intense heat; the only care necessary was to provide a good stock of wood, which should be kept long enough under cover to be perfectly free from moisture (hygrometric at least) when required for use. The quartz bricks proved admirably suited for their purpose, as after constant use for four months the roof of the furnace was in excellent order, not requiring the slightest repair.

The wear of the bricks was found to be greater at the sides near the bridge than at any other part, and Mr. Joshua Jewell Morgan, the engineer of the company, under whose direction the furnace was erected, considers that this excessive wear might be prevented by altering the shape of the furnace so that the transverse area of the passage through which the flames pass diminished gradually from the grate to the flue. The hollow bridge of the furnace was fitted with a register attached to small flues passing upwards, so as to admit to the underside of the flame such an amount of air as might be necessary to ensure the perfect combustion of any carbonic oxide gas that might pass over. The binding of the furnace, especially about the grate, proved very effective.

For the particulars of this copper-smelting furnace above given we are indebted to a paper read by Mr. Morgan before the Institution of Civil Engineers during the last session, and our engravings are copied by permission from the proceedings of the Institution.

GIFFARD'S INJECTORS.—It is a remarkable fact that Giffard's injectors can be purchased in France at a price somewhere about one-half of what is charged for the same sizes by the proprietors of the British patents. Messrs. Sharp, Stewart, and Co., of Manchester, English locomotive makers, who export locomotives to the Continent, make it a practice to avail themselves of this difference in price. They send the engines away without fitting their injectors to them; they then purchase them from M. Flaud and Co., in Paris, and get them screwed on to the engines when the latter arrive at their place of destination. A saving, amounting to 10*l.* or 12*l.* per injector, is made in this manner, and an excellent example is set abroad by English engineers how the superiority of British manufactures ought to be looked upon as a thing of the past.

THE CLEVELAND IRON TRADE.—The Cleveland pig-iron trade displays rather less animation; still, the deliveries continue comparatively good, and very few of the makers have large stocks on hand. To Holland and France a few cargoes have been cleared out, but Continental orders are coming in but slowly, and the demand is generally weak. A want of orders is experienced to a certain extent in the malleable iron trade. The foundries of the neighbourhood are only moderately busy; it had been hoped that a large East Indian order for chairs would have been secured, but it has been given instead to a Glasgow house. An order for 14,000 tons of rails for the East Indian Railway has also gone to Wales. A reduction of 10 per cent. in wages is proposed to be made on and after December 7th.

SHEFFIELD.—The trade advices received from Sheffield are of a more cheerful character, some fair orders having come to hand for armour-plates, and also for railway plant. The armour-plates have been ordered for the most part on Government account, and will give employment to a number of men who have been idle for some time past.

DOVER TO CALAIS.—Notice has been given of an intended application to Parliament for an act empowering a company to erect works at Dover with a view to the employment of steam vessels of great power, speed, and burden between England and the Continent. The proposed works are thus described:

(1.) A pier abutting on the east side of the Admiralty Pier, and commencing therefrom at a point about 66 yards to the southward of the south-eastern corner of the Lord Warden Hotel, and extending thence in a north-easterly direction for a distance of about 176 yards into the sea.

(2.) An extension of the present North Pier, commencing at the south-eastern end thereof, and extending thence in the same line for a distance of about 100 yards into the sea.

(3.) The forming a water station, with all needful buildings, wharves, approaches, lifts, apparatus, and conveniences within the proposed piers, and the appropriation of such station and appurtenances to the uses of the Company, such water station being formed partly by the removal of the South Pier head and the reservoirs and works constructed thereon and connected therewith, and the excavation and dredging of the soil whereon the said pier stands.

(4.) Dredging, deepening, and improving the bed of the sea in front of the proposed piers and at the entrance to the tidal harbour, and also dredging, deepening, and improving the bed of the said tidal harbour.

(5.) A short railway (A), commencing by a junction with the South-Eastern Railway, at or near to a point about 300 yards to the westward of the western entrance to the tunnel under Arcliff Fort, and terminating on the south quay of the tidal harbour, at or near the eastern end of the Customs warehouse shed of the London, Chatham, and Dover Railway on that quay.

(6.) Another short line of railway (B), commencing by a junction with the London, Chatham, and Dover Railway in the Dover passenger station thereof, and terminating by a junction with the proposed railway (A) lastly described, in the east side of Clarence-place, about 30 yards from the northern corner of the harbour-master's office.

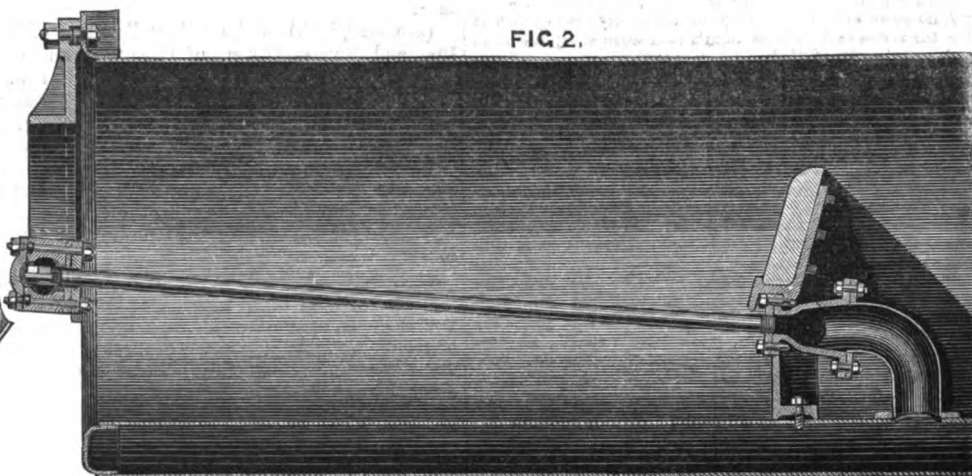
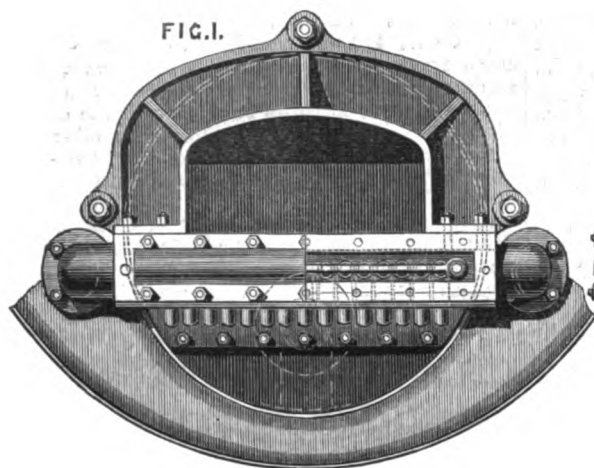
(7.) A graving dock, situate at the northern end, and opening out of the tidal harbour at or near the middle of the said northern quay thereof, with all necessary lock gates and works connected therewith, and extending northward for a distance of about 150 yards, and of a width of about 40 yards; and for the purpose of the said dock, to divert the esplanade at the southern end thereof.

FRENCH PERMANENT WAY.—The Paris, Lyons, and Mediterranean Railway Company has let a contract for Bessemer steel rails to the Châtillon and Commentry Forges Company at 12*l.* 8*s.* per ton. One of the French railway companies is said to be about to introduce iron sleepers on its system.

SEWAGE AT WEST HAM.—Messrs. Lucas and Wilkinson have drawn up a report on the utilisation of the sewage of West Ham. The estimated cost of carrying out the proposals made is 45,000*l.*, viz., about seven miles of forcing main, including compensation and laying, at 4500*l.* per mile; additional engine power, 8500*l.*; legal and engineering expenses and contingencies, 5000*l.* Messrs. Lucas and Wilkinson anticipate that the utilisation of the sewage would produce a net return of 4200*l.* per annum, or 9 per cent. per annum on the capital proposed to be expended.

WATER-TUBE GRATE.

DESIGNED BY MR. N. MOGENSEN, ENGINEER, GLASGOW.



We give in the above engravings a longitudinal section and front elevation of a form of water-tube grate designed by Mr. N. Mogensen, of 408, Vincent-street, Glasgow, our illustrations showing this grate as applied to a Cornish boiler. The grate consists of a number of wrought-iron tubes, 1 in. in diameter inside, and $\frac{1}{4}$ in. thick, placed about $\frac{1}{2}$ in. apart in the clear, these tubes being inclined like the ordinary fire-bars. At their lower ends the tubes are screwed into a wrought-iron plate, which is bolted to a casting fixed in the flue, as shown in the section, this casting being surmounted by another carrying the bridge. The casting to which the wrought-iron plate is bolted forms a transverse tube which is connected to the water space at the bottom of the boiler by a bent copper tube, as shown. The upper ends of the grate tubes pass through another wrought-iron plate, which extends across the mouth of the furnace, and in which are formed a series of stuffing-boxes, one to each tube. The glands of the stuffing-boxes are tightened down simultaneously by a single cross-bar, as shown in the engravings, a simple plan, but one which will not be perfectly effective unless the stuffing-boxes are very evenly packed. The bar has also the disadvantage of blocking up the ends of the tubes to some extent, and it would thus obstruct the circulation of the water. This, however, is a point of detail which can be easily remedied.

The wrought-iron plate containing the stuffing-boxes is bolted to a casting fixed to the front of the furnace, this casting having a water space in it with which the tubes communicate. The water space in the casting is connected with that in the boiler by lateral branches, as shown in the front elevation, and it is furnished with a cover which can be readily removed to gain access to the tubes for cleaning, &c. The employment of stuffing-boxes at the upper ends of the tubes enables the latter to expand or contract freely, and there will thus probably be but little, if any, difficulty in keeping the joints tight. In the case of boilers worked at a high pressure, however, there would be a powerful force exerted, tending to force the front casting away from the front of the boiler, and the other casting back in the flue. Both castings would therefore have to be firmly secured in place. In the case of long grates also, the tubes forming the grate would require a support at the middle of their length. In America, where grates formed of water-tubes have been extensively applied, and with good results, to locomotives burning anthracite coal, it has been found better to zigzag the tubes, placing the alternate tubes at two different levels. This plan enables a greater proportion of air-way to be obtained through the grate, with a given diameter and pitch of tubes, than could be got if they were all placed in one plane, and it is probable that Mr. Mogensen might advantageously adopt the same arrangement, as he easily could do without any material modification of his plans.

THE NEW CONTRACT WITH THE P. AND O. COMPANY.—The correspondence which has resulted in an agreement for granting a new contract to the Peninsular and Oriental Company has been published as a Parliamentary paper. The subsidy is to be 400,000*l.* per annum. By the former contract it was only at the rate of about 4*s.* 6*d.* per nautical mile, or 230,000*l.* per annum. But the line established by the French Government receives about five times as much per mile, and was started with other great advantages; and under these circumstances the Peninsular and Oriental Company demanded 7*s.* 6*d.* per mile to enable them to undertake a new contract. The negotiations carried on have ended, however, in the company agreeing to accept 400,000*l.* per annum, with two conditions—first, that the contract should be for a term of twelve instead of six years; and, secondly, that when the net profits exceed 8 per cent., a fourth of the surplus shall go to the Post Office, it being understood, on the other hand, that when the dividend from unavoidable causes sinks below 6 per cent. the subsidy shall be raised to an amount to cover the deficiency, but is not in any case to exceed 500,000*l.* It is calculated that the terms granted will amount to a rate of about 6*s.* 1*d.* per mile. In reply to a question addressed to him in the House of Commons by Sir H. Rawlinson, Mr. Hunt has stated that it is the intention of the Government to increase the rate of postage to 3*d.* per half-ounce on the commencement of the new service.

PROGRESS OF INDIAN RAILWAYS.

In order to expedite the re-opening of the Bombay, Baroda, and Central India Railway for traffic at the place just south of the Nerbudda river, where the embankment has been washed away by the late floods, the chief engineer of the company has determined to restore, in the first instance, the embankment at the southern extremity of the viaduct, with earth as it was before the floods, and to pitch and erect in the bank the iron piles for the extra spans to be added to the viaduct. A large force of men have for the last few weeks been at work, and it is expected that all breaches in the line are by this time filled up, and that passengers and goods trains are now able to resume passing over the whole line as usual. The piles will be screwed down, leaving the extension of the viaduct for the purpose of affording extra water-way to be completed afterwards, so as not to involve further interruption to the traffic. Through traffic is to be resumed at once.

The construction of railway over-bridges in Bombay is progressing rapidly, under Mr. T. Ormiston, C.E., chief engineer of the Elphinstone works. On the town side the abutment and retaining walls to the approaches of the Carnac bridge are on average about 6 ft. above ground level; the Musjid bridge has not yet been commenced; and the Elphinstone bridge is about 4 ft. above ground level. On the Bunder side the foundations of the abutment of the Carnac bridge have just been finished, and the north retaining wall is about 3 ft. above ground level; the abutment and approaches of the Musjid bridge are about 10 ft. above ground level, and the Elphinstone bridge is still further advanced.

A development of the Ceylon Railway traffic, exceeding the most sanguine expectations, is, it is stated, likely to be realised almost immediately. The return for the week ending October 6th amounted to 2885*l.*

The cost of completing the East Indian Railway, so as to allow of a double line of rails from Calcutta to Allahabad, *via* the loop-line, with a single line throughout the rest of its length, is estimated at 29,466,923*l.* This does not include the Jubbulpore line.

The Madras Government has approved of the railway agent's proposal to attach to goods trains inexpensive carriages, without seats, at a special fare of two pice per mile. This was tried in Bombay and on the Eastern Bengal line; but it was found that the respectable natives will resort to the very lowest class even on long journeys. To meet this the railway agent would restrict the privilege to the labouring classes; but the local Government orders the issue of tickets to all who apply for them.

The Mhowlee viaduct, on the Great Indian Peninsula Railway, between Shahpoor and Atgaum, is to be replaced by an embankment with a 25 ft. water-way. The work has been let to one Rustumjee, at five annas per cubic yard. A great number of bridges on this line might, it is thought, be similarly treated, for apparently bridges have in a great many places been built where embankments with 20 and 30 ft. culverts would have sufficed. The rebuilding of the Mukka Mulla viaduct has been let to Messrs. Glover and Co.; and it is understood that pressure is being put upon those contractors to have the job out of hand by February next.

NOTES FROM INDIA.

Bengal.—The Ganges flood, in Eastern Bengal, is abating. The water has fallen six feet at Koochtea, and along the railway the inundation is subsiding at the rate of about three inches a day. The large bridges never were in danger, but only the small culverts. One flood opening failed, and made a gap in the embankment ninety feet long. A native paper remarks, that the Railway Company have, in conformity with an order of the Governor General, provided refreshments at all their stations for native passengers, yet the difficulty which used to be experienced in obtaining water has not been altogether removed. Native passengers, for want of anything better, have to drink out of their hands. The *Jumna*, one of the new India transports, has arrived at Calcutta. Complaints are rife regarding her unsuitableness for service in the tropics, and it is said that her build is such as to make her roll in the most ordinary sea, and that the ventilation and arrangement of her cabins are unsuited for a hot climate. It is reported that the Civil Engineering College of Calcutta is to cease to exist as a separate institution, and is to form a special class in connexion with the Presidency College. Practical instruction will be given at the Cossipore Foundry to students of the institution. The Government of India has instructed the Bengal Government to carry out most of the Orissa roads, and improvements at False Point Harbour, recommended by the Famine Commission. The irrigation works recommended, are under consideration by Colonel Strachey and the local irrigation department. Admitting the importance of collecting agricultural statistics, and registering meteorological phenomena, the Government of India has asked the Secretary of State to send out Professor Tyndall on a visit of a year to India. Mr. H. F. Blandford, of the Geological Survey Department, under the Government of India, is to be appointed geologist to the Abyssinian Expedition, with special instructions to search for coal.

Central Provinces.—The Godavery Navigation works will take a considerable amount of time and money before any benefit can be derived from them. It is proposed to expend during the current year 24 lacs of rupees on the first barrier, and it is considered that navigation will be clear up to the foot of the second barrier by June, 1868. Flotillas, combining light draught with great power and stowage room, have arrived out from England, and more are expected, which are to be the pioneers of commerce on its waters. Including these works, the expenditure of the Public Works Department in the Central Provinces amounts to 245,175*l.*, being 62,710*l.* less than the outlay of the preceding year. No wonder the roads, the weak point of the administration, are neglected, although the highways from Bombay to Agra and Calcutta pass through the Provinces. And it is far from creditable that in six years the number of miles of metalled and bridged roads has increased from 70 to only 400, just as it would have been more satisfactory if, in pushing on the local railway to Nagpore, the late Chief Commissioner had not forgotten the imperial line to Jubbulpore. The Deputy Commissioner of Chindwarra has recently explored the fine coal-field in that district. He has now been able to trace coal southward to the crest of, or to some spot below, the southern slopes of the Santpooras. The great extent and richness of the Chindwarra coal-field has been made clear. The discovery of excellent coal, one seam being eighteen feet thick, in the upper valley of the Towa, about fifty miles from the Railway Station of Etarasee on the main line, is most important. Mr. Blandford, of the Geological Survey, will visit the district this season.

North-Western Provinces.—On 14th October last, a conference of Government engineers took place at Allahabad, to discuss the systems at present in force for the construction and repair of imperial roads. A system of management was there decided upon which will test the energy of the engineers employed, as they are in future to be solely responsible both for the quality and quantity of the work done. The present system of large contracts is to be abolished, and the work is to be done by assistant engineers, with native agents under them. Small contractors are to be employed when available.

Madras.—After the unfortunate failure of engineering works on the Great Indian Peninsula Railway, the Madras people are looking into the state of their line. A report on the works, by Mr. Smart, the civil engineer, giving an assurance of their stability, has recently been submitted to the Government. Mr. Smart was not satisfied with examining the face-work only, but caused the piers and abutments of a large number of bridges and culverts to be opened out. In no instance did he discover un-

sound work. Major Shaw Stewart, the consulting engineer, says the success with which Mr. Smart is prosecuting the works is the more gratifying, inasmuch as he is the first in the Madras presidency who, with sufficient means and appliances, has undertaken contracts for work upon an extensive scale. Captain Darrah is at present engaged in superintending the erection of an iron girder bridge across the Cooum, at its mouth, which will do away with the necessity for the yearly construction of the bar across that river to form a road connecting the north and south beaches of Madras.

Bombay.—The relative commercial advantages of Calcutta and Bombay are thus compared in a letter which has recently appeared in the *Times of India*: "Beyond a pleasant climate and one of the finest harbours in the world, Bombay has nothing to boast of. Calcutta has a good climate, a fine harbour, and an immense back country opened up by railway, which are all elements of success; but the element of success is the productions of a country, and Bengal is far ahead of western India in this respect. Calcutta does not depend, like Bombay, upon one article of export, and until the latter presidency takes to producing other articles besides cotton it will not advance." The Sassoon General Hospital at Poona, built through the liberality of Mr. David Sassoon, was opened on the 7th October by his Excellency the Governor of Bombay. The building, which was designed by Colonel Wilkins, R.E., cost 31,000*l.*, Government giving the site and about one-third of the amount. It is fitted up for the accommodation of 144 patients; but, in the event of an epidemic, the east verandahs may also accommodate 60 more, being 200 in all. Two new municipal markets are rapidly approaching completion at Bombay. One of these, which is for the sale of meat and fish, is 200 ft. in length by 60 ft. in width, and the other, for the accommodation of vegetable dealers, is 140 ft. by 120 ft. They have both been erected from the designs of, and under the superintendence of, Mr. Russel Aitken, the executive engineer to the municipality. It is now hoped that the through communication between Bombay and Madras will be completed by the end of 1870. Cotton, to the extent of 148,696 lb., and valued at Rs. 50,550, was shipped from Kurrachee during the month of September last. A survey party is about to proceed from Wassud to locate the Nee-much and Delhi extension, on the Bombay and Baroda line of railway.

RUSSIAN RAILWAYS.

THE St. Petersburg correspondent of the *Times* supplies the following interesting information: "A few particulars on the Russian railway system, and the progress it has already made, will not be out of place just here. The principal lines open for traffic are the one connecting St. Petersburg with Cracow and Königsberg, and the St. Petersburg-Moscow line. From Dünaburg, a station on the first-mentioned line, a branch shoots off to the harbour of Riga in a northern direction, and to the city of Witepsk in a southern. The latter place is to be connected with Orel, in Central Russia, by way of Smolensk, and the works are sufficiently advanced to warrant the hope that the line will be ready for use by the 1st of January, 1869. The next link in the road to the Black Sea is Orel-Kursk-Kieff, but this is in a backward stage, and will, at the very earliest, be completed two years later. Continuing our survey in the same direction, the next is the Kieff-Balta line, which will shortly be available for commerce. Between Balta and Odessa the locomotives are already running. Passing over to the central provinces we find three lines issuing from Moscow, besides the one to St. Petersburg. One goes due north to Yaroslavl; the other due east to Nishni, on the Volga, whence is steam communication all the way down to Astrakan; the third, proceeding south-east to Ryazan, terminates for the time being at Koeloff, whence it is to be continued both southward and eastward. Southward the works are being rapidly pushed forward to Voronezh. The eastern extension, which has not yet been taken in hand, will touch the Volga at Samara, from which latter place the shovel is already levelling the way to Orenburg. In addition to these, which are the main lines, the Great Southern is to be united with Moscow by what, in so vast a country, may be called a short cut to Orel and Kursk. As far as Toula, which is a third of the distance, it is complete. Westward, Moscow will be connected with Brzesc and Warsaw by Smolensk, earthworks having already had a beginning in the eastern section of this enormous tract. No other important lines have been commenced. The Riga-Mitau-Libau, and the Odessa-Novoselica—the latter place situate on the Austrian frontier, near Czernovitz—will be the junction of the Galician and Moldavian and South Russian railways. Without particularising a number of less useful lines, I will content myself with saying, in conclusion, that the railways already opened exceed 3000 miles in length; that those near completion traverse about half this distance; that a third category, only just commenced, are about 2000 miles long; a distance equalled by lines projected and likely to be carried out. The great work is going on with the utmost energy, a large portion of available funds being steadily applied to an object equally calculated to assist in commerce and war. If, as is likely, the St. Petersburg-Moscow line should be sold to Mr. Winans or some other bidder, the proceeds are sure to be spent in laying down rails somewhere else."

THE 15 IN. RODMAN GUN.—Admiral Farragut, in a recent despatch from Sheerness to his Government, observed as follows: "Experiments were being made with our 15 in. gun and the English 9 in. rifled gun, and of course were highly interesting. The targets were riddled by both, though it appears to me that the 15 in. gun produced more destructive effects. The experiments have not yet decided the relative merits of the two; for, although they accord to our iron superiority, they consider that the conical shot of their 9 in. gun, weighing 250 lb., will accomplish greater penetration, while the 15 in. gun has greater crushing power."

AMERICAN STEAM-PACKETS.—The American line of steamers between New York and Havre, of which the *Arago* and *Fulton* are the chief vessels, has been discontinued for want of patronage, and the steamers are to be sold.

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. 620, 10*d.*) John Robert Breckon, of Darlington, and Robert Dixon, of Crook, patent arrangements for facilitating the screening and loading of coke. According to these plans, the coke is conveyed from the ovens by endless chains of buckets, which raise it and deliver it into "distributors," which in their turn discharge it into the screening-hopper, from which it passes into the wagons placed to receive it. Special arrangements for keeping the chains of buckets tight, and for working the "distributors" are included in the patent.

(No. 621, 8*d.*) John Garrett Tongue, of 34, Southampton-buildings, patents, as the agent of Hart Foster Pease, of Brooklyn, U.S., a form of steam-engine or pump, in which the piston is connected directly to the crank by a connecting-rod, no piston-rod being used. In order to allow steam to be admitted to both sides of the piston, the cylinder-cover next the crank-shaft is of such a shape that it forms a casing enclosing the connecting-rod, crank, &c., the crank shaft working through a stuffing-box on one side of the casing. The whole object of the arrangement appears to be to reduce the total length of the engine as much as possible for a given length of connecting-rod, but any advantages the plan may possess in this respect are far more than balanced by its obvious disadvantages.

(No. 626, 1*s.* 10*d.*) Edward Storey, of Lancaster, patents various methods of constructing steam-boilers. A description of the numerous arrangements proposed by Mr. Storey would occupy more space than we could spare here, and we shall therefore only say that the main feature of the plans is that each boiler proper is surrounded on all sides by a double casing, between which and the boiler is a space or flue through which the waste gases from the fire pass on their way to the chimney. The feed-water for the boiler is made to enter this external casing first.

(No. 631, 1*s.* 10*d.*) Charles William Siemens, of 3, Great George-street, patents some improvements in the construction of the class of spirit and water meters known as "inferential" meters, the object of these improvements being to prevent the accuracy of such meters from being impaired by contractions of their inlet passages due to deposits from the fluids to be measured. The patent also includes the exceedingly ingenious arrangement of meter for measuring and registering the amount of absolute alcohol contained in a liquid passed through it, exhibited by Mr. Siemens at the late Paris Exhibition, and described by us in *ENGINEERING* a few months ago.

(No. 633, 1*s.* 4*d.*) Alphonse Louis Normandy, of 17, New Park-road, Stockwell, patents arrangements of heated air or gas engines. In one form of these engines, in which reciprocating pistons are employed, the pistons are each made in the form of a bell dipping into a fluid of great density, such as melted lead; each piston, with the fluid, being contained in a suitable casing. The pistons are to be raised and depressed by allowing the heated air or gases to act alternately on their interior and exterior surfaces. In another form of engine, the air or gas is caused to enter the lower inverted buckets of a bucket-wheel, or chain of buckets, immersed in melted lead or other similar fluid. Various other points of detail are claimed in the patent. We fear that there will not be many engines made on these plans.

(No. 641, 2*s.*) Paul Rapsey Hodge, of 106, Cannon-street, patents various methods of constructing turbines, &c., which could not be clearly described without reference to drawings.

(No. 644, 8*d.*) William Edward Newton, of 66, Chancery-lane, patents, as the agent of William Sellers and Coleman Sellers, of Philadelphia, U.S., arrangements of valve-gear for steam-hammers. The objects of the arrangements are to enable the valves to be at any time worked, either entirely by hand, entirely by power, or partly by hand and partly by power, and to obtain from the hammer-bar a reciprocating movement to work the valve without subjecting the gear to shocks or blows. According to one plan, the valve is driven from any reciprocating part of the hammer through a properly proportioned lever, to three points, on which lever the valve, the reciprocating part, and a hand-lever are respectively connected. Each point becomes in turn the fulcrum, according to the work required from the hammer. By another arrangement the reciprocating motion for working the valve is obtained from that part of the hammer-bar, which is at all times within the steam-space.

(No. 646, 8*d.*) William Clark, of 53, Chancery-lane, patents, as the agent of George Washington Lemley, of Paterson, U.S., a method of driving fans by the direct impact of jets of steam on the fan-blades, the jets being so placed that they discharge the steam in a line with the outlet pipe by which the blast is conducted from the fan.

(No. 647, 4*d.*) Edward Lloyd, of Bow, patents machinery for grinding straw, esparto grass, and similar substances previously to their being converted into pulp for the manufacture of paper. The object of this grinding is to destroy knots and other objectionable substances which would otherwise have to be separated at a subsequent stage in the manufacture of the pulp.

(No. 650, 10*d.*) William Young, of Stratton, and Peter Brash, of Leith, patent a method of effecting the distillation of coal, shale, and other bituminous substances by interposing a stratum of gases or vapour between the casing heated by the furnace and the substance to be distilled, and causing the gases or vapour so heated to pass in a downward current through the materials contained in the distilling vessel.

THE EAST INDIAN RAILWAY.

COLONEL HODGSON has recently published a report on the station to station traffic of the East Indian Railway in the half-year ending June, 1866, from which the following particulars have been extracted: The largest receipts from passenger traffic are shown to have been at Allahabad, after Howrah and Calcutta. At Serampore the number of passengers is greater than at any intermediate station, except Allahabad, although, of course, the bulk of the traffic is with Calcutta. Next comes Burdwan. Of the entire traffic of Howrah and Calcutta, rather more than one-fifth in numbers, and just about one-thirtieth in receipts, was what may be called suburban, that is, bounded by Chandernagore, and about nine-twentieths in numbers, and nearly one-eighth in receipts, was within the limits of Burdwan, of which portion of the line the earnings amounted to about 7*l.* 10*s.* per mile per week; 25,303 passengers booked to Jaisalpoor, most of whom probably intended to go further on, and 17,598 booked at that place for Howrah and Calcutta; 756 only booked through to Delhi, and 333 down from that place, and the receipts show nearly all of these must have been first or second class. In the case of almost ever large town a large proportion of the traffic was with places within 50 miles on each side, showing that the agricultural classes use the line greatly. Between Benares and Mirzapore, Benares and Allahabad, Mirzapore and Allahabad, and Allahabad and Cawnpore, there was considerable traffic. In goods Cawnpore comes next to Howrah. In the half-year 230,568 tons, yielding 421,623*l.* of receipts, arrived at Howrah, and 53,220 tons, yielding 193,008*l.*, departed up the line. At Cawnpore 16,807 tons, yielding 47,111*l.*, arrived, and 25,631 tons, giving 86,800*l.*, departed, chiefly towards Calcutta.

INDIAN RAILWAY GUARANTEES.

A CORRESPONDENT writes as follows: "It is quite a mistake to suppose that the guarantee given by the Government to the Indian Railway is absolute and unconditional, or is not liable to dilution under certain contingencies. For example, it is one condition of the arrangement concluded with the railway companies that a line when opened shall be regularly worked, and that at least one train shall run from end to end of it each way daily. It is another condition that the railway shall be maintained at the expense of the company in good working order. If, however, any railway when opened does not pay its working expenses, the loss thence accruing will devolve upon the company, and not upon the Government, and the same result will ensue should the railway be carried away by floods, or suffer extensive injury by such accidents as those which have recently befallen the Great Indian Peninsula Railway, as upon the company falls the work of reparation. Of course the railway companies will endeavour to maintain an opposite hypothesis, and can no doubt appeal to precedents where their interpretation has been apparently admitted. Thus, in the case of the line of railway constructed by the Scinde Railway Company between Kurrachee and Ghisree, not only is there no train plying daily from end to end, but hardly a train has ever run upon it at all, and the rails are rusting out, and the works going to decay, without benefit to any party. Why has the condition prescribed by the contract not been enforced in this case? Is it because the line has not a separate contract, but constitutes a part of the Scinde scheme? Such a plea has manifestly no force, as the intention of the Government manifestly was that it should not be called upon to pay interest upon a scheme which was of no public advantage. Yet this is the very thing it is doing in the case of the Ghisree branch. Then, in the case of the Scinde main line, long after the line was declared open and complete, continual additions have been sanctioned to the guaranteed capital for repairs and reconstructions. Yet such concessions are quite inconsistent with the terms of the contract. The fault lies no doubt in lax

Government supervision, and in the plastic nature of the agent by whom the Government is represented. It is high time that the matter should now be looked in the face, and the Government should clearly understand the position into which it is allowing itself to slide."

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

(Continued from page 486.)

THE water is taken from Loch Katrine to the service reservoir at Mugdock by an aqueduct 25½ miles long, the built and tunnelled portion of which is 22 miles long, with a height and width of 8 ft., and a uniform slope of 10 in. per mile. The valleys of the Duchray, the Endrick, and the Blane are crossed by cast-iron syphon pipes 48 in. in diameter, of an aggregate length of 8½ miles, and a mean fall of 1 in 1000. Provision has been made at the bridges, and other places, for laying two additional lines of pipes when the increased consumption requires it; and one of these lines, a pipe of 36 in. diameter, is being laid between the two 48 in. pipes. On the line of this aqueduct there are no less than 25 important iron and stone bridges, and 80 distinct tunnels, varying in length from 1½ mile downwards, and forming a total length of 18 miles.

The Mugdock service reservoir is 8 miles from Glasgow, and has a water surface of 60 acres, with a depth of 50 ft. The surface of the water is 312 ft. above the level of the sea. It contains 26 days' supply at the present rate of consumption, and repairs can therefore be made on the aqueduct without interrupting the supply to the city. The water is taken to Glasgow by two lines of 36 in. pipes, with provision for additional pipes, as may be required. The sluices, self-acting throttle-valves, momentum-valves, and many other details of this great work are all worthy of notice, but I cannot now do more than allude to them. The waterworks were opened by the Queen on the 14th of October, 1859, and the total cost was 1,592,000*l*.

The water is now supplied to nearly all the villages and populous places round about Glasgow, and the natural increase of the revenue is about 5000*l*. per annum. The water rate paid is 1*s*. per pound for dwelling-houses, and 1*d*. per pound additional on all property within the Parliamentary limits.

Notwithstanding the great purity of the Loch Katrine water—more than nine times as pure as that supplied to London—the inhabitants of Glasgow yearly consume upwards of 1000 tons per annum of foreign matter in the water from that lake.

The Greenock new waterworks include two reservoirs, with an aggregate capacity of above 1,200,000,000 gallons. The embankments are 2200 ft. and 850 ft. in length respectively, with a height of about 60 ft. in the centre. The tunnel for conveying the water from these storage reservoirs to the point of distribution is fully 14 mile long, and there will be filter-beds having an area of 6700 square yards.

The waterworks commenced at Paisley consist in the construction of a store reservoir to hold 76,000,000 of cubic feet, having an area of 100 acres, a maximum depth of 35 ft., and a catchment of 1220 acres. From thence the water will be taken by an aqueduct of 6½ miles in length to filters to be constructed above the present store reservoir at Stanley, about 2 miles from the centre of Paisley. The works are also intended to provide a supply for the towns of Johnstone and Elderslie.

The new waterworks at Port Glasgow, which were opened last month, consist of a reservoir on the Finlaystone Burn, with a filter and service-tank at Parkhill. The reservoir covers an area of 26 acres, and contains 8,800,000 cubic feet of water, or more than 100 days' supply for a population of 12,000. The depth of water is 15 ft., and the top water-level is 346 ft. above the mean level of the sea. The service-tank is 256 ft. above the sea, and with this pressure the highest houses in the burgh can be supplied.

The Edinburgh Water Company are engaged in collecting and leading to the farther end of the existing aqueduct at Rashie Dean, about 12 miles south-west from Edinburgh, the springs of Crosswood, the most distant of which is about 6 miles beyond Rashie Dean. A reservoir is also being constructed on Crosswood Burn, to afford compensation to that stream and to the rival Almond for the abstraction of the spring water. The springs in question are expected to yield about 75 cubic feet per minute—say, 675,000 gallons a day—and the capacity of the reservoir is 25,000,000 of cubic feet, its area being 62 acres, and its greatest depth 38 ft. The aqueduct is laid out so as to be capable of bringing in additional springs at the boundary between Mid-Lothian and Lanarkshire, but no Parliamentary powers have yet been got for taking those springs. The additional supply now being brought in, which is barely 10 per cent. on the present supply, will serve for a few years; but, with the rapidly increasing demands of this city, some much larger source of supply must soon be found.

The details of the scheme for the drainage of the Water of Leith are so well known to the inhabitants of Edinburgh, that it is not necessary for me to do more than allude to it. Except during floods, no sewage now enters the stream from Coltbridge to the sea, and it would be absolutely limpid and free from all impurities were it not for the paper-mills and other manufacturing works along the river.

The recent jury trial regarding the pollution of the North Eak has such an important bearing on the question of the Water of Leith purification, that it may be of some interest to the society to describe the nature of that pollution, as well as the steps recently taken by the paper-makers for its amelioration.

The quantity of paper made at the mills on the North Eak has risen from 681,000 lb. in 1807 to 11,175,000 lb. in 1863.

Rags and ropes were alone used up to 1861, when Spanish grass was introduced; and, owing to the great reduction in the cost of foreign paper, following the abolition of the import duty in that year, the paper-makers gladly availed themselves of this new fibre, "Esparto," which enabled them to produce a cheaper paper than formerly, and thereby meet the competition of the foreigner.

Paper is now made from rags and Esparto, and the refuse discharged occasionally or regularly into the stream, according to circumstances, consists either of dry, semi-solid, or liquid impurities.

The dry refuse, either floor sweepings or dustings of rags, was, prior to 1841, thrown into the river, but since then has been collected and sold to farmers and others.

The semi-solid refuse is the sediment left after mixing dry bleaching powder or chloride of lime with water. Owing to the much greater quantity of chemicals necessary to bleach Esparto fibre, there has of late years been a great increase in the quantity of waste chloride of lime, and difficulty at present is found in its disposal. The paper-makers desire to keep it out of the river; and while in one or two cases the neighbouring farmers have been enterprising enough to use it as manure, yet, in the greater number of the mills the mill-owners have not been able to do better than store it in heaps, where it solidifies, and becomes in course of time quite hard. It is believed to be fitted for application to clay lands or peat mosses; but the large proportion of moisture it contains, and the distance and height above the mills to which it requires to be carried for application to suitable ground, have hitherto delayed the utilisation of the waste chloride of lime. The consumption of bleaching powder on the Eak has increased from 113 tons in 1835 to 964 tons in 1863.

The liquid impurities are, however, by far the most objectionable of the refuse thrown into the river.

In the early part of this century writing-paper was made from rags of so clean a character that no more soda was used than is employed in proportion by a washerwoman. But since then the extension of the trade, and the necessary use of rags from Russia and other countries, where the population are of very filthy habits, have obliged the paper-makers to employ rags of a much coarser and dirtier character than formerly, and thereby the great use of "soda" was begun. The quantity of soda used on the North Eak has increased from 85 tons in 1835 to 570 tons in 1856. After the introduction of Esparto fibres the soda rose to 980 tons, without any corresponding increase in the quantity of paper manufactured.

It will be seen, therefore, that the exigencies of trade and the effects of legislation have caused the paper mills, which, when first established on the Eak, were comparatively harmless, to become now an intolerable nuisance, and cause of pollution to the river to which they owe their birth.

The paper-makers have been at great expense in experiments to remedy the nuisance and in procuring the highest chemical advice; but the result can as yet hardly be called a triumph. Some of them are at present boiling down the liquors, in which Esparto has been boiled, in shallow pans, or by Swan's patent process; and by incineration of the residuum in a reverberatory furnace they get back a great part of the soda. One of the manufacturers is erecting works at the seaside, at which the Spanish grass is intended to be boiled and washed, and afterwards sent as "half stuff" up to the works to be made into paper. This, though really begging the question altogether, is highly satisfactory for the stream. Prevention is better than cure, and there appears to me no reason why all paper-makers should not buy the Esparto grass in a boiled state, instead of each man boiling it for himself, more especially as the patentees of the Esparto process are now ready to sell half stuff to those who wish it, instead of the raw fibre.

The washings from the various machines contain a good deal of fibre and colouring matter. Some of the fibre is retained by conical "save-alls," and some by submergence in settling tanks. The best invention, however, for purifying liquor containing fibre is Needham and Kite's filter-press; but it is both costly to buy and to work. One firm has three of them in use for the liquor from their three machines for making writing-paper, and they discharge 70 gallons per minute of transparent water, which, when it entered the filter, was full of fine fibre. A great deal of the ultramarine and other colouring matter is also retained with the fibre. The liquors are driven into the filter presses by a pump, and after being forced through two plies of strong cotton cloth, exude through hundreds of finely cut grooves in the framework of the presses.

I am glad to learn that the papermakers on the Water of Leith are rousing themselves from their apathy, and are likely to do as much as their brethren on the North Eak. The Water of Leith does not certainly flow through the beautiful parks of spirited noblemen, but it does flow through the metropolises of Scotland, the inhabitants of which will never reap the full benefit of the money they have laid out in purifying their stream, till those who are polluting it higher up have also done their duty in arresting the sources of the contamination.

The sewerage of Portobello was completed some years ago, and nearly half the expense of the scheme was incurred in works to preserve the purity of the sea-beach, by carrying the sewage in iron pipes out to low water.

The Haddington sewerage works are not yet commenced. It is proposed to utilise the sewage of this town by irrigating some adjoining land. For this purpose, the sewage will have to be pumped to a height of about 30 ft., and Lord Wemyss has undertaken to pay half the estimated cost of pumping.

Jedburg is bringing in a supply of above 60,000 gallons of water a day, by gravitation from the Blackburn springs to the highest part of the town.

Hawick lately got a supply of nearly 400,000 gallons per diem by gravitation from the river Allan.

Selkirk has a supply, if required, of above 100,000 gallons a day, from a well sunk in a haugh near the river Ettrick, pumped up to about 300 ft. above the highest part of the town, by a water power on the Ettrick. This river forms the natural outfall for the sewage of Selkirk, but it will be possible to irrigate above 25 acres of land belonging to the town with the sewage, after it is collected by the sewers now being formed. As the bed of the river is sometimes dry in summer, from the water going down the mill-lade, the new sewers will discharge into the lade itself, below the lowest point at which the water is used for manufacturing purposes.

The water for Peebles has been brought a distance of five miles, in a 5 in. pipe, from a stream which gives more water during dry weather than the town requires. There is, therefore, no store reservoir; but there is a small reservoir, containing about twenty days' consumption, which supplies the town while the stream is in flood. There is also ground for a filter, if required.

A waterwork and system of sewerage is being executed at Moffat. Clay pipes are used for the sewers, and the water is

brought in by iron pipes, with turned and bored joints, from some strong springs a few miles above the town.

The new water supply to the Bridge of Allan is by gravitation, principally from a burn which rises on the west of Demyat. There is a collecting and storing reservoir on the stream of 8½ acres, with an extreme depth of 20 ft., capable of storing more than 19½ millions of gallons. This reservoir is 250 ft. above the distributing tank, the greatest pressure from which will be 295 ft. The intended supply is 25 gallons per diem to a maximum population of 4500.

The burgh of Alloa is at present supplied with water from Gartmorn Dam, which lies two miles to the east of the town. The water is conducted to the filters in an open cut or lade, exposed to contamination from several sources. It is now to be taken in pipes, and large and efficient filters are also being made to provide for the increasing population.

The Dunfermline town council, having purchased the property of the water company, are constructing an additional store reservoir, to hold nearly seven millions of cubic feet. As there is at present considerable waste from overflow, it is expected this will enable the works to afford a sufficient supply for a good many years. Dunfermline has lately also been drained on the small tubular pipe principle.

The burghs of Kircaldy and Dysart, with a population of 20,000, have power to obtain a supply of water from the Falkland hills, from a gathering ground about nine miles distant, consisting wholly of pasture land, and having an average elevation of 1000 ft. The water is to be led to a distributing reservoir near Dysart, high enough to afford every building within the district a supply under pressure of from 40 to 50 gallons per head per diem. This plan of grouping adjacent burghs or populous places for water purposes might, I think, be carried to a greater extent than has hitherto been done. Small places, by combination, might then go longer distances for really good water and a plentiful supply, than they could possibly do singly.

St. Andrews has lately been drained. The town is divided into two districts, and the sewerage of each taken in iron pipes out to low water. The water supply is also being improved.

The drainage of Dundee was begun in the year 1856, and, with the exception of two outlying and thinly populated districts, the whole town has now been drained in accordance with the original plan. The town, however, is increasing so rapidly, by the addition of new streets, that the work of drainage can hardly be said to be completed. Tubular fire-clay sewers have been laid wherever tubes would suffice for the passage of the water, and egg-shaped brick sewers for the mains as they approached the outfall. There are 25 miles of tubular sewers, at an average cost per lineal yard of 13*s*., and 10 miles of brick sewers, averaging 33*s*. per lineal yard. The total cost of the drainage was about 56,000*l*. The water used for flushing the sewers is the waste water from the various mills and factories in all parts of the town, and flushing-gates are placed at numerous junctions, by means of which water can be made to flow through several series of sewers before it reaches the river. No ventilation of these sewers has been attempted, the town surveyor being of opinion that it is unnecessary where sewers are made sufficiently smooth inside and flushed with water so as to prevent all deposits. A great many of the streets at Dundee are very steep, some of them being 1 in 8; but in a few streets, where the fall is not great, and a supply of water for flushing could not be obtained, silt takes place, mostly of sand. This is cleaned out at intervals by an apparatus of a simple character. A windlass is placed over a man-way leading directly to the sewer, and another over the next man-way, about 50 yards distant. An iron chain is taken from the one windlass to the other, having scraping tools and brushes attached to it, and the sewer is easily and rapidly cleaned. In forming the sewers, it was necessary to excavate not less than 26,000 cubic yards of whinstone rock, and this was done by gunpowder, through crowded and narrow streets, without accident. Nearly all the sewage has been taken to one point in the river Tay, at a considerable distance from the town, so that at any future time it may be conveyed to the country for irrigating purposes by means of iron pipes and pumping apparatus, or be otherwise utilised.

The new works of the Dundee Water Company consist in the construction of an additional store reservoir in Crombie Den, capable of holding 32,000,000 of cubic feet. The area is 45 acres, and the greatest depth 55 ft. The reservoir is for the purpose of enabling the Water Company to store up and use the whole yield of their gathering ground of about five square miles, whereof a large part now runs to waste. This can be but a temporary expedient, and a much larger supply must soon be procured for the town of Dundee from some more distant source.

The town of Perth is divided by the river Tay into two drainage districts—the western, or Perth proper, and the eastern, or Bridgend. The natural outlet for the sewage is the river. On each side a catch-sewer is proposed to be made along the side of the river, to receive all the sewage from the street-drains, and discharge it at a remote distance below the town, keeping in view the probability of pumping it up, and applying it for irrigating the lower part of Moncrieffe Island, situated in the river a little below the town. The principal and most densely populated part of the western district lies low and flat. The gradients of the main drains will range from 1 in 750 to 1 in 200, at such depths as to admit of gradients for the house drains, of from 1 in 36 to 1 in 45. Abundant flushing is obtained for the whole of the main drains from mill-lades that intersect the town. Deodorising ventilators, reaching to the tops of the houses, are to be connected with every drain. As the western district is subject to floods, which have thrice during the last twenty years risen from 12 in. to 24 in. above the lowest parts of the streets, apparatus has been designed to prevent the sewage rising up through the gullies from the drains. This apparatus consists in a hollow india-rubber ball, hung by a chain within a water-tight chamber, so as to be entirely clear of the flow of the sewage in the gully. When acted upon by a back flow, this ball floats into the mouth of the gully-pipe, and is intended to prevent the sewage rising to the streets.

The eastern district affords for the most part facilities for step gradients in the drains.

The water supply for the western district is filtered from the river into a long drain or reservoir, in the upper end of Mon-

crieffe Island, and pumped up to a high level. The works were constructed many years ago. Of course, in carrying out the scheme of drainage, the purity of the filter-beds is kept in view. There is always a large amount of water in the river, and a rapid current, leaning rather to the western side. The lowest summer discharge is estimated to be twelve hundred times the sewage discharge. The catch-sewer in the western district will be 5 ft. diameter, of brickwork, and, in consequence of its length, capable of containing, if required, the whole sewage of the town during the short time the tide lasts at Perth.

The main drains are some of them egg-shaped, from 3 ft. x 2 ft. to 4 ft. x 2 ft. 8 in., and other pipes from 2 ft. in diameter downwards. The scheme is at present being carried out.

Important water and sewerage works have been executed recently at Aberdeen, but the information promised me has not arrived in time for this address.

In laying before the society this short notice of what has been recently done by hydraulic engineers in Scotland, rather than the general review of the yearly progress of science and art, which some of our former presidents have so ably given in their addresses, I have had to abstain from many tempting subjects of interest at the present time. The sudden change in the armaments of Europe, from muzzle-loading to breech-loading rifles; the effect of Major Palliser's chilled shots upon iron armour-plates; the world's exhibition of industry at Paris; the gradual introduction of steel, the material of the future; the meeting of the British Association at Dundee—are all tempting topics. One subject only of great interest I shall say a few words about: the effect of trade unions on the prosperity of this country. It appears to me that, in interfering so much with individual labour, these unions tend to undo a great deal of what the introduction of machinery has done to make England great and prosperous. Machinery tends to equalise labour, and to bring it to one standard; but it is to the highest possible standard. Machinery puts the child on the level with the adult. It enables any one of sufficient intelligence to attend a machine to do as much work, and as good work, as the most skilful man. Machinery spreads a given quantity of work over the fewest possible hands. But what are the unions doing? Their object is to bring down labour to the lowest practicable standard, and to lower the work of the adult; to prevent a man of industry and intelligence from doing more than a fixed low average of work; in short, to spread a given quantity of work over the greatest number of hands. Trade unions are, therefore, antagonistic to machinery, and the introduction of the latter, instead of hand labour, into every department of industry, is one of the means of counteracting their bad effects. I do not, however, consider that strikes and unions are interfering with the general progress of arts and manufactures, or the civilisation of the world at large. On the contrary, their tendency is, perhaps, to benefit the general cause of civilisation, by improving the resources of other countries. In many branches of manufacture England hitherto has had a monopoly, which she cannot hope to retain always. But now the price of labour in this country, combined with the low standard of work allowed by the unions, and the uncertainty in the labour market, which prevents manufacturers entering into large contracts with safety, must break down some of the monopoly we have enjoyed, especially in the iron trade. It is no secret to engineers that a great deal of work is at present being done abroad, which some years ago would have been done in this country. It is for the working men of England seriously to consider whether they are wise to follow a course of action which may drive away trade to countries fully prepared, by low wages, by a high standard of technical education, by the introduction of railways, and by the development of mineral wealth, successfully to compete with us in the markets of the world.

In not attempting what, in my hands, might have been an imperfect review of the recent progress of science and art, I have, of course, been influenced by the yearly increasing difficulty of giving a condensed account of science in its many branches, and of invention in its meteor-like streams. The world is in a state of scientific tension. Discovery after discovery, invention after invention, nay, whole sciences are rushing into existence, and springing up in the highly prepared and cultivated ground. In these days no man, looking back to the science of his boyhood, dare predict the wonders which his children may not live to see. It was not so formerly. The seeds of many of the most useful modern inventions were sown long, long ago, in barren ground, by men thoughtful beyond their age. The vital and essential principle was there, but required the sunshine of advanced civilisation and knowledge, or the forcing heat of necessity, to ripen it. The idea of the steam-engine was sown at Alexandria 120 years before Christ, but lay inert, like the ear of wheat in the mummy's coffin, till it burst into full activity 1800 years afterwards. The bricks of Babylon were stamped with hieroglyphic characters; but the invention of printing only sprang up in the 15th century, after lying dormant for 3000 years. Thales of Miletus, 600 years before the Christian era, noticed the phenomenon of light springing from rubbed amber; but that light was quenched and almost forgotten, till Gilbert, of Colchester, twenty-two centuries afterwards, founded the science which he named after "electron," the Greek for the sage's amber.

A man in one age used formerly to sow; another, at some distant future age, to reap.

It is to be noticed, however, that now—and the idea is a solemn one to thoughtful men—the interval between seed-time and harvest is quickly becoming shorter. Many great discoveries, many useful inventions, are sown, spring up, and ripen in a century, nay, in the lifetime of one man. Geology, an photography are sciences but of yesterday; and Wheatstone has lived to see the junction of two hemispheres by an invention at whose birth he was present.

What is to be the end of all this knowledge? If knowledge be power, then is man indeed getting powerful. To what is it all tending? What limit of knowledge can a created being attain?

We know that there was once a period in the early history of man's civilisation when they began to build a tower whose top might reach to heaven, and we are told that "the Lord came down to see the city and the tower, which the children of men builded: and the Lord said, Behold, the people is one, and

"they have all one language; and this they begin to do: and now nothing will be restrained from them which they have imagined to do."

Are we approaching another crisis in the history of man's progress? We cannot tell; but we do know, and are sure, that all things are working out the wise purposes of Him, "Who out of darkness called forth light."

SOCIETY OF ENGINEERS.

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

On the Connection between the Shape of Heavy Guns and their Durability. By ARTHUR RIGG, Jun., Engineer.

(Continued from page 487.)

THE following summary statement of the proportions between the breech and barrel of the foregoing examples will correctly represent their relative durability, if made of the same metal and on about the same scale:

I.	Fig. 8	Parrott gun	Breech 1 to barrel	2½
II.	"	5 Navy gun	"	1
III.	"	6 Columbiad	"	1
IV.	"	1 68-pounder	"	1
V.	"	9 Blakely gun	"	1
VI.	"	8 Armstrong gun	"	1
VII.	"	2 Whitworth gun	"	1

Although American guns head the list, yet it is more from accident than design on their parts; for General Gillmore, who commanded artillery operations before Charleston, and who is, therefore, a thoroughly competent authority, in writing on the subject of the uncertain and unequal endurance of the Parrott guns, remarks, that it seems to be a question of some doubt whether it is attributable to "practical difficulties necessarily connected with the mode of manufacture in its application to large guns; to varying or capricious properties in the metal used; to inherent defects in the form given to the gun; or the resultant of some or all of these several and distinct causes." In remarking upon the existing American artillery, and what ought to be its capabilities, the same writer adds: "No rifled guns of large calibre are yet made and in service possessing sufficient endurance to stand, with certainty, 800, or even 500, rounds with a service charge of $\frac{1}{4}$ to $\frac{1}{2}$ of the weight of a solid elongated projectile suitable to the gun; and the service demands a gun strong enough to sustain the shock of at least 1000 charges of powder, in as large quantities as can be burned with useful effect behind the projectile, at any required elevations."

When to these remarks is added the restriction of the monitor guns from firing more than 20 rounds, it is evident that the Americans have very little more insight into the true principles of strengthening their guns than we ourselves, and that they place no great confidence in their own gigantic ordnance.

The foregoing examples would be very incomplete without some notice of the great success recently achieved by Major Palliser's converted guns. At present they are made by boring out the 68-pounders, and inserting a coiled wrought-iron barrel with a 9 in. bore, the breech being closed by a screw. Thus these guns possess the great radial strength of Sir W. Armstrong's coils, combined with the longitudinal resistance given by the heavy breech of the 68-pounder. Originally they were made like Fig. 10, but found to give way at the part shaded; the proportions between the breech and barrel were as 1 to 6; and there was not sufficient power to resist the longitudinal strain. With the object of reducing the diameter of the screw, the plan was altered to Fig. 11; and the success of these guns is most remarkable. The proportions between the breech and barrel are now as 1 to 4½, which is exactly the same as possessed by the 68 pounder (Fig. 1); and it is very instructive to observe how the slight deviation for this proportion in Fig. 10 actually neutralised every advantage of the wrought-iron core, and gave a gun by no means remarkable for endurance.

One of these converted guns, Fig. 11, passed satisfactorily, without bursting, the following test: 100 rounds were fired altogether; the first ten with service charge of 16 lb. powder and 68 lb. shot, and adding another shot after each succeeding ten rounds; so that the last ten were fired with ten shots, or 680 lb. of metal.

Another 68-pounder, converted into a 7 in. gun by an inner supplementary coil, was proved to 800 rounds between the 8th October, 1864, and the 16th January, 1865. A small crack was discovered at the 750th round, in spite of which 50 rounds were fired without the gun bursting.

Perhaps the most severe trial was borne by a 32-pounder, converted on Major Palliser's plan. The ordinary service charge would be 6½ lb. of powder for shells, and 14 lb. for solid shot:

Rounds fired.	Charge.	Weight.		Remarks.
		Shot.	Shell.	
2	16	150	64	32-pounder converted gun.
10	20	100	64	
5	10		64	
5	16			Shells burst in the gun: they scratched the bore, but did not interfere with the subsequent loading.
10	16	64		
				Air spaces were left between the powder and shot for 5" to 25" long.
71	{ 10 to 30	{ 50 to 150		
				Gun burst with 80 lb. powder, and 150 lb. cylinder-casing cracked, but no explosion took place. Wrought-iron barrel sound, but bulged.

These examples suffice to show an endurance of a very high order, and it cannot be doubted that the wrought-iron coiled

barrel is about the strongest system for enduring a severe test: but as there are some unexplained molecular changes that take place under the influence of frequent blows, it is still a question whether guns of this material will maintain the same long-continued endurance with heavy charges that cast iron possesses with lighter charges. No heavy gun has yet been proved that cannot be burst by long-continued use, and the common test of unusually heavy charges scarcely meets all the requirements of warfare, where a long-continued endurance with the ordinary service-charge is the real test to which guns are subjected. Indeed, the actual rough practical use of artillery is frequently lost sight of in modern examples. One contains as many adjustments as would be required for an equatorial telescope, and another forms a fine specimen of the perfect accuracy of British manufactures; but in times of war the machinery of the one becomes hopelessly deranged, and a few grains of sand win an easy victory over the other. Many of the other attempts are so eminently impractical, or so useless, even if perfectly successful, that it is really marvellous why they should ever have been tried.

There seems to be much confusion as to the real nature of the forces acting in a gun. It is not a pressure like steam, but a sudden violent blow, depending upon the "strength of the powder." The error of considering this force a pressure, and not an impact, may be found pervading most writings on the subject. The following remarks are from the pen of no mean authority, and they indicate this misapprehension very clearly: "Cannot we have a system by which a shot shall be impelled by the action of the powder-gas on a piston or base of twice, or even three times, the diameter of the shot, and presenting, therefore, four or nine times its sectional area? Only in this way can we hope to obtain low-pressure unburstable guns, which shall, nevertheless, fire the very heaviest shot, of the very best form for penetration, at the very highest velocities."

The same idea lurks in the following remarks by Major Palliser, although the last sentences contain the gist of the whole argument:

"There are two ways in which a gun can be burst, viz., by the bursting of the barrel, or by the end being blown off. . . . In an ordinary cast-iron gun the whole longitudinal pressure acts upon the end of the bore. If the bore be 8 in. diameter, this pressure will, in round numbers, be distributed upon 50 square inches. If, however, the gun be bored up to 13 in., and lined with a barrel 2½ in. thick, the longitudinal pressure will act upon 50 square inches, as before, but will be transferred to a surface of about 130 square inches; and thus the longitudinal strength of the gun becomes more than doubled. In fact, every way of regarding the subject shows that the circumferential strength should be applied internally, and the longitudinal strength should be borne by the outside; and this is precisely the reverse of the principle upon which the wrought-iron guns of the service are made."

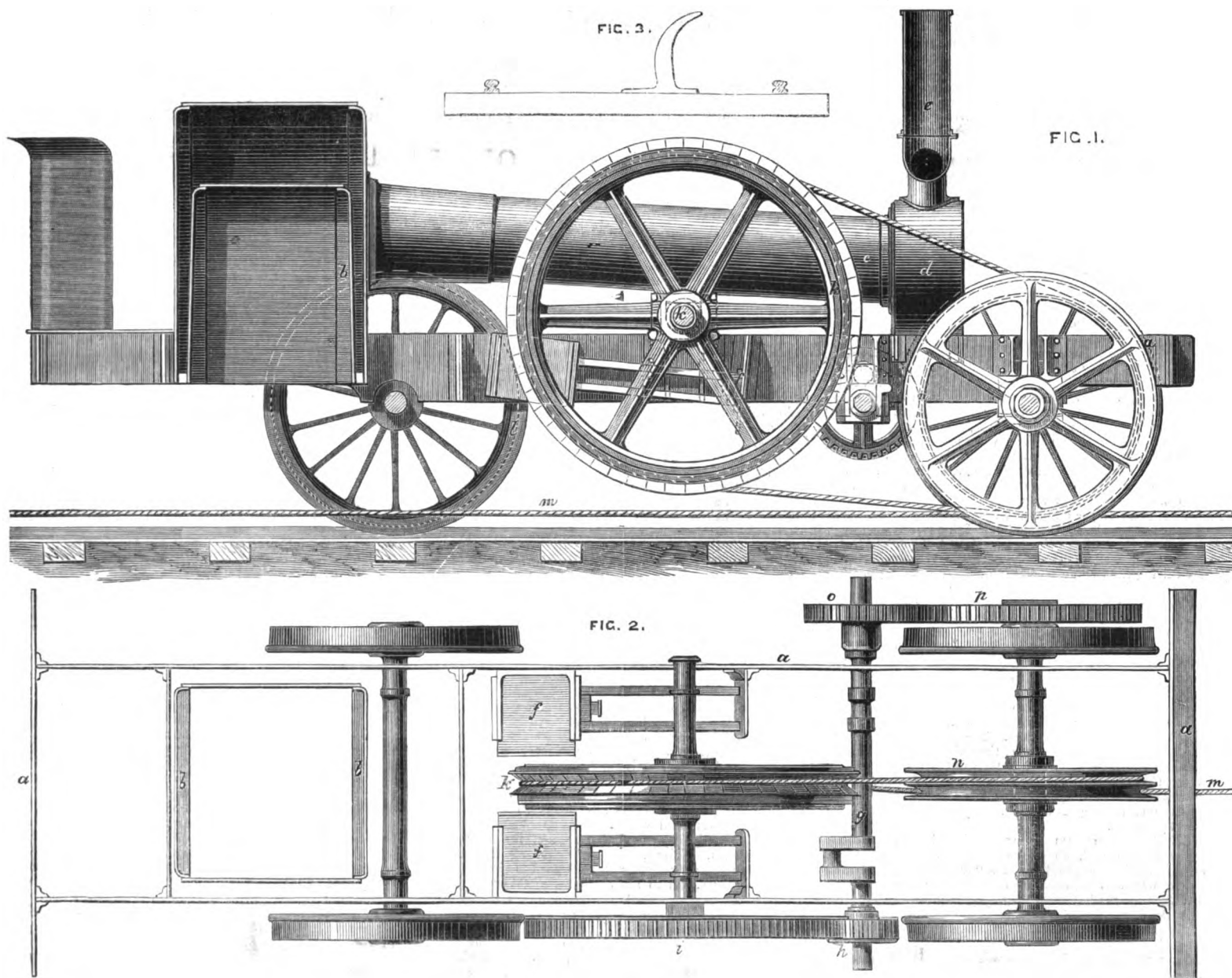
This is about the most recent and explicit declaration that has been made on the subject of longitudinal strain, and may fairly be regarded as the final opinion of the War Office authorities. The idea of separating the forces into circumferential (or radial) and into longitudinal is very correct in theory, and practical, as well as the assignment of a special share of duty to each part of the gun; but the force of explosion, or, more correctly, the blow given by the shot, and exerted on 50 square inches, cannot be reduced by spreading it over 130 square inches, unless it be at the same time received and absorbed by an additional mass of metal. If the cubic contents of the breech remain unchanged, no alteration in the form of construction will make any less longitudinal strain; but if, instead of some square inches area, a few cubic inches of metal were added behind the breech, then the endurance of these guns would be greater, and the coil welds would not open. No strength can be added by an imaginary transference of the blow from a small surface to a larger area, without there be more foundation to receive and absorb it. Were the gun closed at both ends, and a charge of powder fired, then, perchance, the argument of differential areas might be worth something, though it looks rather obscure; but once let the shot be discharged, and the question becomes one of impact and not of pressure; and to the confusion between these two kinds of forces may generally be traced the long, costly series of failures which have marked the progress of so many years.

In conclusion, it is evident that there can be no reason why English guns shall not always reliably exhibit the same endurance that was shown by the solitary Parrott gun that bore 4606 rounds. It is simply a question of correct principles of construction, and if it be desired still further to enhance the powers of the guns which Major Palliser has begun so well, the question of longitudinal strain is that to which attention must be given. Great success has already been achieved by returning to the old 68-pounder, with its weight of breech and barrel as 1 to 4½; but a still larger development of this principle, even to the American proportion of 1 to 2½, or perhaps in some cases surpassing this, will produce a gun which cannot be equalled upon any other system, still less is it likely to be excelled.

STATE EDUCATION.—Lord Russell's resolutions on national education, to be moved in the House of Lords on Monday next, are the following: "1. That in the opinion of this House the education of the working classes in England and Wales ought to be extended and improved; every child has a right to the blessings of education, and it is the duty of the State to guard and maintain that right. In the opinion of this House the diffusion of knowledge ought not to be hindered by religious differences, nor should the early employment of the young in labour be allowed to deprive them of education. 2. That it is the opinion of this House that Parliament and Government should aid in the education of the middle classes by providing for the better administration of charitable endowments. 3. That it is the opinion of this House that the Universities of Oxford and Cambridge may be made more useful to the nation by the removal of restrictions, and by the appointment of a Commission to consider the better distribution of their large revenues for purposes of instruction in connexion with the said Universities. 4. That the appointment of a Minister of Education by the Crown, with a seat in the Cabinet, would, in the opinion of this House, be conducive to the public benefit."

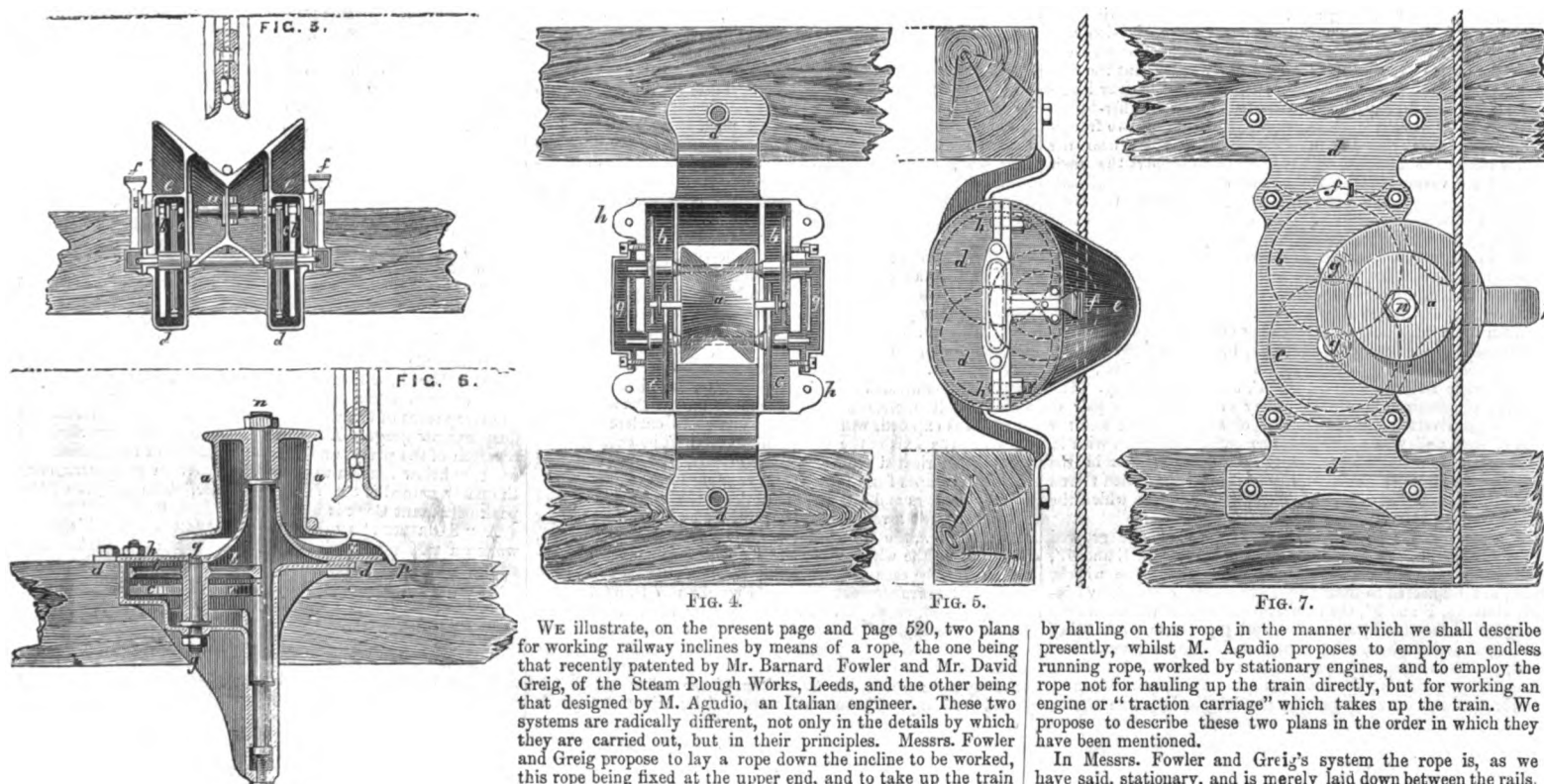
LOCOMOTIVE WITH CLIP-DRUM FOR STEEP GRADIENTS.

DESIGNED BY MR. BARNARD FOWLER AND MR. DAVID GREIG.



ROPE-CARRYING PULLEYS FOR USE ON STEEP GRADIENTS.

M. AGUDIO, ENGINEER,



We illustrate, on the present page and page 520, two plans for working railway inclines by means of a rope, the one being that recently patented by Mr. Barnard Fowler and Mr. David Greig, of the Steam Plough Works, Leeds, and the other being that designed by M. Agudio, an Italian engineer. These two systems are radically different, not only in the details by which they are carried out, but in their principles. Messrs. Fowler and Greig propose to lay a rope down the incline to be worked, this rope being fixed at the upper end, and to take up the train

by hauling on this rope in the manner which we shall describe presently, whilst M. Agudio proposes to employ an endless running rope, worked by stationary engines, and to employ the rope not for hauling up the train directly, but for working an engine or "traction carriage" which takes up the train. We propose to describe these two plans in the order in which they have been mentioned.

In Messrs. Fowler and Greig's system the rope is, as we have said, stationary, and is merely laid down between the rails,

being secured at the top of the incline, or at the upper end of each section of it, if it is worked in two or more lengths. The rope employed is a steel rope of the kind used with steam-ploughing tackle; but its strength may of course be varied according to the work it is required to perform. It is carried on suitable cast-iron supports, which may be fixed to the sleepers by trenails. These supports are of the form shown in Fig. 1, and they are placed at varying distances apart according to the curvature of the line, the "horn" by which the rope is guided back to its place when dropped by the engine, being always placed on the inner side of the curve. Where the line branches or is met by sidings, arrangements are provided for coupling the main-line rope to either of those of the branch lines by a shackle or other convenient means, and appliances are also provided for securing the ends of the branch-line ropes when the latter are disconnected from the main rope. It is proposed to lay a single line on each incline, and in cases where the latter is of considerable length, to provide loop lines or passing-places, where the trains can be transferred from one engine to another, the engines themselves not passing each other, but remaining on the main central line, and hauling their trains over the loop lines by means of hook-rope.

The arrangement of the engine which Messrs. Fowler and Greig propose to employ for hauling on the fixed rope is shown by the engravings on the previous page, which comprise a longitudinal section and plan. The engine consists of a frame, *a*, carrying a tubular boiler of the locomotive form; but instead of this boiler having a single barrel, as usual, it has two barrels, *c*, placed side by side, at a short distance apart, so that the winding drum can work in between them. The firebox casing, *b*, is made rather high, and the barrels, *c*, and the tubes contained in them, slope downwards towards their smoke-boxes, *d*. The barrels only have this downward slope, however, when the engine is on a level piece of line; when the engine is on the incline on which it is intended to work, the barrels become nearly or quite horizontal. The chimney, *e*, is branched at its lower end so as to join both the smoke-boxes of both barrels.

The cylinders are placed at *f*, and the connecting-rods are coupled to cranks on the crank-shaft, *g*. The engine is carried on two pairs of wheels, *l*, the hind pair being merely carrying wheels, whilst the leading pair are capable of being driven from the crank-shaft, *g*, by means of the pinion, *o*, and spur-wheel, *p*. By driving the leading wheels from the crank-shaft in this manner, the engine can be moved on a level where the rope is not laid down, or where it is disconnected. The pinion, *o*, is driven by the crank-shaft, *g*, through the intervention of a clutch, so that it can be thrown out of gear when desired. The crank-shaft, *g*, also carries another pinion, *h*, which gears into the spur-wheel, *t*, placed on the shaft, *k*, and connected to it by a clutch. The shaft, *k*, runs in bearings fixed to the frames, *a*, and it carries midway between the frames the winding-drum, *k*, this being one of the well-known "clip" drums first used by Messrs. Fowler on their ploughing-engines, and since applied by them for other winding purposes. The rope, *m*, first passes in contact with one of the grooves of the guide pulley, *n*, on the leading axle of the engine, and is then led rather more than half round the clip drum, and back again to the other groove of the guide pulley, which lays the rope again between the rails. The working of the engine will be readily understood without further explanation.

In M. Agudio's system the rope, which is of steel wire, is, as we have stated, an endless one, driven by stationary engines; and it is employed to work a "traction carriage," the adhesion of which is depended upon for hauling the train up the incline. In the "traction carriage," represented by the elevation and plan on page 520, this adhesion is obtained not merely by the insistent weight of the carriage itself upon the rails, but by employing a series of horizontal wheels to clip a mid-rail, as in Mr. Fell's Mont Cenis engines. The rope is arranged to traverse outside the rails, the ascending portion being on one side and the descending portion on the other, and both portions are employed to give motion to the "traction carriage" in the manner which we shall now proceed to explain.

The mechanism of the traction carriage is divided by M. Agudio into four parts, namely, the apparatus receiving the motion from the travelling rope, the gearing transmitting this motion to the wheels, the appliances for obtaining adhesion, and the brake apparatus. These four portions we shall describe in their respective order, first saying a few words about the carriage itself. The framing of the carriage consists of four longitudinal frames, *M*, *N*, *M'*, *N'*, connected by the buffer-beams and by the intermediate cross frames, *P*, *P'*. The two frame-plates, *N*, *N'*, are placed at a short distance apart near the centre line of the machine, and they serve to support the inner ends of the various shafts, &c., whilst the other frames, *M*, *M'*, are placed outside the carrying wheels, and are of the form shown in the side elevation. The carrying wheels, of which there are two pairs, are 2 ft. 3½ in. in diameter, and are placed 10 ft. 4 in. apart from centre to centre. Their axles have outside bearings, and are provided at their ends with cranks, as shown in the figures. The details connected with the horizontal wheels will be described presently.

What M. Agudio terms the receiving portion of the mechanism consists of four grooved pulleys, *A*, *B*, *A'*, *B'*, each 4 ft. 7 in. in diameter, and each carried by an independent shaft, these shafts being lettered *a*, *b*, *a'*, *b'*, respectively. The grooved circumference of each pulley is formed by a pair of angle irons rivetted one on each side of an iron plate; and the boss of each pulley has a pinion formed in one piece with it. These pinions are marked *C*, *D*, *C'*, *D'*. The grooves in the rope pulleys are filled for a depth of about 1½ in. with tarred hemp tightly hammered in, this forming a bed upon which the steel wire rope bears.

The gearing for transmitting the motion of the grooved pulleys to the wheels consists of two spur wheels, *E* and *E'*, which gear with the pinions already mentioned. The wheels, *E*, *E'*, are connected to their respective shafts, *a* and *a'*, by friction clutches, *F* and *F'*, the frictional surfaces of these clutches being forced together by a constant spring pressure, so that they will slip if too much strain is brought to bear upon them. This arrangement is adopted to prevent an undue strain from being at any time applied to the endless rope. The friction clutches are thrown into or out of gear by the handle, *L*. The shafts,

e, *e'*, carry at their ends cranks, *ff'*, from which rods, *gg'*, *g'*, *g*, respectively extend to arms, *h* and *h'* on the two rocking-shafts, *o*, *o'*, situated near the front end of the machine, and it is from these rocking-shafts that both the vertical and horizontal wheels of the carriage are worked.

The manner in which the motion is communicated from the endless rope to the wheels is thus as follows: The ascending portion, *c*, of the endless rope passes round the grooved pulleys, *A*, *B*, and drives—through the pinions, *C* and *D*, the wheel, *E*, and the friction clutch, *F*—the shaft, *a*; and the crank at the end of this shaft imparts an oscillating motion to the rocking lever, *f*, to which it is connected by the rod, *g*. In the same manner the descending portion, *c'*, of the rope imparts through the corresponding parts on the other side of the carriage an oscillating motion to the lever, *f'*. The oscillations of the levers, *h* and *h'*, are isochronous, but one is half a stroke in advance of the other, the cranks, *rr'*, on the carrying axles, to which the levers are connected by the rods, *gg'*, being at right angles to each other. This arrangement for communicating the rotary motion of the shafts, *e*, *e'*, to the carrying wheels appears to be a very roundabout one; but M. Agudio states that it has been adopted on account of its enabling him to get over the difficulty of the two shafts, *e* and *e'*, being driven by the rope in opposite directions.

Besides the two sets of mechanism on either side of the machine being driven in opposite directions, however, there is another point requiring special attention, and that is, that the pulleys, *A*, *B* and *A'*, *B'*, are driven at a different circumferential speed. The ascending and descending portions of the endless rope, of course, run at the same velocity, but the speed imparted to the grooved pulleys is respectively due to the difference between the speed of the corresponding portion of the rope and that of the carriage. Thus the circumferential speed of the pulleys, *A* and *B'* (around which the descending portion of the rope passes), is that due to the sum of the respective speeds of the rope and carriage, whilst that of the pulleys, *A* and *B*, is that due to the difference of these speeds. In the case of the traction carriage we are describing the rope is intended to be run at a speed three times as great as that of the engine, the diameter of the carrying wheels being one-half that of the grooved pulleys; and it thus follows that the circumferential velocity of the pulleys, *A* and *B*, will be double, and that of the pulleys, *A'* and *B'*, four times that of the carriage. The speed of the pulleys, *A* and *B*, being thus twice as great as that of the pulleys, *A'* and *B'*, the pinions, *C* and *D*, and wheel, *E*, are all made of one uniform size, whilst on the other side of the carriage the wheel, *E'*, is of double the diameter of the pinions *C'* and *D'*; and the shafts, *e* and *e'*, are thus driven at an uniform speed.

As will be seen from the plan, there are three pairs of horizontal wheels, *u* and *u'*, the axles of these wheels being carried by a pair of movable frames. These two frames are capable of sliding on guides fixed to the transverse frame-stays, *F*, *P*, so that they can be approached to, or withdrawn from, the centre line of the engine. The movement of the frames is effected by the handle, *Q*, which works, through the intervention of bevel gearing, a pair of right and left handed screws acting on the extremities of the pair of double beams, *R* and *R'*. Each of these double beams is coupled to the ends of three springs, *z*, the centres of which are connected to the lower bearings, *y*, *y'*, of the axles of the horizontal wheels. The upper bearings of these shafts are also carried by the sliding frames, the latter being thus of a box form. This arrangement is similar to that adopted on Mr. Fell's engines, and it has been designed to give a certain amount of elasticity, and to allow the horizontal wheels to adjust themselves, to some extent, to the curvature of the road. The axles of the horizontal wheels have cranks at their upper ends, these cranks being coupled by rods, and the front pair being also connected by the rods, *tt'*, to a pair of crossheads, *ss'*, worked by arms on rocking-shafts, *o*, *o'*. The horizontal wheels are also connected by intermediate pinions, as shown in the plan.

The brake apparatus consists of a pair of steel jaws, *K*, *K'*, which, when closed, clip the central rail, these jaws being acted on by means of screw and bevel gearing worked by the handle, *H*, placed within convenient reach of the man in charge of the machine. The friction clutches, *F*, *F'*, also act as brakes to some extent, as they enable a retarding force to be exercised through the horizontal wheels and carrying wheels.

We must now describe the arrangements employed by M. Agudio to support the endless rope. These are shown by Figs. 3, 4, 5, 6, and 7, on page 517; Figs. 3, 4, and 5 being respectively a transverse section, sectional plan, and side elevation of the supporting pulleys used on straight portions of the line, and Figs. 6 and 7 being a vertical section and plan of the arrangement employed on curves. These pulleys are very ingeniously arranged, the bearings being constructed on Attwood's plan, so as to diminish the friction as much as possible. Referring to Figs. 3, 4, and 5, it will be seen that the pulley, *a* (which may be of cast iron or of wrought iron in two pieces), on which the rope rests, has its axis carried by four wheels or rollers, *b*, *c*, *b'*, *c'*, placed in pairs upon two shafts running in bearings, *g*, *g'*. The discs or rollers just mentioned overlap each other, as shown in the plan, and the axis of the main pulley is furnished with collars, which run between the discs, and prevent lateral displacement. The whole of the apparatus is enclosed in a cast-iron case divided into three chambers, that in the middle, which is bottomless, containing the main pulley, the upper part of which is exposed, whilst the side chambers enclose the discs on which the axis of the main pulley rests. The axes of these discs are lubricated from the oil-reservoirs, *f*, *g*, the excess of oil which escapes from the bearings running down to the bottoms of the chambers and serving to lubricate the circumference of the discs. The arrangement is such that by loosening the four small bolts, *h*, the upper part of the casing can be lifted off, thus leaving the whole of the details clear for inspection or removal. In the case of the pulleys used on curved portions of the line, the arrangement shown in Figs. 6 and 7 is, as we have already stated, employed. In this case the pulley, *a*, is entirely above the casing, *d*, and consists of a roller fixed upon a vertical shaft, *n*, which is guided by a brass tube or socket. The lower end of the spindle runs in a bearing, and bears upon a screw by means of which the position of the roller can be adjusted vertically, and about the middle of its height the spindle

bears against the circumferences of a pair of friction discs, *b*, *c*, arranged to overlap each other, as shown in the plan. The discs run on spindles, *g*, secured as shown in Fig. 6, and, in order to ensure efficient lubrication, the box containing them is filled with oil through the opening, *f*. It will be noticed that, as shown in the vertical section, the pulley is made hollow, and the top of the casing is carried up within it so as to prevent, as much as possible, the entrance of dust or dirt into the chamber containing the anti-friction discs. The same arrangement of pulleys is used on all curves, whatever the radius may be, the distance between the consecutive pulleys being, however, decreased with the decrease in the radius. M. Agudio's rule is to place the rollers at a distance apart of not more than 2° of the arc of the curve.

The frictional resistance of the pulleys will of course vary according to the weight of the rope supported, the weight of the pulleys themselves, the distance of the pulleys apart, the curvature of the line, and the dimensions of the various spindles and anti-friction rollers, &c. In the case of pulleys having the proportions shown in our engravings, however, placed on a straight line at a distance of 12 metres (19 ft. 4½ in.) apart, and carrying a rope weighing 2 lb. per yard, M. Agudio estimates the resistance of each pulley (measured at the circumference) at 0.08124 lb. On a curve of 200 metres (658 ft.) radius, the pulleys would, according to M. Agudio's rule, be placed at a distance apart of 7.98 metres (about 26 ft.), and the total resistance of the pulleys (measured at their circumference) on a length of one kilometre (= 621 mile), is estimated by M. Agudio as 32 kilogrammes = 70.4 lb.

We have now described the main features of M. Agudio's system, and our notice has run to such a length that we are compelled to make our remarks upon it as brief as possible. The main advantages claimed by M. Agudio are, that as the rope is run at a much higher speed than the traction carriage itself, the strain upon it is reduced, and it may thus be made lighter and be worked with less friction, whilst, as it is not employed for hauling the train directly, there is comparatively little chance of an accident in the event of the rope breaking, it being possible to hold the train by means of the brakes. For working the rope M. Agudio proposes to employ water power one winding engine being situated at the top and the other at the bottom of each incline. When the upper end of the incline is situated at a great elevation, he also proposes to provide steam power for working the upper winding machinery, this power being available in the event of the supply of water failing. Against these advantages may be set the complication of the arrangement, and the fact that the whole traffic on a line worked on this system is likely to be stopped by an accident to one of the winding engines. This last objection could, however, be overcome by providing duplicate sets of winding machinery, and on any important line this would probably be done. It appears to us, also, that the construction of the traction carriage might be greatly simplified. The plan of converting the rotary motion of the reciprocating motion, and then reconverting this into rotary motion again, is very objectionable, and we feel sure that complicated system of coupling and connecting rods would be found to give trouble in practice. As in the case of Mr. Fell's engines, also, there is every reason to believe that the unequal wear of the tyres of the vertical and horizontal wheels will give much trouble, and it is, in fact, more than doubtful whether the mid-rail system will ever be capable of being worked with success. For inclines less steep than, say, 1 in 10 or 1 in 11, also M. Agudio could well dispense the mid-rail and gripping wheels, and could obtain the necessary adhesion by placing on the traction carriage a portion of the load to be taken up, thus increasing the insistent weight of the carriage upon the rails. Of course, in this case the number of carrying wheels would have to be increased in order to keep the weight resting upon each wheel within moderate limits, and it would be desirable to provide a system of compensating beams by which the load would be equally distributed on all the wheels.

M. Agudio exhibited one of his "traction carriages"—without the mid-rail gear, however—at the International Exhibition of 1862, and the particular machine shown in our engravings was exhibited at the late Paris Exhibition. Some experiments with the former carriage were conducted at Dusino in September, 1863, and some very good results obtained; and other trials have from time to time been made. Of these trials, however, our space will not allow us to speak at present, and we must therefore postpone any notice of them to a future occasion, when we shall have some further remarks to make on M. Agudio's system of working inclines, as well as on that proposed by Mr. Barnard Fowler and Mr. Greig.

GREAT GLACIER OF NEW ZEALAND.—The *Westland Observer* has an account of a visit paid recently by the chief officers of the Geological Department to the great glacier on the west side of Mount Cook. The foot of the glacier, which is but 13 miles from the sea, is 1900 ft. wide. The great peculiarity of this glacier is not only its immense size, but the consequent fact of its descending to so low a level, 640 ft. above the sea level, instead of ending, as is usually the case, at an altitude of some 3000 or 4000 ft., close to the limit of perpetual snow, among Alpine vegetation. Here the green bush extends some thousands of feet above the glacier, on the steep sides of the range in which the glacier has cut the deep narrow gorge. Not a single Alpine plant rewarded the research of the party, and the temperature on the glacier was scarcely below that on the flat below. With some ceremony the party named it the Victoria Glacier. The height of the peak of Mount Cook is found to be 12,382 ft.

A "SACRIFICE" IN BOOKS.—Mr. Scott's Russell's great work on "Naval Architecture" was published at 31l. 10s. to subscribers, and 42l. to other purchasers. We understand, however, that a well-known publishing firm lately bought 500 copies at 30s. each, and they will be sold at 2l. 10s. A swindling canvasser lately obtained the work, unbound, from a draughtsman at the Thames Ironworks, on the pretence of getting it cheaply bound for him. The fellow was caught, and got four months' hard labour for his rascality. The value placed upon the book by the owner was 4l. 4s.

THE ELECTRICAL ANTI-INCRUSTATOR.

TO THE EDITOR OF ENGINEERING.

SIR,—The efficient way in which the electrical anti-incrustators perform their work, both of preventing incrustation in new boilers and of the removal of it from old ones, is a fact upon which it is not necessary to insist. But hitherto I have not found any theory of this apparatus which has appeared to me to be sufficiently satisfactory. The most reasonable one I have heard is that of decomposition* underneath the incrustation: but this theory is untenable in the majority of cases, from the fact that, the quantity of electricity developed being very little and the decomposing surface very large, the current in each point may be regarded as infinitely small. I have, therefore, been led to seek for another explanation, and have found one, which I offer, with all modesty, to the consideration of electricians.

The anti-incrustator consists of an arrangement of metallic points fixed in a boiler, in such a position that it collects the electricity carried by the outgoing steam. In a word, the application of this apparatus converts a boiler effectually into an hydro-electrical machine. In Mr. Baker's form, a star of metallic points is supported in an insulating collar, and connected electrically with the plates of the boiler by means of a copper wire. When the steam is passing by the star, the latter becomes electrified, and communicates its electricity, through the copper wire, to the boiler. It is probable that the water is charged, at the same time, with a similar amount of the opposite kind of electricity.

Now there are two different things to be accounted for: 1st, that if the boiler is new, it receives no incrustation; and, 2nd, that if it is an old one, and even thickly incrustated, the incrustation breaks up and falls to the bottom.

The first may be accounted for in two ways. According to Jürgensen's experiments,† particles of solid matter suspended in badly conducting fluids, which are under the influence of an electric current, move bodily from one pole in the direction of the other. Supposing now a current to be established between the metal of the boiler and the water, through the steam, which, in its formation, may carry off sufficient of one kind of electricity to leave the water charged with the other kind, the suspended particles might have a tendency to go from all sides of the boiler towards the centre. The other explanation is, that the suspended particles, the instant they touch the sides of the boiler, become charged with the same kind of electricity, and are therefore repelled from it.

The second phenomenon, that of the breaking up of an old incrustation, is more complicated. When the inner surface of an ordinary boiler is covered with a thick deposit which is heat-insulating, the interior of the latter becomes the virtual boiling surface, whilst the boiler-plates become superheated and very quickly burn away. As soon, however, as the electrical anti-incrustator comes into play, the water and the metal parts take opposite electricities, which are able to attain a comparatively high tension, because the incrustation acts as a dielectric. It would seem that, under these circumstances, a phenomenon of repulsion,‡ which is familiar to every student of static electricity, steps in. The phenomenon in question is that of the emission of water from a bucket through a capillary tube, or out of a sponge, as soon as it is brought into connexion with the prime conductor of an electrical machine.

When the water in the boiler is electrified, it is able to percolate through the pores of the incrustation, just as it does through a capillary tube in running out of the bucket, which it was unable to do when in an unelectricized condition. Forcing their way through the deposit, the water particles, attracted, perhaps, in the same direction by their opposite electrical state, approach the superheated surface of the boiler, where they are converted suddenly into steam, and, in expanding, burst up the incrustation. According to this view, electricity plays but an indirect rôle in the affair—that of facilitating only the percolation of the water through the incrustation, on the under side of which it explodes in its formation into steam. In the prevention of further incrustation, however, it is probable that electricity comes more directly into action, in causing, as I said before, the solid particles to be repelled from the boiler surface by similar electrification, as soon as they make contact with it, or by the law which causes a definite motion to be imparted to particles of solid matter suspended in a badly conducting fluid through which a current of electricity is passing.

London, October 28, 1867.

ROBERT SABINE.

THE RIVER AMAZON.—The British Consul at Pará, in an official report, and referring to the recent opening of the Amazon to the shipping of all nations, observes that it must be some time before foreign capital can compete with the subsidised Brazilian company who own the eight steamers now on the Amazon. The contract was made in 1852 for twenty-five years, at an annual subsidy of about 80,000*l.*, and the amount has since been increased. The company, in 1866, carried 10,249 passengers, receiving 12,000*l.* for passage money, and 33,000*l.* for freights. The total value of produce exported from the Amazon in 1866 amounted to 799,983*l.* The imports to Pará amounted to 510,429*l.* sterling. The trade with Bolivia by the Madeira river has much increased, and will make considerable further progress whenever steam navigation is re-established. The trade with Venezuela by the river Negro has but little increased, as no steam communication has as yet been re-established. The Amazon river is navigable as far as the frontier port of Tabatinga for vessels of the largest size, but the different tributaries, though of great breadth, are crossed by waterfalls or hidden banks, rendering them impassable by vessels drawing much water. The two provinces of Pará and Amazonas have together a population of about 300,000 souls, without including the wild Indians who infest the dense forests, and many of whose tribes are almost unknown.

* ENGINEERING, vol. iii., p. 24.

† See the "Archiv für Anatomie," &c., 1860, p. 673.

‡ Lardner's "Handbook of Electricity," page 71.

THE GLASGOW LOCOMOTIVE WORKS.

(Continued from page 475.)

THE foundations for the machine tools are built up in solid masonry from a considerable depth below the floor of the shop, the straight rows in which the machines stand allowing this to be effected by raising plain straight walls in the foundations parallel with the outer main walls of the buildings. Each wall is covered at the top with heavy cast-iron plates, bolted down firmly through the entire depth of the wall. The machines are placed upon these cast-iron plates, requiring no further attachment, and are therefore removable at will, whenever the necessity for repairs or an alteration in any of the internal arrangements should make this desirable. Many of the drilling-machines are fixed to horizontal beds attached to the columns of the building. Each of these machines is simply the jib of a radial drilling-machine, with one or two drilling-heads fitted to it and fixed to a pair of columns instead of being supported on a pillar. A very firm support is thus formed, and it allows the two drills to be placed at any required distance from each other, so as to bore two holes at the same time. The drills are, however, independent of each other in working. The machines for boring the bosses of wheels have a very ingenious arrangement for withdrawing the boring-bar when the hole is completed. The nut which incloses the feed-screw at the top of the boring-spindle is made in two halves, and can be opened and closed by the attendant by means of a hand-lever. The spindle is overbalanced by a counterweight, which draws the bar up very quickly the moment the nut looses its grip upon the thread of the feed-screw, and the feed motion is ready for self-action whenever the attendant brings the two halves of the nut to a close. The boring of the wheels is the first operation in the turning-shop, as the system of finishing wheels and axles upon their own bearings is carried through in all operations. The wheels are turned upon steel mandrils, which take the place of the axles until the latter are combined with their respective sets of wheels, and the final turning of the tyres is effected by running them upon their own axle, and in bearings fitted between the face-plates of the double-wheel lathe. It is only due to Mr. Dubs to state that the beautiful double-wheel lathe which we noticed in our recent description of the Hyde Park Locomotive Works, and which we erroneously ascribed to Messrs. Neilson Brothers, instead of the firm of Neilson and Co., was made from his designs at the time he was connected with the last-named firm. The double-wheel lathe at the Glasgow Locomotive Works is of the Whitworth Company's make; the two face-plates are each driven by independent driving gear, and in working together they are not connected by a driving-shaft, as usual in double-wheel lathes. Mr. Dubs finds that there is no sensible torsion upon the axle in this case, as the two face-plates are very correctly speeded, and each has sufficient power to overcome its share of the work without any considerable fluctuations in the speed. A very fine and costly machine is in use for "quartering" or boring the crank-pin holes in locomotive driving wheels. This machine has been designed by Mr. Dubs, and made at his own works with the greatest care and precision. It consists of two headstocks placed opposite each other on a solid bed, each of the heads carrying one boring spindle upon its inclined side. The axles are in this machine held between centres, and not upon their own bearings; but the strain upon the centres is relieved by supports, which can be adjusted from the bed so as to hold the tyres and remove the action of their weight from the centres. Mr. Dubs, on a previous occasion, constructed a simpler machine for boring the crank-pin holes from the inside, but that machine was not as complete as the one now in his works. The planing-machines work with Mr. Whitworth's reversing tool, and their tables are provided with some very convenient chucks for holding numerous pieces of work which are simultaneously operated upon. The lathes for turning railway axles, which have been first specially made for Mr. Dubs by the Whitworth Company, have since come into great favour, and the Whitworth Company have exhibited one at the Paris Exhibition.

A great number of small shaping-machines is used for shaping nuts and bolt-heads, most of the latter being cut to a hexagonal shape from round forgings, as we before stated. A very striking innovation is the attention and care bestowed upon the precision of moulders' work in the foundry. The moulding-boxes for the locomotive cylinders are all planed and squared at their joints in the position corresponding to the central axis of the cylinder, a pair of holes or bearings are bored out so as to form a nice fit for an iron

spindle in the centre of the pattern. The pattern itself is built up upon that iron spindle, and runs upon the latter in the lathe, so as to make the axis of the spindle the proper centre line for the cylinder itself.

The system of general management is very remarkable, and worthy of imitation. The drawing-office is looked upon and strictly maintained as the place where every detail has to be worked out, and no afterthoughts or alterations are allowed to be carried out in any of the working departments. The details are not only drawn out each complete by itself, but drawings upon small sheets of paper, say 12 in. x 15 in. in size, are made of every single piece required, and these small sheets are more conveniently used in the shops, each by the parties immediately requiring it, than is the case with large drawings which contain a great number of details clustered together. This necessitates the making of a greater number of tracings than is usual in similar establishments, and Mr. Dubs has been extremely successful in procuring suitable "hands" for doing this class of work. There is a special drawing-office in the Glasgow Locomotive Works, apart from the rest of the offices, and this is occupied by three women selected from a factory where they had obtained some practice in drawing patterns for cloth-printing. Mr. Dubs states that they have been extremely quick in acquiring the necessary skill for correct tracing, that they work with superior accuracy and industry as compared with the well-known class of apprentices and other individuals comprised under the technical denomination of "youngsters," and last, but not least, that they have no ambition to make designs of their own, but keep to copying all the more faithfully and conscientiously the more skill they acquire. We need hardly state that these tracings are done at a very economical rate, and that they save a vast deal of time and trouble to the more valuable and higher paid draughtsmen in the office. Mr. Dubs has sagaciously taken the precaution of dividing the drawing-office for his female employees into small compartments by thin partition walls reaching up to the ceiling, so that the girls cannot see each other, and, as far as we can judge, have less inducement to carry on conversation to any excessive degree. We lay some value upon this very successful attempt to employ women for making tracings, since it shows a mode of overcoming the universally known difficulty of copying engineering drawings at a cheap rate and in a suitable style. The facility for supervision and order effected by the arrangement of a central store, through which all the work must pass, is similar to that we have noticed in our description of Messrs. Neilson and Co.'s works; but Mr. Dubs has gone a step further in his own works, by laying out graphical registers or tables of the whole movement of work as it goes on in the different branches of his establishment. These tables are laid out in advance, and they show within certain limits at what precise date such special article is expected to pass, say, from the forge to the turning-shop, or from the boiler-shed to the erecting-shed. The date of delivery of each engine is thereby marked and shown on these diagrams for many months in advance, and the state of affairs is checked and controlled from this general plan being compared with the partial or special plans in the hands of the different foremen. We believe there is not much art in making some plan of that kind on paper, but we consider it the height of skill and management of a works that such a plan laid out at the beginning of the current year should not be out of date with the actual state of affairs in the shop at this present day by more than a few days' work of accidentally delayed labour.

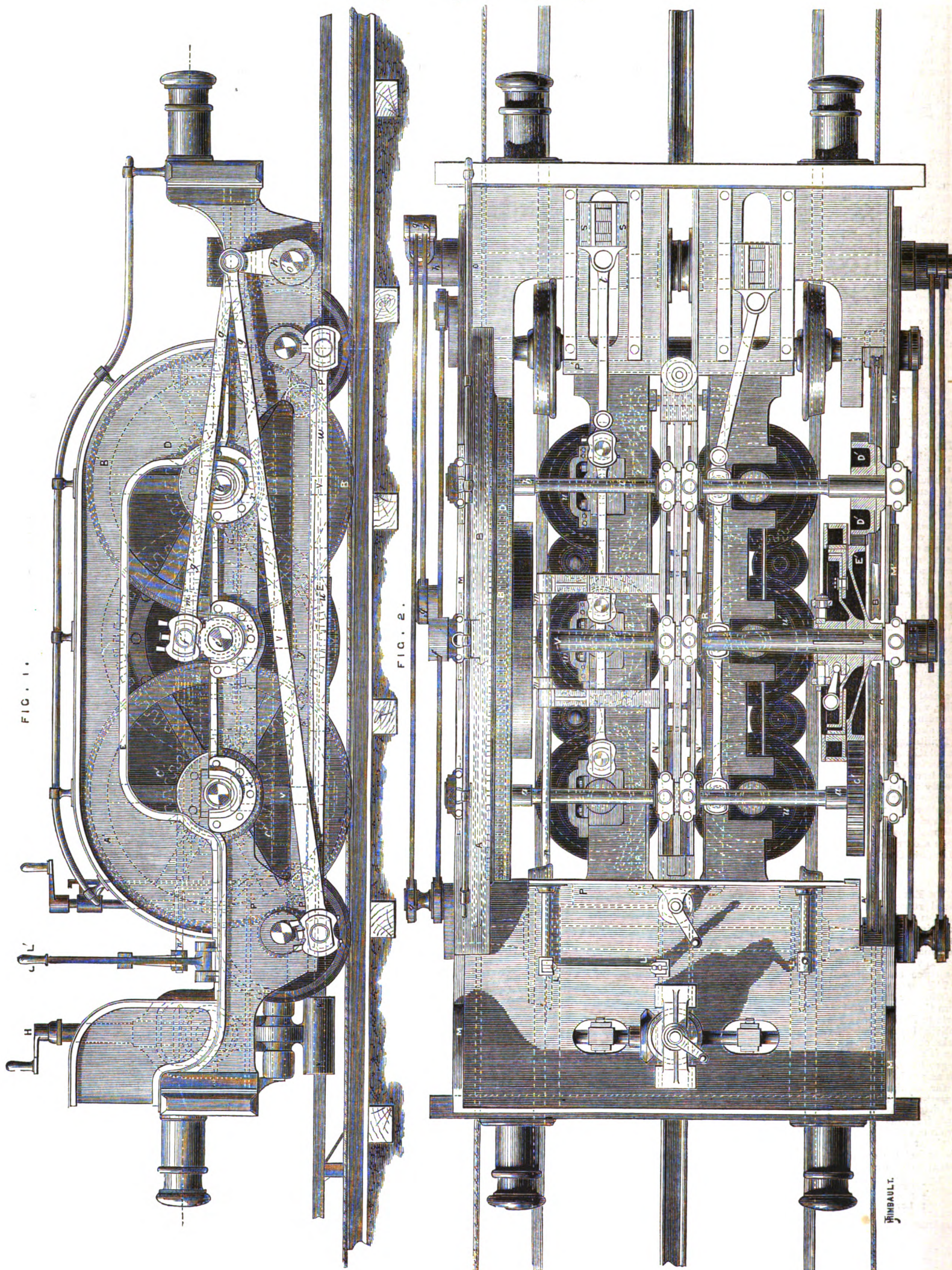
CONCRETE BUILDINGS.—An operative bricklayer, who has "reported" upon what he saw during an excursion to Paris, refers to the concrete houses (they are not many) being built there. In some cases the walls are built by first running up parallel rows of deal boarding at a distance apart answering to the intended thickness of the wall, and of a height of 5 ft. or 6 ft. The concrete is then shovelled in between these boards and allowed to set, after which the boarding is carried up higher, and more concrete added, until the whole of the walls is complete. The door-frames and window-frames are fixed in their proper places as the work proceeds. Such walls naturally have a very rough appearance, and some of them in the Emperor's model concrete-built dwellings are being coated with plaster of paris 1½ in. thick, smoothed and coursed to imitate stone. In some other cases, concrete blocks are made in wooden moulds, greased within, and these blocks are employed as stone. The writer adds the remark that "the French builders do not approve the concrete system of building."

IRISH STEAM SHIP-BUILDING.—A new paddle steamship was launched last week from the yard of Messrs. Walpole, Webb, and Bewley, Dublin. She was built for the City of Dublin Steam-Packet Company, and is the first of the class constructed at Dublin. She has been named the Mullingar, and is a very creditable specimen of Irish work.

TRACTION CARRIAGE FOR STEEP GRADIENTS, AT THE LATE PARIS EXHIBITION.

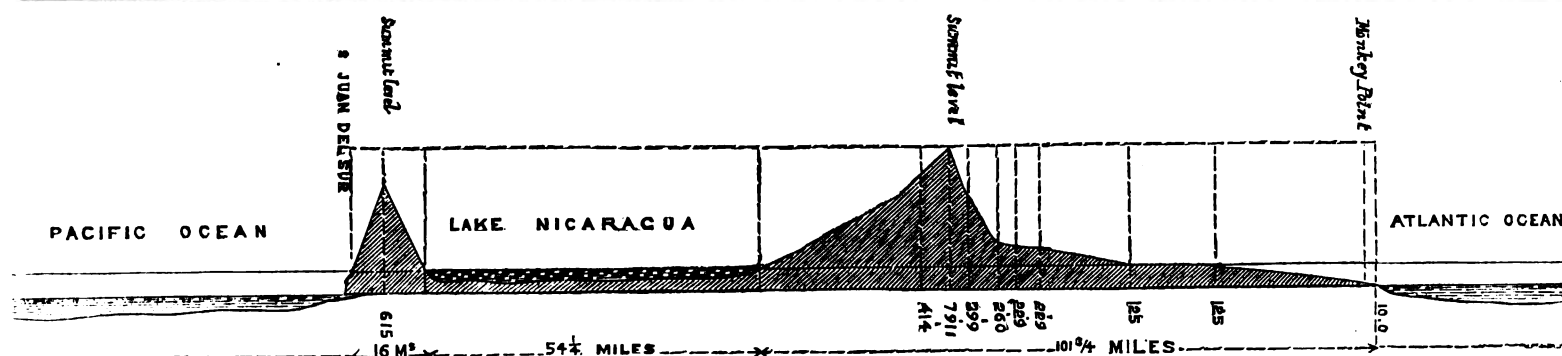
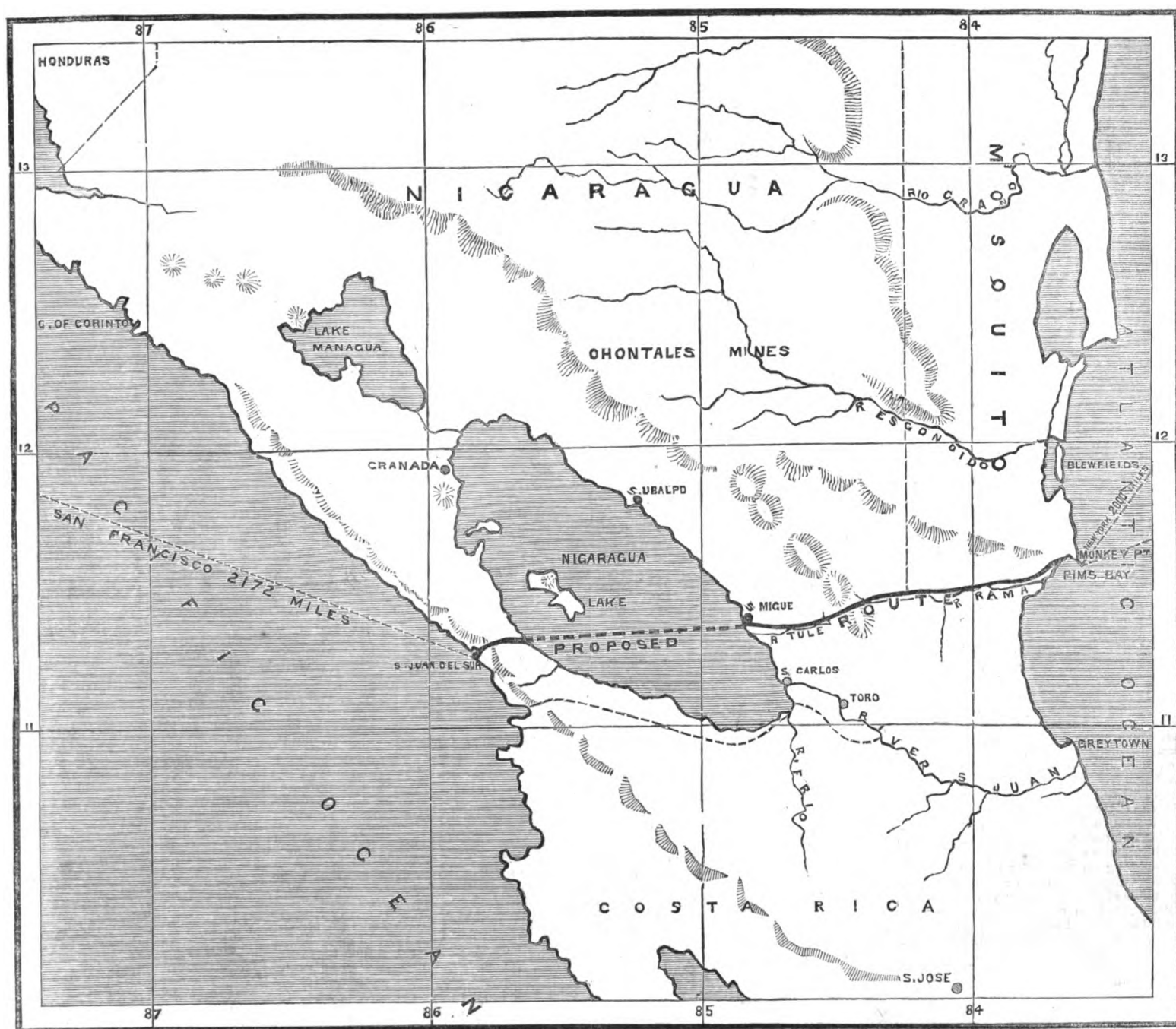
M. AGUDIO, ENGINEER.

(For Description, see Page 517.)



THE NICARAGUA INTER-OCEANIC RAILWAY.

MR. JOHN COLLINSON, ENGINEER.



THE state of constant panic and financial depression to which the countries of Europe, and occasionally America, have been subject during the last two years, though retarding the fulfilment of many of the smaller enterprises, has not prevented the successful introduction and prosecution of some of those whose proportions are almost gigantic, and whose interests are not merely local, but international.

On the American side of the Atlantic the great efforts of its people have been directed of recent years towards improving the means of communication between the eastern and western provinces of their immense empire.

To effect this the option of two modes exists, either to construct railways directly across the northern part of the Continent, necessitating, from their great length, much time and outlay before completion, or to take advantage of one of the narrowings of the continent in Central America for an inter-oceanic communication, and from thence connect with the eastern and western ports of the United States by means of fast lines of steamers.

With respect to the former plan, such liberal encouragement has been granted by the Government of the Republic, that one of the projected routes is advancing with what appears to us almost incredible rapidity, the track being laid, often at the rate of two miles per day; while several other schemes, with the same objects in view, are being pushed on with the characteristic energy of the American nation.

But while these northern routes are receiving the impetus of Government encouragement, the Isthmian schemes are not neglected. Government expeditions have been repeatedly despatched to test the feasibility of some of those which have been from time to time advocated, but none as yet have been reported on as answering the expectations raised by their promoters.

Two routes alone are worked across Central America, one the Panama Railroad, which, in spite of its many drawbacks, has attained unprecedented success; and the other, a transit across Nicaragua, worked by steamers up the river San Juan and across Lake Nicaragua, and thence to the Pacific

by stage coaches. This transit, although necessitating many changes, both for passengers and freight, has for many years, on account of the superior healthiness of the climate and the shortening of the distance it effects between New York and San Francisco, fairly divided the traffic with the Panama railroad, and would still do so, were it not that its eastern port at Greytown has so steadily and completely silted up, that no vessels even of the smallest tonnage can now enter it, nor are there any reasonable prospects of it ever being opened out again.

But while this once favourite Nicaraguan Transit has been dying a lingering death dictated by inexorable nature, another projected route across the same country, independent of the once rightly called harbour of Greytown, has been steadily progressing in public favour and estimation, as its indefatigable originator and his associates have year by year developed their scheme, and have at last, by patient and laborious investigations, furnished such practical proofs of its soundness as must convert even the most sceptical.

The project to which we allude is the Nicaragua Railway, originated by Captain Bedford Pim, and of which Mr. John Collinson is the engineer. As we introduced the subject to our readers in November of last year, we shall not now dilate on points then touched on, but briefly communicate the aspect which the affairs of this great enterprise have assumed since then.

In January of this year, when Captain Pim and Mr. Collinson laid their project before the New York capitalists, though much of the proposed line had been carefully examined, it was yet urged that the survey should be completed before committing themselves finally to the scheme. This Mr. Collinson undertook to carry out; and at the meeting of the Royal Geographical Society, on Monday, November 26th, he gave an instructive and interesting account of the successful accomplishment of his labours.

Before, however, entering upon a summary of the results disclosed by this survey, we may state that they have proved so satisfactory that a company has been organised by certain influential New York capitalists, who have been for many years engaged in perfecting a system of inter-oceanic transit, in conjunction with the concessionaire, Captain Bedford Pim, with a view to carry out the undertaking; and it is confidently anticipated that early in the ensuing year they will be in a position to commence the necessary works under the direction of Mr. Collinson.

In describing the proposed route, we must refer our readers to the plan and section we give on the previous page. It will there be seen that, on the Pacific, San Juan del Sur has been selected for the terminal port. This natural harbour has been used for many years by the old Transit Company, and found to meet all their requirements. It lies north of the equatorial calms, so harassing to sailing ships approaching the Bay of Panama, and is, therefore, well fitted to receive the trade which cannot afford to incur the delays attending the present route. It presents a large area, with soundings of from 18 to 40 ft. at low water, well sheltered from the S.W. winds, which are the worst on the Pacific coast. The extreme rise and fall of tide range over 7.1 ft.

From this port to the lake two routes have been carefully surveyed, one by Colonel O. W. Childs, over a summit level of 174.50 ft., and another by Mr. Bailey, C.E., over one of 615 ft. above the Pacific Ocean; each is perfectly practicable for the construction of an economical railway.

Across the lake to the mouth of the Tule river, a distance of 54½ miles, steamers are to be used of the following dimensions: extreme length, 200 ft.; depth, 10 ft.; beam, 33 ft.; and draught, 3 ft. These steamers will have a saloon running along the centre of the deck, on each side of which a line of rails will be laid, capable of receiving, together, six American cars, which, in their turn, could accommodate over 350 passengers, who would thus be enabled, if so disposed, to travel from ocean to ocean without quitting their seats.

The tract of country lying between the mouth of the Tule river and the Caribbean Sea, a distance by railway of 101½ miles, was, up to the last few years, an untraversed wilderness, uninhabited, and covered everywhere by thick forest and jungle. It is on this section that the efforts of Mr. Collinson have been especially directed to complete the missing link by discovering across it a practicable route, the difficulty in obtaining which may be imagined from the fact that the vegetation is so dense as to preclude the possibility of taking observations for more than a few feet on either side of the laboriously cut trail.

Following up the valley of the Tule, however, with a gradient first on 1 in 500 and then 1 in 150, the foot of the range of hills separating the watersheds of the lake and Atlantic has been reached, and thence the summit level ascended and crossed with a gradient of 1 in 135, at a distance of 31½ miles from, and at a height of 619.86 above, the lake.

Inclining downwards at 1 in 80, the headwaters of the Rama river (emptying into the Caribbean Sea, eleven miles south of the terminal port) were then reached, and from there the line was completed by easy gradients and long stretches of level down the valley of the Rama.

In ascending and descending the hills many curves are used, but none sharper than 600 ft.

The selected Atlantic terminal port, Pim's Bay, is a well sheltered harbour, into which the "northerly" those scourges of the gulf, can find no entrance. It has been carefully surveyed by Captain Owen, in 1836, Captain Barnett, in 1840, Captain Bedford Pim, in 1858, and finally by Captain Preston West, in 1865. Opening to the south, it lies to the leeward of Monkey Point and two small islands, and over an area of 5000 acres, gives sounding of from 18 ft. to 24 ft. The rise and fall of tide is about 2 ft.

Throughout the whole of the country good building stone, in the form of trappean, granite, and sandstone rocks, may be obtained, whenever requisite, without hauling more than a few hundred yards. Between the lake and Pacific, limestone of good quality and quantity has likewise been found. Timber for sleepers and bridges is over-abundant, and lignum vite, so serviceable for the former in the case of the Panama Railroad, can be obtained on the line without any expense of carriage.

One important question, that of labour, remains. Some few years ago it was plentiful and cheap, both in Nicaragua and on the Mosquito coast, but for many reasons, some of which alone we can briefly indicate, this favourable state of affairs has ceased to exist. Formerly, a great number of Caribs, who are excellent workmen, annually came to Greytown for employment; but a visitation of cholera, from which the country is only now recovering, has almost completely frightened them from making their customary appearance. The recently developed Chontales mines have likewise been a severe drain on the labouring resources of the country, and the gradual, though sure, extinction of the various Indian tribes, once so numerous, has completed the falling off.

But though the local sources are thus drying up, those from which the Panama Railroad drew her best and most efficient supplies are full to overflowing. The condition of the negro, who alone of mankind is fitted for hard work under a tropical sun, is giving rise, at this very time, to the gravest

considerations both in the United States and in the island of Jamaica. They are able and at last willing to work, but in neither place is there a sufficiency of it for them, and, should no outlet arise, they must starve or remain dependent on the people's bounty.

We may therefore rest assured when the time arrives, with a carefully arranged system of importation, the negroes will be only too glad to avail themselves of a chance of exchanging their present condition for the certainty of work and plenty, in a congenial climate, on the Nicaragua Railway.

BOILER EXPLOSIONS.—Upwards of three thousand boilers are now under the inspection of the engineers of the Manchester Boiler Association and of the Midland Boiler Association; and the Boiler Assurance Association of Manchester also inspects a very large number. The frequency of boiler explosions has much decreased this year as compared with former years; but it is an important question whether some general system of inspection should not be enforced by law, all over the kingdom, for it is almost invariably the fact that the boilers which explode are not under proper inspection. At the inquest on William Barker, one of the four men who were killed in the boiler explosion which occurred on the 14th ult., in the chemical works of Messrs. Illingworth, Bradford, the jury returned the following verdict:—"That the jury find that the said William Barker was killed by an explosion of a steam boiler at the chemical works of Messrs. Illingworth, at Lister-hills, Bradford, and that there was gross recklessness and negligence in purchasing a worn-out, second-hand boiler, and not using sufficient means to ascertain its strength after having it repaired; and that the jury earnestly request that the coroner will draw the attention of Her Majesty's Secretary of State to the evidence and circumstances of this distressing explosion, being strongly of opinion that, from the frequency of such accidents, some measures should be adopted by Her Majesty's Government for having an inspection of boilers by a competent engineer or other person, in the same way as is done in respect of factories generally." Some boiler-makers who were on the jury and in the court seemed to be rather amazed at the exposition by the coroner (Mr. Dyson) of the law as to the responsibility of a boiler-maker undertaking the repair of a steam boiler. He said that a man who undertook to repair a boiler was bound, morally and legally, to ascertain whether there was any defect in that boiler beyond any to which his attention might be called, with a view to its repair, and, if he found any defect, to point it out to the owner; if, on finding any defect, he passed it over and omitted to call the attention of the owner of the boiler to it, he would be both morally and legally responsible. The boiler-makers of the district, it appeared, had previously held the notion that their responsibility ceased when they had repaired any defect to which the owner of a steam boiler had called their attention with a view to its repair, and that it was no business of theirs to look for or to care about other defects.

THE BRITISH ARMY.—We keep up in India, at a cost of 17 millions a year, an army of 250,000 men, supposed, from the circumstances of the country, to be permanently ready for active service. We keep up in the rest of the British Empire, at a cost of 15,000,000, an army of 120,000 men, also supposed, when necessity arises, to be available for duty. The cost of the departments in both countries—of ordnance, transport, commissariat, and so on—amounts to millions, which are supposed to be expended with a view to secure readiness for war. And, finally, we spend 10 millions on a fleet, capable, as we all congratulate ourselves, of going anywhere and doing anything. In short, we spend altogether 42 millions, twice the French expenditure, upon inferior armaments; and then, when a mere section, a single legion, as it were, of that force is required for active service, we have at once to spend millions more, in a frantic hurry, and under circumstances which compel us to raise the price of the things we want in half the markets of the world. Surely there is here some grievous waste, some evidence of defective organisation? Mobility is the first characteristic of efficient armies, and somehow the British army never is mobile. We construct at infinite cost a delicate and, as experience shows, a very powerful engine, and then somehow have to pay almost its value for fuel and grease to get it in motion. There is transport, for example. We are always paying for transport at a rate which makes foreign shipowners pale with envy, and upsets the calculations of the best financiers, yet the transport of troops ought surely to be one of the duties of a navy, one of the fighting agencies supposed to be provided out of the 210,000,000, half the cost of the railway system, which we spend on armaments every five years. Is it cheap, whenever we want to move, to be compelled to buy animals in a hurry, or might not each regiment, with a little management, be kept permanently in a position to be useful? It is just the same with the volunteers at home. We have a fine citizen army of 160,000 men, an army which, if it were one, would be ample defence against any invasion, but which could not move 100 miles or keep itself alive for three days for want of the necessary departments. Would not the money granted, if thriftily spent, provide these useful adjuncts to our force? We will not say that it would, because we know quite well that the department will immediately show that we have forgotten the cost of pack-saddles or mule girths, or extra socks, or something of that kind; but the total expenditure contrasted with the total result does, we humbly submit to the cabinet, suggest either inefficiency or waste somewhere.—*Spectator*.

EXHIBITION OF INDIAN COTTON AT BROADCH.—We desire to direct the attention of our readers, especially of the makers of implements and machinery who may intend to become exhibitors, to a letter which appears in our pages, announcing the postponement of the Cotton Exhibition at Broadch until the end of next year.—*Cotton Supply Reporter*. Broadch is easily accessible from Bombay, being on the Bombay, Baroda, and Central India Railway, and distant a journey of only seven or eight hours from Bombay. It is on the river Ner-budda also, and all heavy machinery can be sent there very cheaply by native coasting craft.]

THE INSTITUTION OF CIVIL ENGINEERS.

At the fourth ordinary general meeting, session 1867-68, held on Tuesday, the 3rd inst., Mr. John Fowler, president, in the chair, the first ballot for the session was taken, when eighteen Members and twenty-three Associates were duly elected, including as Members: John Hallen Abbott, district engineer, G. I. P. Railway, Munmar, Bombay Presidency; Edmund Cooper, district engineer under the Metropolitan Board of Works; George Gordon, resident engineer on the Madras Irrigation Company's works, Bellary, E. I.; Francis Hawkes, resident engineer, G. I. P. Railway, Bombay; Samuel Waite Johnson, locomotive superintendent, G. E. Railway, Stratford; David Logan, late chief engineer, Great Southern Railway of India; William Low, Wrexham; John Stevenson Macintyre, resident engineer, G. E. Railway, Metropolitan and Suburban Extensions; John Mackinlay, chief engineer and inspector of machinery to H.M. Dockyard, Bombay, and surveyor to the Port of Bombay; Walter McClelland, Bombay; William Menelaus, chief engineer and manager of the Downais Ironworks, Glamorganshire; John Preston, district engineer, G. I. P. Railway, Bombay; Thomas David Roberts, resident engineer, Brecon and Merthyr Railway, Brecon; Anthony Sherwood, district engineer, G. I. P. Railway, Sholapore, E. I.; John Frederick Spencer, chief engineer to the North-Eastern Marine Engineering Company, Sunderland; William Henry Wheeler, engineer to the Borough of Boston, and to the Boston Harbour Commissioners; John Sheldon Wilkinson, Manchester; and George Hustwain Wright, district engineer, G. I. P. Railway, Jubbulpore, E. I. And as Associates: Frederick Edwards Archer, Public Works Department, Calcutta; Benjamin Baker, Westminster; Lieut. Gordon Bigsby, R.E., executive engineer, Department of Public Works, Bengal; Herbert Bland Browning, assistant engineer, Scinde Railway, Umballah; Thomas Long Colley, Plymouth; Charles Davis, assistant engineer, G. I. P. Railway, Bombay; Herbert Louis Augustus Davis, assistant engineer, G. I. P. Railway, Hooshungabad, E. I.; William Henry Delano, Cheapside; Thomas Eastman, resident engineer, Santiago and Valparaiso Railway, Chile; John Marshall Easton, district manager for the construction of works, Jubbulpore line, E. I. Railway, Allahabad; John Hyde Edwards, assistant Engineer, G. I. P. Railway, Bombay; Captain Charles Wilson Faber, director, G. N. Railway; Charles Gandon, resident engineer and manager of the gas works, Smyrna; John Howard, Westminster; Thomas Manson Rymer Jones, assistant-engineer, Madras Railway; James Livesey, Westminster; William Luke, assistant-engineer, Delhi Railway; Thomas Edward O'Brien, assistant-engineer, G. I. P. Railway, Nassick, Bombay; Edward Charles Patterson, Westminster; William Smallpiece, Westminster; William Tjouw, Great George-street; Henry Eltze Victor, district engineer, G. I. P. Railway, Nursingpoor, E. I.; and James Birdsall Walton, Westminster.

THE INSTITUTION OF CIVIL ENGINEERS.

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

Name of Candidate.	Recommended by
William Berrell	James Simpson, jun.
Jabez Church, jun.	Jabez Church, sen.
Edward Crompton	John Fowler.
Frederick Harry Mort	James G. Fraser.
Thomas Reynolds	John Fowler.
William Tweedie	John Hawkshaw.
Antonio Augusto Vieira	Henry Law.

YOUNG'S PARAFFINE WORKS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your account of Young's Paraffine Works, in stating that the refining apparatus was made by J. Norman and Co., you have fallen into a slight error, which you will perhaps permit me to correct. While the works were in Mr. Young's hands, all the designs were prepared by me, and the machinery made in parts by a great many engineers in Glasgow and elsewhere, and put together by Mr. Young's workmen, under my sole superintendence. A few such parts were made by Messrs. J. Norman and Co.

This plan was always adopted, as in erecting such works it was no part of the design to let the various engineers understand the nature of the machinery they were making.

I am, your obedient servant,

ALEXANDER KIRK.

Cranston-hill Foundry, Glasgow, Dec. 3, 1867.

NEW SOUTH WALES RAILWAY.—Mr. John Whitton, engineer-in-chief to the Government of New South Wales, has recently arrived in England on a short visit, after eleven years of professional labour in Australia. Under his management the railway system has been introduced and successfully developed amid constant commercial and engineering difficulties. We recently published drawings of some of the new rolling-stock just completed for a portion of the New South Wales Railways, and in the accompanying description we inadvertently stated that Mr. John Fowler, and not Mr. Whitton, was the engineer to those lines.

POT SLEEPERS.—At the late meeting of the shareholders of the Calcutta and South-Eastern Railway Company, the chairman stated that the pot sleepers on that line answered admirably.

EXHIBITION AT THE MANCHESTER INSTITUTION OF ENGINEERS.—The Council of the Manchester Institution of Engineers have announced that they intend holding an exhibition of objects of engineering and scientific interest, about the middle of next month, and they solicit the loan of models of machinery, &c., particularly those illustrating new inventions. All communications are to be addressed to the secretary, 28, Princess-street, Manchester. We trust that the exhibition may be well supported.

THE MONT CENIS RAILWAY.

THE Mont Cenis Railway shareholders met, on Friday last, to authorise their directors to increase their bonded debt from 125,000*l.* to 202,600*l.*, and to pay 10 per cent. interest, instead of 7, as heretofore. The line is completed, but the service is not commenced because, it is stated, "some of the engines have not been sufficiently tested, as part of the materials have proved of inferior quality." The engines were made by Messrs. Gouin and Co., of Paris, whose engineer, Mr. Lloyd, was once with Sharp, Roberts and Co., of Manchester, and Messrs. Gouin have made upwards of 600 locomotives, and are reputed among the best makers on the Continent. The boilers are of steel, but we have not learned that any difficulty has arisen from the adoption of this material, which is now very largely used for boilers upon several of the French and German lines.

We have heard, however, that the engines would not work properly round the two-chain curves, and we have given our reasons, in former articles, for doubting their permanent success, even if once successfully started. They are indisputably the most complicated engines ever made, and they are otherwise objectionable from the small size and unequal wear of the driving and gripping wheels.

THE AMERICAN GUN TRIALS.

THE Americans, like ourselves, are employing the leisure of their artillery officers with a series of trials of their heavy ordnance against armour-plates, the plates, in their case, being backed with the masonry of fortifications. There, as here, whatever is done in the way of testing ordnance finds its way into the papers, and we found, last week, in the journals we receive from New York, more or less pretentiously explicit accounts of the trials of the 12 in. and 15 in. Rodman "rifled" guns at Fortress Monroe. This, certainly, was the first we had heard of the Rodman 15 in. gun being "rifled." The account we read, too, spoke of the "solid round shot," fired from the Rodman 15 in., as of 610 lb. weight. Now all shot, except Mr. Whitworth's six-sided shot, are "round" in some direction or other, however cylindrical or conoidal they may be, but we are always accustomed to regard "round shot" as spherical shot, and the spherical shot which fits the 15 in. gun weighs but 453 lb. in cast iron and 498 lb. in steel. The account went on to say that the 640 lb. solid round shot, fired with 100 lb. of powder from the 15 in. Rodman gun, acquired an initial velocity of "from 1500 to 1600 ft. per second." This variability of 100 ft. per second represents a variation in the force of the powder in the ratio of the squares of the velocities, or as 225 to 256, but we will take the mean initial velocity as 1550 ft. per second. At this velocity the shot might have been fired straight upwards, *in vacuo*, to a height of $1550^2 \div 8.01$, or 37,442 ft., and to lift 640 lb. (the weight of the shot) to this height, by means of 100 lb. of powder, would require that each pound of powder should do 239,630 foot-pounds of work; that is, that each pound of powder should lift 1 ton more than 100 ft. high, or 1 lb. 239,630 ft. high, or nearly 107 tons 1 ft. high. Now such a result as this, say 107 foot-tons per pound of powder, has never been attained in any ordnance known in England, and we have no reason to suppose it has ever been known in America.

Convinced that there was some mistake in the newspaper reports, we preferred to say nothing about them in our last number, notwithstanding that we found the account of the New York daily papers copied into the usually accurate *Army and Navy Journal*. This week, however, we find the whole string of pretended facts in the letter of the *Times's* American correspondent. If the reported results were correct, they would surpass, in the work done by the powder, anything ever before known in gunnery; but it is clear, upon several good reasons, that they are not correct, and we prefer to await further particulars.

ENGINE-DRIVERS.—We have great pleasure in announcing that the South-Eastern Railway Company have made very judicious arrangements with respect to two, at least, of their engine-drivers who take passenger trains into Hastings. These men in turn work, including the dinner-hour, three days each week 16½ hours, leaving off very late, and the other three days 8½ hours. On the long days the engine-men quit work so tired that, to use his own expression, "he hardly knows how to sit down." During these dark and somewhat foggy evenings, particular attention is required, which, from over fatigue, cannot be given. We therefore recommend such of our readers who are weary of life, or who wish to have a leg or arm fractured, to travel by a late train, and there is a reasonable prospect of their wish being attained at the expense of the railway company.—*Brighton Observer*.

THE ST. HELIER HARBOUR COMPETITION.

TO THE EDITOR OF ENGINEERING.

SIR,—Having been absent from home for a short time at the commencement of last month, the notice in your paper of the 1st November, on the harbour of St. Helier, Jersey, escaped observation until my attention was drawn to it by a letter from a friend yesterday; and as it contains matter requiring explanation, I would be glad if you would permit me to make the following remarks on the subject.

I have more than once been consulted by the leading commercial bodies in Jersey, on the subject of harbour improvement, and, in the year 1860, sent in plans and reports for the extension and improvement of the harbour there.

In September last year I received a special invitation from the "States" of Jersey, offering me "150*l.*" to visit the island for the purpose of preparing drawings, working plans, specifications, estimates, and reports for the proposed works and improvement of the harbour of St. Helier," and at the same time informing me "that, if my plan was adopted, I would be entitled to a premium of 200*l.*, in addition to the superintendence of the works, on such conditions as might be subsequently agreed upon." This invitation I was obliged respectfully to decline, as having already sent in plans for such a work, and seeing no reason for changing the opinions I fully expressed in the report accompanying them. I considered it quite unnecessary, even could I have found it convenient to do so, to put the States of the island to the expense of another visit.

I, however, forwarded to the Harbour Committee my plan and report of 1860, with a letter of explanation; and as my opinions as to how the new works there should be carried out seem to be singularly in unison with the views expressed in your leader of the 1st November, I venture to forward the papers for your inspection, perusal, and use, if you see fit to appropriate any of your valuable space to such an object.

I am, Sir, your obedient Servant,

GEORGE FOSBERY LISTER,
Civil Engineer.

Dockyard, Liverpool, Dec. 2, 1867.

Copy of Letter referred to.

SIR,—Though I was unable to accede to the wishes of the Harbour Committee so kindly expressed through Mr. De Quetteville, in September last, to visit Jersey, for the purpose of preparing plans for the improvement of the harbour of St. Helier, I, nevertheless, take so great an interest in the matter, and entertain such strong and carefully matured views on the point, that I venture to think it might be desirable officially to lay before the committee, when the subject comes on for discussion, the several plans and reports which I had the pleasure to submit to the local Chamber of Commerce, when called upon by them some seven years since to consider the subject of dock and harbour extension; and if you approve of this suggestion, I will be glad if you will be good enough to take the necessary steps for that purpose.

I am not aware, in issuing instructions to the several engineers and others who have been invited by the Harbour Committee to compete for the designs in question, whether the maximum or minimum accommodation required for the present or prospective trade of the port has been specified. If such has been done, it will be a simple matter to test how nearly the plans I have submitted approach those requirements. If no instructions of the kind have been given, I venture to think that as a step preliminary to any examination of the several plans, and as a matter of sound commercial policy, some general conclusions on those points be first arrived at. If this is done, I confidently expect the result will go far, if not entirely, to prove the correctness of the views I have already enunciated; for, by the plans I have submitted, I have recommended the construction of a floating dock which (measured by the working capacity of the docks in Liverpool) will be sufficient to carry on business to no less an extent than 360,000 tons of shipping per annum. This, though largely exceeding the trade of the port, is a justifiable excess, by reason of its admitting of a very economical form and class of work being carried out, and fully according with the condition of property along the existing quays.

The sill of the passage into the dock can be laid at the lowest requisite level, even at that of low-water spring tides, if necessary. It would be approached through a thoroughly sheltered basin or vestibule, which may also be used as, and continue to form, an integral portion of the present harbour. This basin would, of course, be deepened to suit whatever level the sill is laid at.

With reference to the outer or packet harbour which I have recommended, I have no hesitation in saying that its site comprises the largest clear area of deep water space that can be obtained within the roadstead, having an area of no less than 10 acres, with 1770 ft. of available quayage, and a depth (after the removal of a few rocky heads) of from 12 to 15 ft. at low water of equinoctial spring tides. It would be thoroughly sheltered from all winds and free from sea, while it could be approached whenever vessels would attempt to run for the harbour, with as much freedom as is possible when nearing so dangerous a coast. Besides these advantages, there would be no tendency to sand accumulating within it, which is a point demanding careful consideration, and which, as far as I can at present judge, no other site in the neighbourhood is free from.

Beyond these few remarks it is unnecessary now to enlarge upon the proposal, as my original reports, still doubtless in the possession of the Chamber of Commerce, enter very fully into most of the details connected with the works. If, however, you see fit to submit the papers to the Harbour Committee, and if called upon by them to do so, I shall be happy at any time to give any further information that may be required.

I am, Sir, your obedient Servant,

(Signed) GEORGE FOSBERY LISTER.

Dockyard, Liverpool, July 27, 1867.

E. L. Bisson, Esq., President of the Harbour Committee,
St. Lawrence, Jersey.

[We shall illustrate the above plans in our next number.—Ed. E.]

TUMBLING-BEAM ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—In the remarks accompanying the illustration of the "Tumbling-beam Engine," you have omitted to mention that the arrangement was designed (and, I believe, patented) by the late Elijah Galloway for Mr. F. P. Smith in the early days of the screw-propeller.

The latter gentleman showed me, I think, in the year 1844, a model of this construction, combined with a multiplying motion of extraordinary ingenuity, in which a crank on the end of the engine-shaft was made to drive another, of half its radius, fixed on the screw-shaft, at double its own number of revolutions, the connexion being through a system of links.

The engine and multiplying motion are illustrated in the early editions of Bourne's *Treatise on the Steam-engine*.

I remain, my dear Sir,
E. R.

Sheffield, Nov. 30, 1867.

WEST HAM DRAINAGE.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to the paragraph on the West Ham Drainage in your last week's paper, I think, to obviate the necessity of any explanation from me, you might publish, in your next issue, the report I left at your office yesterday. It is an obvious injustice to me that a plan designed entirely by me should be appropriated by others whom I merely called in to confirm my figures and judgment. I am willing to believe that they are not to blame for what, uncorrected, is calculated to place me in a false position with those who requested me to report upon the West Ham drainage, and who know Messrs. Lucas and Wilkinson only through Your obedient Servant,

WM. RUSS.

Brentwood, December 3, 1867.

IMPROVEMENTS AT NEWCASTLE.

SINCE the passage of the Newcastle-upon-Tyne Improvement Act of 1865, important works of improvement have been carried out there. The report of Mr. Thomas Bryson, town surveyor, states that whereas, prior to 1865, an average of but eleven streets were opened yearly, 83 have been already completed and sewered since that time, the cost being assessed upon the abutting property. Mr. Bryson's sewers have been important works of construction, one of them having been made at an extreme depth of 46 ft. These sewers are made with an inclination not less than 1 in 72, and the average fall is 1 in 86. Mr. Bryson attaches great importance to giving sewers such a rate of inclination that they shall discharge their contents as rapidly as possible, and not become subterranean receptacles for sewage. With respect to sewer-ventilation, Mr. Bryson observes:

"In ventilating sewers, very little has hitherto been done, but the necessity for a more complete and systematic action is becoming every day more urgent. Amongst the many schemes proposed, that of carrying up flues alongside of a furnace chimney with an Archimedian screw ventilator at the top appears to me to be the most effectual; when this is not practicable, tubes could be carried up alongside of blank walls to above the roof of dwellings, assisted with or without a jet of gas. As a preliminary step, a selection of sites suitable for this purpose has been made for the committee's approval."

OUR EXPORTS.—The Board of Trade returns for October show a falling off of 1,046,782*l.*, or about 6 per cent., in the declared value of our exportations, compared with the corresponding month of last year. As against the same month of 1865, however, they show an increase of 2 per cent. Much of the reduction from last year is due to the decline in the price of cotton, and not to any diminution in the industry of the country, our shipments of cotton goods having been of 8 per cent. less money value than in October, 1866, although in their quantity there was an increase of 1½ per cent. Iron manufactures show an increase of 13 per cent. The value of our exports of the produce and manufactures of the United Kingdom for the first ten months of the present year has been 153,051,639*l.*, showing a reduction of only 3¼ per cent. from the total of the corresponding period of last year, which was the largest ever attained. Making allowance for the extent to which the prices of raw material have been reduced, the total of the present year, although nominally rather lower than that of 1866, may be considered to represent a greater amount of actual trade than has been witnessed at any former period.

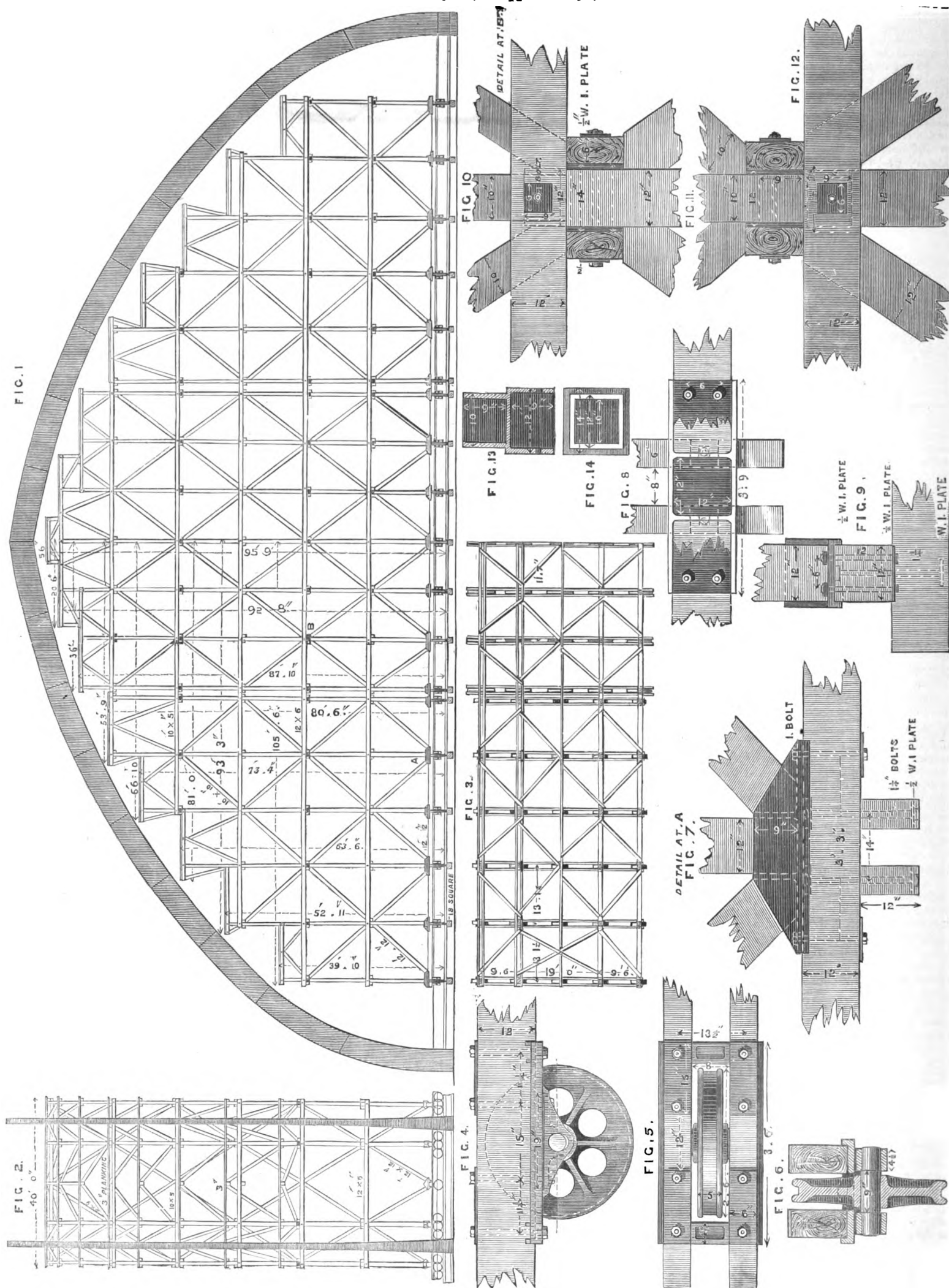
THE FRENCH-AMERICAN ATLANTIC TELEGRAPH.—From the following extract from the *Moniteur* of the 23rd ult., it appears that the French Government have granted no special privileges to any one line of Atlantic telegraph: "There has not yet been created any direct line between France and America; but, according to all appearances, the enterprise will shortly be attempted by a company disposed to accept its risks, without demanding any grant or privilege. The Government maintains the resolution to apply, in such measure as the interest of the country demands, the principle of free competition to the establishment and exploitation of submarine lines, and not to grant to any company an exclusive privilege."

GAS IN MARSEILLES AND TOULOUSE.—The Imperial Continental Gas Company made 1608 million cubic feet of gas last year, as compared with 1495 million cubic feet the previous year. In June last they were supplying gas to 659,699 lights. The net profits of the company amount to 140,000*l.* a year upon a nominal capital of one million; but upwards of another million of undivided profits are also employed. From difficulties at Marseilles and Toulouse, it is not impossible that the whole of the company's establishments there may become a dead loss.

TRAVELLING SCAFFOLDING FOR THE ROOF OF THE ST. PANCRAS STATION.

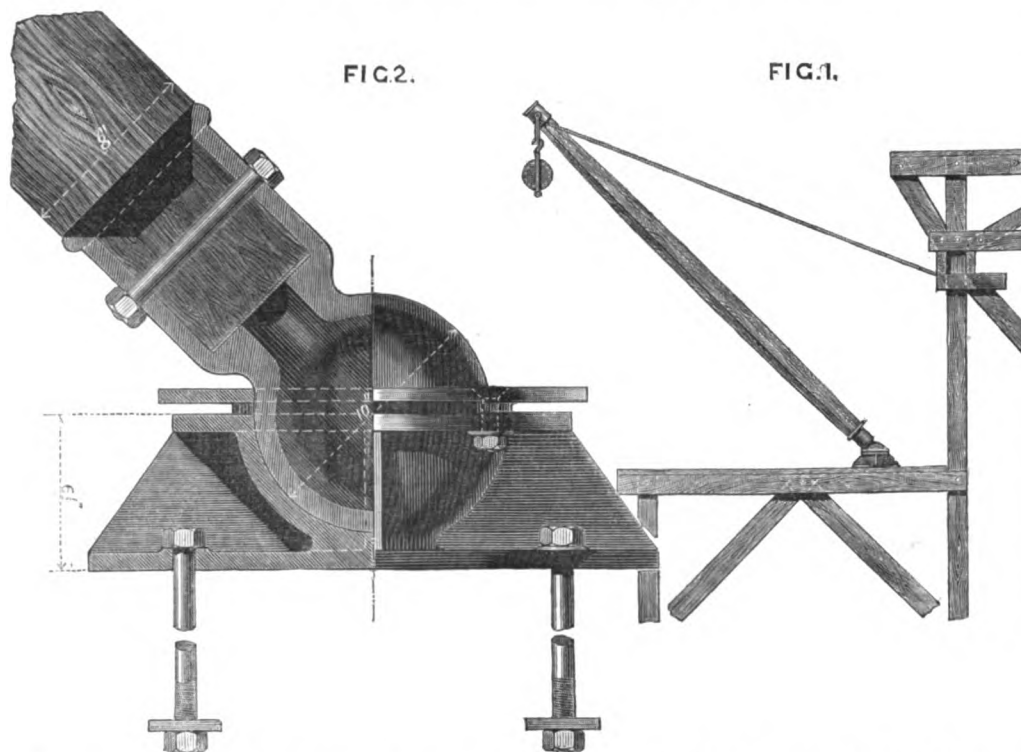
DESIGNED BY MR. JAMES G. N. ALLEYNE, BUTTERLEY IRONWORKS.

(For Description, see opposite Page.)



CRANE AT THE MIDLAND RY. WORKS, ST. PANCRAS STATION.

DESIGNED BY MR. JAMES G. N. ALLEYNE, BUTTERLEY IRONWORKS.



We give, this week, full details of the remarkable structure which for the last month or two has attracted the attention, and raised the conjectures, of the thousands passing the site of the Midland Railway Station abutting on the Euston-road. It may possibly have been guessed by the majority that the huge staging towering some 130 ft. above their heads was connected in some way with the future erection of the roof; but it would hardly be anticipated, we think, that the entire structure, occupying a bulk of considerably more than half a million cubic feet, was so arranged as to be capable of being moved bodily with great facility by successive increments of 30 ft. from the position it at present occupies almost up to the Euston-road.

Although the staging under consideration is the largest one yet constructed on the travelling system, it is of much the same type as several of its predecessors, the earliest example of which probably was the one used in the erection of the well-known Birmingham roof. In that instance the case was complicated by the necessity of maintaining the railway traffic during the erection of the structure, a condition always involving, if not any very great practical difficulty, at least a considerable amount of care and anxiety. Another difficulty also was incurred on account of the unequal spans of the principals, which necessitated successive alterations and adaptations of the framing.

In the case of the Midland roof, these complicating conditions are not obtained, and the advantages of a travelling stage will, consequently, be more strongly marked. The span and height of this roof would, for economic reasons, render a staging throughout the entire length of the roof inadmissible. The only alternative to the plan adopted would be to rig up a couple of derricks, and hoist each half of the main rib into its place bodily, securing it by guys till the purlins could be fixed. In that case the ribs would require stiffening temporarily by a few tie-bars, in a manner somewhat similar to that pursued in the erection of the 9 ft. top tube of the Chepstow bridge. Doubtless much greater practical convenience would appertain to the travelling stage, and it was well to adopt it in the present instance.

A glance at the design of the staging either on the drawing or on the ground will satisfy the most nervous that perfect security is attained. It is obvious no money has been spared to ensure that end; indeed, some of the American viaducts of the same height, having to carry trains at full speed, would look slight by its side.

Referring to the engravings, it will be seen that the staging is of sufficient width to accommodate one complete bay of the roof, consisting of a pair of main ribs with the intermediate purlins, and that for facility of movement it is split up into three portions. Each segment is made up of four parallel systems of trussed framing braced together in every direction, both horizontally and vertically; in fact, wherever a rectangle is formed by the intersection of the uprights and horizontals, at least one, and frequently two, diagonal struts are introduced. Under each upright, and under the rakers between each centre pair of uprights, wheels are placed. In the side segments one wheel only at each point is introduced; in the centre segment, the wheels are arranged in pairs. The total number of wheels is 130, and by that means the weight of the staging with its insistent load is distributed with tolerable uniformity over nineteen lines of rails bolted to sleepers 18 in. square. These rails and sleepers are to be laid in front of the staging as the work advances, and we understand the arrangements for shifting the staging are thoroughly efficient, and have answered all expectations. The ends of the uprights are fitted with cast-iron shoes at the bases and

at the junctions of the different lengths, where the scantlings are reduced from 12 in. square to 10 in. and 9 in. square. The ends of the diagonals are well bedded and secured by bolts, and there will consequently be no danger of rocking. The importance of attention to this detail of construction is often evidenced in cases where severe strain has to be sustained, as in the construction of tunnels or dams, when it is not at all uncommon to find a raker driven 2 or 3 in. into an upright in a very few hours. Our engravings illustrate both the arrangement and principal details of the scaffolding, the two figures on the present page referring to the neatly contrived derrick cranes with which the scaffolding is provided.

THE RAILWAY BEARS.—Ursa Major, last year, gave the banks a true Bruin's hug, doubling up one or two concerns not very strong in the (money) chest, and greatly weakening the credit of many others. This year the amiable animal is worrying the railway companies, and has already got his teeth in in several instances. Just now, the Caledonian Railway Company is the chosen victim, but other companies need not complain of any appearance of partiality, as they will all be served with a hug and a bite in turn. As much as 20 to 24 per cent. per annum, and, in one reported case, 60 per cent., has been paid for the loan of Caledonian stock until the next half-monthly settlement, while 9 per cent. has been paid for Midland and Yorkshire and Lancashire, and 6 per cent. for Brighton. The pretended sellers of shares at a great discount commonly have no shares to sell. This was the case last year with the banks, and an Act was passed which stopped the gambling, by declaring invalid all sales not accompanied by an actual transfer of the shares. Mr. Waldegrave-Leslie has now obtained leave to bring in a bill for a corresponding protection of railway and gas shares. These ought, in common sense, to have been included in the bank share sale act of last year, and, had they been so, much mischief and great loss would have been prevented.

INEFFICIENT BRAKES.—The fifth series of official reports upon railway accidents, recently published, records three casualties which were wholly or partially caused by a want of brake power in the trains. One happened to the limited mail on the London and North-Western Railway last July, when the vans and carriages broke from the engine, and afterwards came into collision with it, resulting in injuries to both guards and to fourteen passengers. Colonel Yolland observes that "the ordinary west coast rolling stock was under repair at Wolverton, so that the guards had only single brakes to depend on, instead of continuous brakes connected with the next carriage," and "that it took nearly half a minute to put on one of these brakes. The other accidents referred to took place on the North-Eastern Railway, one a collision between an express train and a goods train, the other a collision between a mail train and an empty coal train. The inspector remarks as to the former that "it is a most dangerous practice to despatch heavy express trains without very much more brake power than was available in the present instance;" and as to the latter, that "some portion of blame rests with the person who is responsible for the trains being despatched with the amount of brake power prescribed by the rule of the company," the rule in this instance having been disregarded.

THE GREAT EASTERN.—When the repairs and alterations of the Great Eastern were undertaken, last winter, by Messrs. George Forester and Co., of Liverpool, she was under charter party to one Jules Despeches. Messrs. Forester's claim amounts to 35,000*l.*, and the owners now resist payment on the ground that only the charterer is liable, he being, we believe, now abroad.

GIBBAL'S VENTILATING FAN.

IN *ENGINEERING* for September 13th last we gave the admirable paper of Mr. G. Cope Pearce, the engineer of Crawshaw's ironworks at Cyfarthfa, upon mechanical ventilation for mines, and in this was given a drawing and a full description of Guibal's ventilating fan. So far as useful effect is concerned, measuring this according to the amount of coal consumed in producing it, almost any fan, driven direct by a steam-engine, is far more economical than an upcast shaft heated by a furnace. But fuel is never dear in a coal-mine—practically it has no value so far as ventilation is concerned; and furnace-ventilation is subject to no break-downs, as an engine and fan might be. Mr. Nasmyth was one of the first to introduce the fan. One of his was used at Skiar Spring Colliery, near Milton, and Elsecar, nine miles or so from Sheffield; but it was not working when we were last at Milton. Another was put to work at Abercarn, in South Wales, a splendid pit belonging to the Ebbw Vale Company; but the fan was removed long ago, and an upcast shaft has replaced it. Mr. Waddle, of Llanely (Thlan-*et-ly*, in the English tongue), has made some of these fans of a diameter of 31 ft. 6 in., driven by a pair of 24 in. cylinders, of 2½ ft. stroke, at the rate of seventy revolutions per minute. In collieries where it formerly took 10 tons of coal per week to give a ventilation of from 10,000 to 12,000 cubic feet of air per minute, under a pressure of ½ in. of water, the centrifugal fans have, with 14 tons of the same coal per week, given 30,000 cubic feet of air per minute, under 1½ in. pressure, which is three times the quantity of air, under more than three times the pressure, or, say, ten times the quantity of mechanical work with but one-half more coal.

Messrs. Black, Hawthorn and Co., of Gateshead, are, we have lately learned, the original English makers of the Guibal fan. A Newcastle paper informs us that they are making several of these fans for mine-ventilation. We shall be much gratified to learn of their entire success.

MR. PENN'S WOOD BEARINGS.

WE fully reported the history of Mr. Penn's valuable and, indeed, remarkable invention of wood bearings for the stern tubes of screw steamships, in *ENGINEERING* of May 4th, 1866. We at the same time gave a full report of the cases of Penn v. Jack, Penn v. Bibby, and Penn v. Fernie, the whole proceedings being practically, however, against Messrs. Jack. The case, we need hardly repeat, went against the defendants upon all points, yet Messrs. Jack moved for a new trial, which also went against them.

On Tuesday the case of Penn v. Jack again came on before Vice-Chancellor Stuart, on an adjourned summons for the purpose of determining the amount payable to the plaintiff, Mr. Penn, by the defendant, for damages in respect of the infringement of the plaintiff's patent for improvements in the bearings of screw propellers. The plaintiff had obtained a decree against the defendant, with a declaration that he was entitled to damages. In the course of the inquiry as to damages, which was being prosecuted in chambers, it appeared that the defendant had built 68 ships, of 12,517 aggregate horse power, fitted with propellers which had been held to be an infringement of the plaintiff's patent. The defendant consented to pay the royalty of 2s. 6d. per horse power in respect of plaintiff's patent, that being the amount paid upon obtaining a license, but objected to pay the further sum of 2005*l.* claimed by Mr. Penn as manufacturer's profits. The question now argued was whether the damages were to be confined to the 2s. 6d. per horse power, or were to include the additional 2005*l.*

Mr. Cotton, Q.C., and Mr. T. Aston appeared for the plaintiff; Mr. Kay, Q.C., and Mr. Ford North were for the defendant.

The Vice-Chancellor disallowed the claim for the additional 2005*l.* made by the plaintiff, holding that 2s. 6d. per horse power, being the sum which he had lost in the first instance by the wrongful manufacture by the defendant without license, was the measure of compensation in assessing damages, and all that the plaintiff was entitled to.

THE PANAMA AND NEW ZEALAND STEAMERS.—The four steamers of the "long line" of 6500 miles from Panama to Wellington, the *Kiakoura*, the *Mataura*, and two others, have been hard at work during the past year. The company's half-yearly report states that, although the operations of the company since the date of the last accounts have not enabled the board to recommend an immediate dividend in respect of the first six months of the current year, the general improvement in the earnings of the vessels, both on the main line and on the local lines in New Zealand, has been, on the whole, very encouraging. The receipts for freight and passage money on the Panama line, which for the three months from December to March averaged 2900*l.* per month, have since been maintained at the monthly average of 4300*l.*—a progressive increase which would, it is believed, have been much greater but for the effect on the through traffic from the outbreak of yellow fever in the West Indies. This fever having now entirely disappeared, better results are anticipated.

SMITH AND COVENTRY'S SCREWING-MACHINE.—In our description of Messrs. Smith and Coventry's screwing-machine, on page 493 of our last number, we stated that the dies are placed in radial grooves in a casting; this, however, is not the case, the dies being surrounded by case-hardened wrought-iron surfaces. Each bolt is screwed by once running up the dies; and when a bolt has been screwed, it is removed, and another started without stopping the machine—an important advantage, which enables ½ in. bolts to be screwed at the rate of seven in two minutes. Even cup-headed bolts, with square necks, can be screwed without stopping the machine. We have received a letter from Messrs. Smith and Coventry, complaining that we did not state that the machine was a "patent." Our readers will, however, have noticed that in our descriptions of machinery we do not, as a rule, state whether it is patented or not.

NEW RAILWAY BILLS.

(From the Times.)

THE notices of intended application to Parliament for railway Bills in the Session of 1868 are 109, as compared with 171 for 1867, 450 for 1866, 415 for 1865, and 360 for 1864. Considering the protracted effects of the panic of May, 1866, and the continued want of confidence in railway enterprise and railway securities generally, it seems surprising that so many notices for the incorporation of new companies should have been given to carry out what might be considered very doubtful projects; and, as powers are sought to lease or sell some of them to other companies, the object appears speculative and intended for private advantage.

About 50 per cent. of the intended Bills are for the extension of the time granted in 1864, 1865, and 1866, for the purchase of lands and completion of works; including also the abandonment of several branch and extension lines, Acts for which were obtained two years ago by great exertions and at enormous expense. With the exception of notices of application for the extension of time to purchase lands and complete works, and to abandon useless and fighting lines, those for the actual requirements of established companies are very few. The Eastern Metropolitan Underground Railway Company seek to be incorporated for the purpose of making a railway from the Great Eastern line at Bow to the East London Railway at Whitechapel, and thence to the Metropolitan (extension to Tower-hill) line at Aldgate; also to form a junction line at Bow with the North-London Railway, and to sell or lease the undertaking. The Islington Company propose to make a railway from Lower-street, Islington, to Little Moorfields, to the north of the Moorgate-street station of the Metropolitan Railway. The East-London Railway Company seek for an extension of time for the purchase of lands and houses, to make up and down junction lines with the Brighton Railway, the New-cross station line, and to abandon portions of lines not required. The London and Blackwall Railway Company require further time to purchase lands and complete the works of the Millwall Extension line. The Metropolitan Railway Company propose to make a short railway from their line under the meat and poultry market in Smithfield to the London, Chatham, and Dover Railway at Snow-hill, and to extend the time for the purchase of lands and completion of works, and for making the deviation on the company's Western Extension line. The Metropolitan and St. John's Wood Company ask for an extension of time to purchase lands and complete the works of the extension to Hampstead, granted by Act 1865. The South-Eastern and London, Chatham, and Dover Companies jointly seek for power to abandon the London, Lewes, and Brighton "fighting line," sanctioned by Act 1866. The Metropolitan District Railway Company ask for an extension of time to purchase lands and houses, and to complete works. At the same time the Board of Works seek for power to prevent delay in the opening of the Thames Embankment, and the roadway and streets thereof, by any default on the part of the Metropolitan District Railway Company in proceeding with their railway in connexion with the embankment. The Great Eastern have given notice for extension of time for the purchase of lands and completion of railways, especially in reference to their Metropolitan Station and Railway and the Alexandra-park branch. The South-Eastern and the London, Brighton, and South Coast Railway Companies intend to apply for power to unite them for the purpose of joint management, working, and maintenance as one undertaking. It is proposed to incorporate a company to construct a subway under the river Thames from near the Tower to Vine-street, Southwark. The Waterloo and Whitehall Railway ask for an extension of time to purchase land and construct works. There are three distinct notices of intended application to Parliament for the construction of street tramways. The Metropolitan Tramway Company (Limited) propose to lay down street tramways from the Archway-road, near Highgate, to Finsbury-place; from Seven Sisters-road, through Camden-town and Tottenham-court-road, to Oxford-street; from Whitechapel to Stratford; from High-street, Clapham, to Kennington-park-road, Lambeth; from Brixton-hill to Kennington, and from Kennington to Westminster-bridge. It is proposed to incorporate the London Street Tramways Company, to make tramways from Upper Holloway to Camden-town and Bishop's-road, Paddington; from Camden-road, Bayham-street, to New Oxford-street; from Holloway-road to Islington and Smithfield; from Westminster-bridge-road to High-street, Borough; also from Westminster-bridge to Clapham and to Brixton. Each tramway is to occupy 5 ft. 3 in. in width and pass along the central portion of the street, or within 4 ft. of an imaginary central line. Liverpool is to be favoured with twelve street tramways. Notices for extension of time for purchase of land and completion of works have been given by fifty companies. Notices of abandonment of authorised lines have been given in respect of the Chichester and Midhurst, the Surrey and Sussex, the Newhaven Tramway, the Ouse Valley lines, the Tunbridge-wells and Eastbourne, the St. Leonard's and the St. Leonard's Deviation line, all belonging to the London, Brighton, and South Coast Railway Company. By the West Riding and Grimsby Company the abandonment of the Keadby and Lincoln Extension is sought. By the Worcester, Dean Forest, and Monmouth Company power is sought to abandon the Great Malvern to Abinghall, and from Abinghall to Newland, also the extension from Newent to Gloucester. By the North-Western and Charing-cross Company power to abandon the undertaking and dissolve the company is sought. By the Lymington Harbour and Docks Company is sought the abandonment of the Railway Act, 1861. By the Sevenoaks and Tunbridge it is proposed to abandon part of the undertaking. By the Bristol and Exeter Company power is sought to abandon the Tiverton and North Devon Railway. By the Bristol and North Somerset to abandon one line not required. By the Caledonian it is proposed to abandon the Bangholm Junction, the Shieldhill branch, the Crieff connecting Junction, and Barrhead and Paisley branch. By the Ilfracombe Railway Company it is intended to abandon the undertaking and dissolve the company. By the North British it is proposed to abandon No. 1 of the Lasswade branches, No. 1 of the Coatbridge lines, the

Dundee Branch Railways, the St. Margaret's diversion line, the Camps, &c., branches, No. 1 and No. 3, authorised by the Devon Valley and North British tranches; No. 2 railway authorised by the General Powers Act, 1867, and also a portion of No. 2 railway authorised by the Financial Act, 1867. The South-Eastern and London, Chatham, and Dover Railway Companies propose to abandon the London, Lewes, and Brighton Railway (Act 1866).

The intended new railway companies are the Isle of Wight (Newport Junction), for making junction railways to Sandown and Newport; the Monmouthshire and Great Western Junction, for making railways from the Western Valleys Railway to the South Wales Railway and to the Alexandra (Newport) Dock branch; the Somerset and Dorset propose to purchase the existing Somerset and Dorset Railway, and to wind up the affairs of the company; the Ross and Monmouth and Forest of Dean seek for power to make a railway from Lydbrook to the Ross and Monmouth Railway at English Bicknor; the Eastern Metropolitan Underground, for making a railway from the Great Eastern Railway at Bow to the East London Railway at Whitechapel and to the Metropolitan Tower-hill Extension at Aldgate; the London, Thames Haven, and Kent Coast Company, for making a railway from Herne Bay Pier to the Herne Bay station of the Kent Coast Company; Islington Railway Company, for making a railway from Lower Islington to Little Moorfields; the Liverpool and Birkenhead Railways and Ferry Junction, to make a railway from the Birkenhead and Chester Railway to the river Mersey, and from the Dingle Tunnel of the Garston and Liverpool to the opposite bank of the Mersey; the interval on the Mersey was to be worked by a steam ferry; the Glastonbury and Street Company, for making a tramway between those places; the Great Marlow Railway Company, for the construction of a railway from the Wycombe branch of the Great Western to Great Marlow; the Isle of Wight Central, for making railways from Newport to Sandown; the Isle of Wight, Cowes, and Newport Junction, for making three railways to connect the Cowes and Newport and the Isle of Wight Railways; the Langdale and Windermere, for making tramways in Westmoreland; the Birkenhead and Liverpool Railway Company, for making a railway from the Birkenhead Railway, passing under the river Mersey to Liverpool, with extensions to other railways; the Weedon and Daventry Railway Company, for making a railway from the Weedon station of the London and North-Western Railway to Daventry.

The proposed amalgamation or joint working of companies are those of the South-Eastern and London, Brighton, and South Coast, who are also, it appears, to work the London, Chatham, and Dover Railway; the London and North-Western and Knighton, Central Wales, and Central Wales Extension; and the Great Western and Bristol and South Wales Union Railway Company.

The Brecon and Merthyr Tydfil Junction Company seek power to define, consolidate, or readjust the several classes of mortgages, bonds, and other securities, guaranteed, preferential, and ordinary shares and stock. Power to suspend actions and suits for a certain period, to convert debentures and other debts into stock, and to provide for the conversion of Lloyd's bonds and other securities. The Cambrian Railway Company propose to provide for the separation of the undertakings of the company into two separate undertakings, and, in another notice, to confirm a scheme of arrangement filed in Chancery under the Railway Companies Act (1867), and to grant powers to carry the same into effect. The Crystal Palace and South Junction Railway Company propose to form junctions with the Chatham and Dover and the Brighton South London Junction lines, and to raise further capital. The Great Eastern, to alter and improve its management. The Lancashire and Yorkshire, to extend the time authorised for the completion of certain authorised branch railways. The London and North-Western (branches and additional powers), authorising the company to make a railway to Sheffield, the Crown-street, Liverpool, Extension, a railway at Derby, the Harpur-hill deviation, and the Llanberis Junction, and to enter into arrangements with the Midland and the Sheffield Railway Companies. The Midland (additional powers) propose to raise further capital for the general purposes of the railway, and to make the Coton-park branch, the Darfield Junction, a connecting line in the parish of St. Pancras, also the Codnor-park curve, and to extinguish right of way on a footpath at Hendon. The Midland and London and North-Western (Ashby and Nuneaton lines) propose to make the Nuneaton Junction line, the Abbey Junction line at Weddington, and deviations. The North British propose to make a railway over the Forth at Alloa, and to abandon part of the authorised line over the Forth. The Sirhowy Company propose to make nine extension lines. The Bishop's Stortford, Dunmow, and Braintree Company intend to make provision for payment or satisfaction to Messrs. Brassey, Ogilvie, and Harrison, and all other persons and companies, of all debts and sums of money due to them on account of the construction and maintenance of the railway station and works, and to authorise the Dunmow Company and the Great Eastern Railway Company to create preference or debenture stock, to satisfy the claims of Messrs. Brassey, Ogilvie, and Harrison. The Great Western Railway Company ask for power to enable them to make a siding or branch railway at Swansea, and an extension at Stoutbridge. They also ask for extension of time to construct a branch line at Kidderminster, Ruabon, and Wrexham. The London and South-Western and South-Eastern Railway Companies ask for power to widen parts of the Charing-cross line and to construct platforms, &c., to connect the Waterloo station with the Charing-cross station. It is proposed by a notice, to repeal the North British and Edinburgh and Glasgow Railway Company Amalgamation Act, 1865, and to incorporate the Edinburgh and Glasgow Company, with full powers to resume its former position.

NEWCASTLE-ON-TYNE.—Not much is doing in engine building, either for locomotives or steam vessels. The anchor and chain cable trade and the iron trade generally on the Tyne and Wear are slack, and there is no doubt the men engaged in the iron trade will submit to the reduction to-morrow (Saturday), which will be about 1s. per ton off puddling and 10 per cent. off mill men.

ENGINEERING WORK IN PROSPECT.

TO THE EDITOR OF ENGINEERING.

SIR,—Every one of your readers must be pleased, with yourself, "to learn of any large undertaking which shall occupy a considerable amount of English engineering talent," whether at home or abroad.

The ship canal to be constructed in Canada West is no doubt a very interesting and useful work, and, if executed, I hope it will give no cause for dissatisfaction to our friend Brother Jonathan, either on purely commercial or on strategic grounds. But if a sum of eight million pounds sterling can be found in Canada for a work of usefulness, but certainly not of immediate vital necessity, how is it that we cannot find an equal sum for a work of absolute necessity at home, recognised by every one that has given this question the least amount of attention to be a national want, namely, a plentiful supply of wholesome water to the city of London?

While civil engineers lie idle in Great George-street or elsewhere, and navvies and mechanics are half starving, and every one complains of the London-water, and with the approach of every summer is afraid of the cholera, surely the time for the execution of such a work would be well chosen, and London might be supplied with water much in the same manner, and on the same grounds, as some of the towns in Lancashire were provided with streets and drainage during the cotton famine.

Messrs. Hemans and Hassard's estimate is twelve millions; Mr. Bateman's, I believe, seven millions; Mr. Telford McNeill's, five millions; Mr. Bailey Denton's, four and a half millions; and, since last I addressed you on this subject, I notice that another proposal has been started, estimated, I believe, at four millions, namely, that of sinking four artesian wells into the green sand underlying the London chalk. The arithmetic mean between these sums is six and a half millions, which ought to go very far towards realising the desired object.

This new proposal of artesian wells, however, appears to me again to be based upon hypothesis, and leaves the subject wrapped up in doubt and uncertainty; for how can we be certain that we shall find the quantity of water required when we have reached the green sand?

Paris, which stands upon the same chalk formation, and where artesian wells are of old standing, has not deemed proper to extend her experience in that direction, but has quite recently endeavoured to supply itself with water from the sources of the river Dhuis at great cost; and as these works are practically a failure (so I am informed here), she is now laying out another large sum of money to supplement its present supply by an addition from the waters of the river Vanne, not from the sources of that river, you will perceive, but from the river itself, experience having shown that the sources of the Dhuis have become treacherous, and refuse to supply the aqueduct to Paris.

In like manner might the "green sand" turn out, not treacherous, but abortive or barren, and therefore let the authorities in these matters be advised by the experience of others, and go for their water (the which they will certainly have to do); let them go for it to a place where they can see an inexhaustible and sure source with their very eyes, even if it were to the Cumberland lakes, notwithstanding that I have called this a chimerical scheme.

But as I have mentioned the authorities, I am tempted to ask what is the commission doing which has been appointed to inquire into this matter? Its labours have been very silent; let us hope that they are "deep and searching."

I remain, yours truly,

December 3, 1867.

J. J. BIRCKEL.

A FAST STEAM LAUNCH.—The double-screw steam launch, recently constructed at Chatham Dockyard, having been fitted with her high-pressure engines, by Messrs. John Penn and Sons, has undergone her official trial at the measured mile, outside Chatham harbour. The launch is fitted with two pairs of engines of six-horse power (nominal), each driving an independent four-bladed screw, each screw working beneath the counter. Each of the screws is 2 ft. 6 in. in diameter, with a length of 3½ in., and an immersion of the upper edge of 1 in.; during the trials they were set at a pitch of 3 ft. 6 in. The quantity of coals on board during the trial was 11 cwt., and with the necessary stores and the officials and engine-men, the launch had a draught of water of 3 ft. aft and 1 ft. 9 in. forward. On reaching the measured mile at Saltpan Reach, six runs were made at full steaming power, when with a force of wind of 3 to 4, a mean speed of 8.239 knots per hour was obtained, which is considerably higher than that attained by any of the double-screw launches hitherto tried. The load on the safety-valve, by Salter's balance, was 70 lb.; mean pressure of steam in boilers, 79.5 lb.; maximum number of revolutions of screws per minute 308, and minimum 306. The complete circle was made in 1 min. 1 sec., with the rudder put over to an angle of 46 deg., the diameter of the circle being 40 yards, or about three times the launch's length. The engines, during the trial worked with the utmost regularity, and there was an entire absence of priming.

RAIN IN INDIA.—When it does rain in India, it pours. In the Nerbudda valley the average rainfall for the first nine months of the present year was nearly 70 in., and the chief commissioner has already received a detailed report of the damage done by the overflowing of the river in the Hoshungabad district. The deputy commissioner of Saugor reports that on the night of the 11th September 8½ in. of rain fell at that station, and that, as might be expected, much damage was done to the native town and to the surrounding country.

COTTON PROSPECTS IN INDIA.—The Cotton Supply Reporter contains detailed statements of the acreage under cotton-cultivation in India, and the estimated crops in bales of 390 lb.

	Acrea cultivated.	Estimated crop.
Central Provinces ...	611,722	100,000
Bombay Presidency ...	1,078,181	...
Berar ...	1,220,459	230,000

THE NEW CLEVEDON PIER.

The new wrought-iron pier now in course of construction at Clevedon, Somerset, of which we give engravings on pages 528 and 532, involves some very important features and considerations, the engineers, Messrs. R. J. Ward and J. William Grover, having considerable difficulties to contend with, not the least of which is the extraordinary rise and fall of tide in the Bristol Channel, amounting in the present instance to 45 ft. Moreover, the coast itself is one which must occasion trouble in the foundations, owing to its being composed partly of hard magnesian limestone, which is covered at various depths with large loose boulders surrounded by very soft slushy mud. A powerful tide and occasionally stormy sea render the process of fixing tedious and difficult.

The contractors for the whole of the pier are the Hamilton's Windsor Ironworks Company (Limited), of Liverpool, who have recently completed successfully a very large similar work at Colon, in Panama. The contractor for the masonry and approaches is Mr. Ambrose Oliver, of Hitcham, Bucks.

The general dimensions of the structure are as follows:

Length of approaches ... 180 ft.
" the pier (in 8 spans of 100 ft. each) 800 ft.
" the pier head ... 42 ft.
making a total length of over 1000 ft., and giving a minimum depth at extreme low-water spring tides of 6 ft. at the pier-head, which is therefore always accessible. The approaches are generally 25 ft. wide, and are executed in first-class masonry, the footings of which are let into steps cut out of the solid rock. Powerful moorings, or holding-down bolts, which are carried through this work at an angle of 45 degrees, serve to secure the main girders from moving from their bearings.

The pier itself is composed of eight 100 ft. spans, consisting of two continuous wrought-iron girders 3 ft. 6 in. deep, which serve partly to form the parapet. On the top of each girder there is a continuous seat, the back of which is made up of tight boarding. The deck is of 3 in. planking, machine planed and close jointed, laid lengthwise, and cambered in the centre 3 in., so as to give the effect of the long and pleasing perspective of a flush deck on board ship.

The main girders are supported by double cantilevers, so that they could be divided in two in their centres without danger. These cantilevers are composed of Barlow rails, turned bottom upwards, bent, and having flat plates rivetted on their backs, the distance or spandril pieces being a combination of T irons and plates. The main longitudinal girders are kept apart by rolled joists 9 in. deep, 16 ft. 6 in. long, and about 20 ft. 6 in. from each other. Between these again runs a system of diagonal bracing below the deck, the idea being to make the whole superstructure one deep lattice girder laid upon its side.

The piles, which in the deepest point reach the height of 65 ft. above ground—which, added to an average of 15 ft. in the ground, makes them as much as 80 ft. long—are composed each of two Barlow rails rivetted back to back. They are placed at a rake of 1 in 10 both ways; and at the top the pair on each side are brought into intimate union by means of a wrought-iron plate passing between them. The two united rails are bent over, and form an arch of considerable stability. The piles are kept in position by a complete system of diagonal bracing and distance-pieces or struts. That part of the pile which enters the mud is made of 5 in. solid wrought-iron stems, at the end of which comes a 2 ft. 3 in. cast-iron screw. These are carried down to the rock. Where the rock is on the surface, the piles are secured to it as shown in Fig. 6, page 532.

One important and very advantageous arrangement of the piles appears to be that they are so combined and connected as to form in themselves a powerful girder, which would not only resist any tendency to buckling, but would be effectual, probably, in withstanding the shocks of wreckage or of an average-size vessel itself.

The pier-head on plan measures 42 ft. x 50 ft.; it is in itself a formidable structure, being 65 ft. high, and is built of eighteen piles, each made of two Barlow rails, rivetted back to back. At vertical intervals of every 10 ft. come five lower landing decks or stages. These are made of open boarding, laid upon a strong framework of rolled iron joists and girders, which serve as distance pieces between the piles. Horizontally, diagonally, or cross diagonally, runs a complete rigging of wrought-iron rods as bracing, and in the centre up the entire structure are to be carried the stairs, which are wide and ample, and of which there will be five pairs. Around the entire wrought-iron framework runs a vertical casing of 8 in. timber fender-piles, about 2 ft. 6 in. apart, which are intended to distribute the shocks of vessels discharging.

The pier-head is doubtless sufficient for the purposes of a landing-stage, for which it seems to be designed; but, if it is to be used as an attraction for promenaders, as a resort for the residents and visitors of the pretty little town of Clevedon, as a place where the band may play on summer evenings, to the delight of "congregated thousands," then we fear its deck area of 50 ft. x 42 ft. less the stair opening will be found too small. It should have had another row of piles on each side, which would have increased it to 75 ft. x 42 ft. Even then there would have not been too much space, after deducting all the obstructions of band-houses, pollards, masts, ropes, signal-huts, &c., and the numerous necessary adjuncts to a work of this character.

In all other respects, the work seems well adapted for its situation. The large spans are right in view of the difficulty of the foundations. The openings are pleasingly formed by the elliptical arch. Advantage has been taken of the important combined principles of "continuity" and "double cantilevers." The piles, though long, are clustered, and we know that union is strength. Although the use of the Barlow rail as a pile is not altogether new, it has, we believe, never been employed in England before for a work of equal importance.

It remains to be stated that the quantities of wrought iron used are nearly 350 tons; of cast iron, under 7 tons; and that the entire cost of the work will be under 10,000L.

OUR COAL-FIELDS.—It is expected that the report of the Coal Commission will appear in the course of the coming year, but at what time Mr. Hardy, the Secretary of State, is unable to state.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Clyde Shipbuilding for November.—The shipbuilding trade during the past month has shown signs of a little improvement in the numbers of men who have resumed work. In point of vessels launched during the month it has been unusually dull, but that was no doubt caused by the orders on hand a few months ago running out. It is, however, pleasing to note, on the whole, that prospects are much better than they were two months ago. The following is a statement of the number and tonnage of vessels launched during the past month and eleven months, as compared with corresponding periods of two previous years:

	1867.		1866.		1865.	
Month	Vls.	Tons.	Vls.	Tons.	Vls.	Tons.
November	6	3,650	13	12,490	19	15,730
Eleven months	161	102,250	195	110,230	237	142,920

Among the vessels launched during the month there were:

Name.	Character.	Horse Power.	Tonnage.	Builders.	Owners and Destinations.
Ceres	Screw	200	1750	Messrs. Denny Bros. Dumbarton	Austrian Lloyd's Steam Navigation Company.
Irene	Paddle steam-yacht	200	750	Messrs. Caird & Co. Greenock	Trinity House, London. For Lighthouse Inspection.
San Pedro	Paddle	80	350	Messrs. Wingate and Co. Messrs. Swan	Messrs. Proudfoot and Co. For River Plata.
Diamond ...	Screw	...	100	Messrs. Hill	Messrs. Robertson, Glasgow.
Anita	Screw	...	50	Messrs. Stevens	South America.
Lunari ...	Iron sailing ship	...	650	Messrs. Stevens	Captain Connell. South American trade.

Other Shipbuilding Items.—The small steamer, Anita, named in the table above, coaled at Greenock last week, and proceeded over to Gareloch for the adjustment of her compasses, preparatory to starting on her voyage to Buenos Ayres. To cross the Bay of Biscay at this time of the year, and especially during the prevalence of violent storms, in such a small craft as a 50-ton steamer is certainly a perilous undertaking on the part of Captain McVicar, her commander.

The new screw steamship Baltimore, 2200 tons, built by Messrs. Caird and Co., for the North German Lloyd's, for their new line of Bremen and Baltimore traders, which has been lying over at Gareloch for the last two months, was towed back to the Victoria Harbour, Greenock, a few days ago. Her shaft, which has been made in Germany, having arrived, she will now be completed.

There was launched on Saturday afternoon a handsome screw steam-tug from the building-yard of Messrs. Donald and McFarlane, Paisley. As she glided into the water, she was named the Francisco by Miss McFarlane. Her dimensions are, length, 50 ft.; breadth, 12 ft.; depth, 6 ft. She is intended for the South American trade. The machinery, constructed by the builders, consists of a pair of diagonal engines of 20 nominal horse power, steam winch, and one of Chaplin's patent distilling apparatus.

On Thursday there was launched from the shipbuilding yard of Messrs. Walter Hood and Co., Aberdeen, the Ploughman, a fine new brig of 177 tons register N.N.M., classed A 1 at Lloyd's for nine years. The vessel is the property of the Aberdeen Commercial Company, and is to be commanded by Captain Petty.

Glasgow Pig Iron Market.—Since my last budget was made up, the pig iron market has been very quiet and inactive, as a rule, only on one or two occasions becoming firm, but even then the prices have never practically been above 53s. 3d. cash and 53s. 5d. a month. Yesterday a transaction was reported of 500 tons at 53s. 3d.; to-day there has been no change in the prices, and the market has again been inactive. During the month just closed the price of pig iron has declined 2s. per ton, the highest being 55s. 3d. and the lowest 53s. 3d. The stock in Connal and Company's yards at the end of the month was 269,760 tons, with warrants circulating for 198,700 tons. The following is the statement of pig iron shipments from all Scotch ports:

For the week ending 30th November, 1867.			
This year	...	...	tons.
Last year	...	...	9,055
	...	...	10,197
Decrease			
Total since 25th December, 1866	...	...	1,142
For corresponding period in 1865-66	...	...	573,659
Increase			
	...	...	531,705
	...	...	21,954

Glasgow Customs' Revenue.—The following is the amount of Customs' revenue received at this port for the past month, and for the corresponding period in 1865 and 1866:

	£	s.	d.
Month ended November 30th, 1867	115,414	1	4
" " " 1866	102,411	2	11
" " " 1865	67,075	2	1
The revenue from January to November this year inclusive, exhibits, as compared with the corresponding eleven months of last year, the large increase of 244,300L 15s. 4d., the amount for these different periods being as follows:			
January 1st till November 30th, 1866	835,269	14	2
" " " 1867	1,079,570	9	6

Glasgow Harbour Revenue.—As evidence that the trade of the port of Glasgow is increasing at an enormous rate, notwithstanding the general depression throughout the country, I

may mention that the harbour revenue for the past month of November was increased by 1009L 5s. 9d. over that of the corresponding month of last year. The month just closed has not been in any way exceptional, for the increase in the revenue during the five months ending with November has been 5800L. This ought to be considered a very satisfactory state of things.

Caledonian Railway Inquiry.—The last issue of the *Railway News*, in an article on this subject, gave currency to a rumour that the late general manager of the Caledonian, Mr. Christopher Johnstone, at present employed as one of the Government commissioners on the Irish railways, had refused to be examined by the Committee of Inquiry into the affairs of the Caledonian Railway Company. The local journals here have been authorised to give the allegation an unqualified contradiction.

Proposed Chair of Engineering in Edinburgh University.—Dr. Muir announced, at a late meeting of the University Endowment Association, the proposed foundation of a Chair of Engineering in the University of Edinburgh. Sir David Baxter, of Kilmarnock, who has on former occasions proved his warm interest in the university, has, for a third time, presented a sum of 5000L to the Senatus. As a tribute to the eminent Dundee manufacturer who has founded his fortunes by industrial pursuits, the Senatus have recommended that this sum should be devoted to the advancement of technical education. A chair to teach civil and mechanical engineering would be a most important addition to the College. But the interest of 5000L, amounting to 200L annually, would be insufficient to tempt a professor of high eminence to accept this chair. Sir David Baxter has, therefore, very properly made it a condition that the Government shall meet him half-way, and add an equal amount to the salary, making it 400L, besides the fees. The Government readily consented to a similar condition when Dr. Muir founded the chair of Sanscrit. Now that public attention has been so much directed to the deficiencies of this country in technical education, there cannot be a doubt that the Government will warmly welcome this proposal. The proximity of the Industrial Museum to the University renders the latter peculiarly suited to the development of an efficient department of technical education.

The Sewage Question.—A propos of the visit of Messrs. J. F. Bateman and J. W. Bazalgette to Glasgow, of which I spoke last week, it is worthy of mention that an association has been formed this week, whose object is the consideration of the sewage question. Mr. Randolph, who was in the chair on the occasion, has been appointed vice-president. The association already embraces a number of mechanical and civil engineers, chemists, and other manufacturers, and other professional men. On the occasion in question a paper was read on "The Disposal of the Sewage," by Mr. T. Hoey. The manurial ingredients of the Glasgow sewage are estimated by Mr. Hoey at 206,000L annually, and the cost of converting the solid contents of the sewage into dry manure, he estimates at 147,000L. In the course of the discussion which followed the reading of the paper, it was stated that the town authorities of Dundee take up the whole of the ashes, night-soil, and street-sweepings of that town, and sell them for a sum which nearly defrays the cost of removal, while in Glasgow that operation costs more than 20,000L annually. Edinburgh, Manchester, and Liverpool are all much more favourably situated than Glasgow with reference to this pecuniary consideration.

Institution of Engineers and Shipbuilders' Association.—At the meeting of this body, last week, Mr. Robert Duncan, ship-builder, Port Glasgow, read an elaborate paper on "The Proposed Amendment of the Merchant Shipping Act." The mode of measuring the tonnage of ships was the topic chiefly treated of by Mr. Duncan. The suggestions were considered so important, that the discussion upon the paper is postponed to the next meeting. Mr. James R. Napier, F.R.S., followed with a short paper criticising the 3rd, 13th, and 14th articles of the Admiralty Regulations for preventing collisions at sea. The following is the conclusion of Mr. Napier's exceedingly clever reply to "The Rule of the Road for Steamers, Simple, Sufficient, and Intelligible," by "T. G.":

"Although Mr. Thomas Gray, whom I take to be the author of the pamphlet signed 'T. G.', has recently put the rule he has been commenting on, and other rules, into verse as aids to the memory, I submit that at present they are deceitful and dangerous, and ought to be suppressed until the screens are altered; and that the following lines, suggested by a communication in *Punch* on 23rd November, should be authorised, as they represent the effect of the present practice of fixing and screening lights, and are much more likely to prevent collisions than Mr. Gray's version:

"WEATHER DARK AND CLOUDY.
"A., seeing Three lights nearly ahead on Starboard side sings, to aid his memory:
"A meeting steamer I'll not dread,
When I see three lights ahead
I'll port my helm and show my red,
And if I'm smash'd what can be said?
B., seeing a White and Green light nearly ahead on Starboard side, sings, to aid his memory:
"Green to Green, so it's said,
Is perfect safety,—Go ahead.
But if the Lubber port, I say
A collision's likely, Thomas Gray."

Mr. Napier also read some verses which had been written in 1803, on the first steam-barge which plied on the Forth and Clyde Canal. They had long been in his father's possession, but never published. If you publish them, I fear you would almost require to refer your readers to a glossary of the Scotch dialect, unless in the case of those who are "to the manner born."

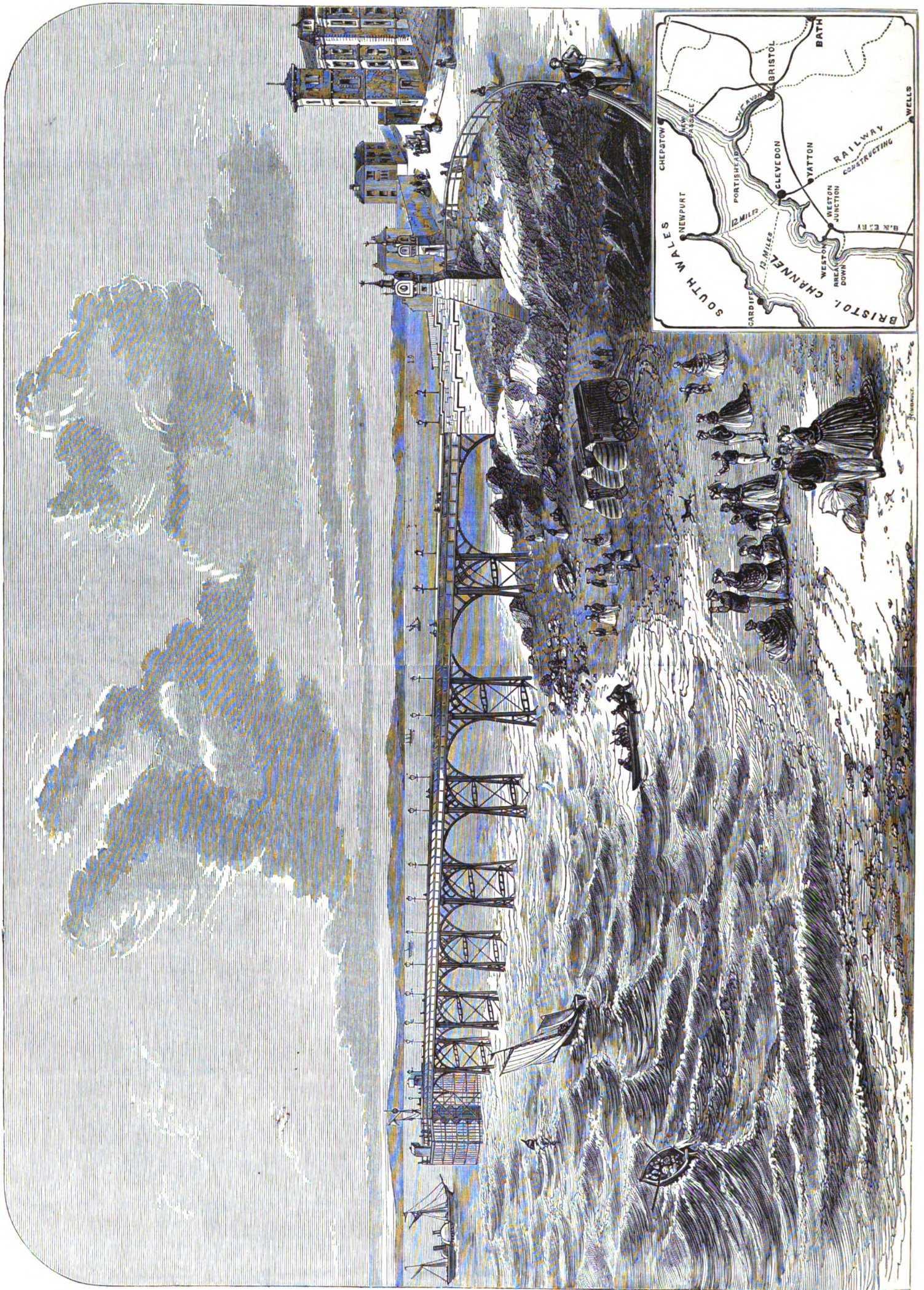
[We shall give these amusing verses next week.—ED.]

SLIP IN A RAILWAY CUTTING.—A man and three horses were killed, on Monday, on the Aldershot extension (now in progress) of the South-Western Railway, by a sudden and large slip of earth in a cutting upon which a considerable force was engaged at the time.

WROUGHT-IRON PIER AT CLEVEDON, SOMERSET.

MR. R. J. WARD AND MR. J. WILLIAM GROVER, ENGINEERS.

(For Description, see preceding Page.)



PUBLISHER'S ANNOUNCEMENT.

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

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A number of advertisements have been unavoidably excluded from our advertising columns this week. We cannot, under any circumstances, allow more space to advertisers than we now give.

The first of our series of portraits of the Engineers will appear in our next number.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 10th, at 8 P.M. Discussion 1: "Description of the Victoria Bridge, on the line of the Victoria Station and Pimlico Railway." By William Wilson, M.Inst.C.E. 2. "On New Railways at Battersea; with the Widening of the Victoria Bridge, and Approaches to the Victoria Station." By Charles Douglas Fox, M.Inst.C.E.

SOCIETY OF ENGINEERS.—Monday evening, December 9th, at 7½ P.M. Annual General Meeting for election of officers for ensuing year, &c.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Wednesday, December 11th, at 8 P.M. "On the Preservation of Timber." By Mr. R. M. Bancroft.

ENGINEERING.

FRIDAY, DECEMBER 6, 1867.

THE PRIVATE BILL OFFICE.

At the rate at which engineering practice is declining, it should not be long before the Private Bill Office is to let, or appropriated as a porter's lodge or a lumber-room. Never in the recollection of the younger generation of engineers has it looked so empty, in the first week of December, as now; never did it present such a beggarly account of empty lockers. But fifty-two railway plans, much the larger number being of unimportant deviations, have been deposited. There are also six tramway plans and sixty-six miscellaneous plans. The list of deposits was printed on Tuesday evening, and the plans were first opened for examination on Wednesday. Previous to that, the *Times* had given a list of deposits, which we reprint elsewhere, but which could only have been compiled from the notices in the *Gazette*, and some of the bills said to have been deposited were not forthcoming on Saturday evening last—the critical eight o'clock of the 30th of November. One of these, announced in the *Times* as having been actually deposited, would have been the most important bill of the session. It was the Liverpool Metropolitan, and a good story attaches to it. A distinguished engineer, one King John, had sent a strong staff down to Liverpool to survey the streets and sound the Mersey, which, as our readers know, was to be tunnelled. Everything was going forward in anticipation of a glorious campaign in the committee-rooms, when another distinguished engineer, also a King John, who regards all underground railway undertakings as his special preserves, despatched a strong force to the scene, with instructions to outflank the enemy right and left. This force arrived in Liverpool early in November, and returned, we believe, on the 18th, with materials for fifty-two sheets of plans, which it was impossible to have lithographed in time for the 30th, and which, we will venture the suspicion, were never intended to be deposited at all. But the King John who was first, in order of time, foresaw, as he thought, the coming war, and effected a retreat from the disputed territory, leaving it in possession of the

other King John, whose military genius had made him master of the situation, but who, having demoralised the enemy by his formidable preparations, quietly disbanded his army of occupation on a long furlough. The result of this fine stroke of professional intimidation is that no bill has been deposited by either potentate, and thus Liverpool is again left to its fate and its ferry.

There is an underground scheme, however, which looks very subterranean indeed. It is that of the Eastern Metropolitan (Underground) Railway, to extend under the Whitechapel and Mile-end-roads, from the Metropolitan District Railway Station at Aldgate to the Great Eastern and North London Railways at Bow. The deposited plan does not at present bear the name of the engineer, but a narrow strip of the paper of the cover has been cut out and a piece of blank paper gummed over it, where the name has doubtless been. If rumour whispers correctly, the name was "John Fowler," and was placed there without the sanction of that gentleman. One Charles Baylis, somewhere near the Poultry, is the solicitor, and we believe he is also the engineer, as well as being the proprietor of freehold land at and near Bow, which would no doubt be benefited by the proposed railway, to say nothing of its value to the nobility and gentry of Whitechapel, for whose accommodation moke-boxes and basket-vans would doubtless be provided. The proposed line for the improvement of Mr. Baylis's property is to be about 2½ miles long, and subways are to be made alongside for the accommodation of gas and water mains, telegraph-wires, &c. We fear Mr. Baylis will find himself called upon to exercise the virtue of patience for a few years, as his line will not be made in a hurry.

Another scheme is that of the Islington Railway, of which Mr. Robert Richardson, of the Inventor's Institute, and Mr. John Inmray, of the same body, and who was lately an axle-maker in the Westminster-bridge-road, are the engineers. Their line is to be overground, 1½ miles long, extending, upon a continuous viaduct, from Islington-green to the Metropolitan Railway Station at Moorgate. Forty-one spans of 150 ft. each, are marked on the plans, and these would nearly make up the length of the line. The gradient is 1 in 75 down, for a considerable distance, from Islington.

Mr. Peter Barlow's Tower Subway, a new Thames Tunnel, in which omnibuses to carry twelve passengers, all inside, are to be propelled by the muscular power of one man, also enters an appearance. The subway is to be about a quarter of a mile long, extending under the Thames from near the Tower to Pickle-Herring-street. The passengers are to be taken down the end shafts, 43 ft. deep, and up again by hydraulic lifts. The tunnel will descend at the rate of 1 in 40, from each end, to a short level under the middle of the river, where the rails will be 61 ft. 6 in. below the level of high water. Mr. Barlow's own account of his scheme, which we noticed last week, is too absurd for serious consideration. If there is really a considerable across-river traffic to be developed between Tower-hill and Pickle-Herring-street, it will require something more than man-worked omnibuses to develop and work it.

The East London (Thames Tunnel) Railway, of which Mr. Hawkshaw, Mr. George Robert Stephenson, and Mr. Burke are the engineers, is to be extended to New Cross, and short new lines, called the Brighton Up Junction and the Brighton Down Junction, are to be made to connect it with the South Coast system. We see gradients marked 1 in 60 and 1 in 77 on the plans.

The Dingwall and Skye Railway, authorised in 1865, and of which Mr. Murdoch Paterson is the engineer, is an interesting line right across Scotland, from the Highland Railway, north of Inverness, to Loch Alsh, where a ferry will take the passengers and goods to Skye. The company deposit a large portfolio of plans for deviations, &c. The line will be nearly a surface line, with no heavy works, but with several miles of gradients of 1 in 50. A pier is to be made at Attadale.

The Carnarvon and Llanberis Railway, already authorised, will be an interesting work, rising from Carnarvon, much of the way at the rate of 1 in 63, to one of the lakes below Llanberis, itself so near Snowdon. The line is to be turned over to that great ramifying concern, the London and North-Western.

Numbered 59 in the Private Bill Office is a deposit by Mr. William Dyce Gay, assisted by Mr. John Hawkshaw and Mr. James Abernethy, as consulting engineer. This scheme has for its object an improvement of the tidal harbour of Aberdeen, a diversion of the river Dee, and a reclamation of a considerable

area on the south side of the present course of the river, which is now useless tidal land. The diversion of the Dee is designed to commence about two-thirds of a mile southwards of the existing upper dock, at a point adjacent to the Caledonian Railway, where the Dee is spanned by the Wellington Suspension Bridge. It will be about 6000 ft. in length, and a channel would be provided 380 ft. wide. The town of Aberdeen is situated almost entirely on the northern bank of the Dee, and possesses an inner and an outer dock, approached by a tidal harbour. The entrance to this harbour is to be improved by the removal of a spit of land which at present narrows the mouth, and the navigation channel is to be widened and deepened for a length of 3000 ft. The existing north pier at the commencement of this navigation channel is to be extended for a length of 400 yards, and a small jetty on the opposite shore is to be removed, and replaced by a breakwater 1200 ft. to the seaward, protecting the channel approaches and the tidal harbour. This arrangement forms an efficient protection, and leaves a clear seaway of some 1200 ft. for entering the harbour.

Nos. 23, 24, 25, are three rival schemes for railways in the Isle of Wight. The first is entitled "The Isle of Wight Central," and is engineered by Messrs. Alfred Giles and William Stratton; it has a total length of 7 miles 1 furlong, and commences by a junction with the Cowes and Newport Railway, near Newport, and terminates at the Sandown station of the Isle of Wight Railway, in the parish of Brading, effecting a junction with that line. With the exception of one tunnel of 294 yards, the railway works are comparatively light in this scheme.

The Isle of Wight, Cowes, and Newport Railway (24) is No. 23 backwards; it is made up of one big line and two little ones, commencing in the parish of Brading by a junction with the Isle of Wight Railway, and ends near Newport, in the parish of Carisbrooke, by a junction with the existing Cowes and Newport Railway. This line is 6 miles 6½ furlongs in length. The short railways, numbered 2 and 3 on the deposit, form double junctions at each end of the main line with the existing railways respectively. Mr. H. D. Martin and Mr. W. Hunt are the fathers of this scheme.

No. 25 is quite original and distinct in its route from the two preceding mains; it consists of two railways which commence in the parish of Brading, and terminate in Carisbrooke parish, having together a length of 9 miles 1 furlong. Line No. 3 is a short line, 10 chains long, the greater part of which has a gradient of 1 in 11. R. J. H. Saunders, Esq., has his name on this deposit. The present prosperity of the existing Isle of Wight railways is great and increasing, but we did not think that any engineer, even in the present hard times, could find the heart to attempt to persuade hopeful shareholders that Isle of Wight railways would prove a desirable and remunerative investment. Mr. Benjamin Piercy deposits plans and sections for nine lines in the neighbourhood of Newport, Monmouthshire. Collectively they make up a length of about ten miles, and comprise a junction between the existing Sirhowy Railway and the Brecon and Merthyr-Tydvil Railway, a junction with the South Wales Railway, and branches to the Tredegar wharves, the Newport docks, and the Pill Bank branch of the Monmouthshire Railway. No works of any magnitude distinguish this scheme, which is free from steep gradients.

No. 124 was shut out in the cold on the imperative 30th, and was not deposited till the 2nd of December, which delay, according to standing orders, is a capital offence. It is a scheme deposited by Mr. J. Simpson, as consulting engineer, and Mr. William Bull, on behalf of the North Middlesex Waterworks Company, and is an application for permission to enlarge their works at Colney Hatch, and to construct a reservoir near Muswell-hill; likewise to make tanks at Muswell-hill, Finchley, and Whetstone, in the parish of Finchley; also to lay down mains through Colney Hatch, Edmonton, Tottenham, Friern Barnet, St. James, Clerkenwell, St. Mary, Highgate, with branch conduits wholly in Tottenham.

THE P. AND O. COMPANY.

THE Peninsular and Oriental Steam Company have lost, according to their accounts, no less than 177,047l. in the last year. The paid-up capital of this company is 3,306,435l., so that the loss is upwards of 5½ per cent. upon this amount. This loss is mainly due to the cessation, last year, of the exports of specie to the East, from which source 220,000l. of annual revenue was formerly derived. The company have also lost one of their ships, the Singapore, valued at 34,300l.,

and the wreck of the Surat involved a charge for repairs of 20,000*l.* more; but both these sums fall upon the underwriting account, which still shows a credit balance of 60,700*l.*, the company being said, by a fiction, to "insure their own ships," which means that they pay nothing to underwriters, but reserve and fund something yearly out of earnings to meet occasional losses.

The new mail-contract, however, just entered into for twelve years will add 170,000*l.* a year to the company's revenues; and in a very probable contingency, that of their being otherwise unable to declare a 6 per cent. dividend, the subsidy will be increased to 500,000*l.*, or 270,000*l.* more than at present, the present subsidy being 230,000*l.* At the same time the company undertake a more frequent service, maintaining a weekly mail to Bombay; but no increase is to be made in the contract speed, which is now 10 knots an hour this side of Alexandria, and 9½ knots beyond Suez. Indeed, the company may exceed the contract time by 24 hours on the 141 hours' voyage in the Mediterranean, and on the 313 hours' voyage from Suez to Bombay, without incurring any penalty, and after this the penalty is but 50*l.* for each 24 hours of delay, a penalty which, with coal at 3*l.* per ton on the other side of the Isthmus, the company could better afford to pay than to keep their contract time, even when the extra provisioning of the passengers is considered—a matter which would be far more than compensated by the lessened wear and tear of the boilers and engines working at the slower speed.

The improvement to be effected under the new contract will be as follows: Calcutta, which now has in the year 24 mails of 34 days, and 24 mails of 29 days, will have 52 mails of 29 days; Madras, which now has 48 mails of 30 days, will have 52 mails of 30 days; while Bombay, which now has 24 mails of 24 days, will have 52 mails of 24 days. It is clear, however, that along with the mails the company must have passengers also, in order to pay their way; and in addition to the competition of the French steamers of the Messageries Impériales, the Calcutta service of the P. and O. Company will in a few years be affected by the completion of the railway between Bombay and Calcutta, when most passengers for the latter city will cross India by rail, instead of going round by Point de Galle and up the Bay of Bengal and the Hooghly. Indeed, this will be the natural route for the mails also; but the company are nevertheless bound to keep up the separate Calcutta service. As for the competition of the French steamers, it is not yet certain how far it may go. The fine French steamers now plying between St. Nazaire and New York have quite run the American steamers off the course, and, to some extent, they have affected the receipts of the English companies. We know that, not only by Frenchmen, but by Americans also, certain of the Clyde-built ships of the French line are now preferred as the swiftest and most luxurious of any crossing the Atlantic, the Cunard steamers not excepted. They enjoy a large imperial subsidy, as do the French steamers to the East, and there is undoubtedly to be, if we should not say there already is, a keen race for supremacy of traffic.

We have said nothing of the Suez Canal, but long before the present contract of the P. and O. Company expires, it should be open to their ships, at a cost far less than that of the Egyptian Railway transport and the maintenance of a separate service. The continuous run of a steamer from Marseilles to Bombay *via* Suez, or even to Calcutta, would be not more remarkable than that of the Panama and Australian steamers, which steam 6500 miles on a stretch, without a single stop for coal or provisions.

The P. and O. Company need cheaper coal beyond Suez. The Labuan coal, which promised so much, and which is really so good, and sold at only 20*s.* a ton at Labuan, is now well shut out of the market by the proceedings of the Lairds of Liverpool, who are in a fair way to break up the company formed for working the coal, and for running steamships to China. At present coal at the P. and O. Company's Eastern stations costs 3*l.* per ton, whereas there is abundance of coal, and very good coal too, in India, close to the railways, in Labuan, in New South Wales, near Sydney, and in Japan. The Singapore Gas Company now obtain first-rate gas coal, at Singapore, at prices below those paid by some English companies.

We ought not to omit saying that the P. and O. Company have, through their managing director and engineers, done their utmost to economise in fuel. They have given every encouragement to makers who undertook to supply the most economical pattern of engine, and have gone as far with quick-going, direct-acting screw-engines, with superheating, high expan-

sion, surface-condensation, steel shafting, &c., as any company in the world. Unfortunately both for the company and the public, some of these trials have not turned out as we could have wished. But enough has been done to prove that, whenever any good case is made out for an improved system of steam machinery, the P. and O. Company will not be the last to take advantage of it.

CONVERTED GUNS.

SIR JOHN PAKINGTON, in reply to a question by Major Anson, has assured the House of Commons that it is the intention of Government, in the course of the next year, to convert a large number of 32-pounder cast-iron guns into 64-pounder rifles. This is not to be done at Woolwich Arsenal, but under the immediate superintendence of Major Palliser himself. Sir John, however, stated that the Ordnance Department were of opinion that the 68-pounder, when converted, would not be able to withstand the heavy charges required, and he intimated that, although throughout all her Majesty's possessions we are deficient in the proper and requisite number of rifled guns, the conversion of the 68-pounder would not be attempted.

A correspondent of the *Times*, evidently well informed, thus explains the circumstances under which the Ordnance Committee arrived at the conclusion, two years ago, that the converted 68-pounders would not withstand battering charges:

"It is but fair to say that the gun on which the Ordnance Select Committee founded that report two years since was not a true Palliser converted gun.

"The state of the case is this: A 68-pounder was converted on Major Palliser's plan, and fired 800 rounds with charges ranging from 16 lb. to 20 lb. of powder; at the 750th round the inner barrel was split, apparently, according to the Ordnance Select Committee report, from the use of round-bottomed shells; 50 rounds were then fired without causing any further change in the gun.

"At this stage it was determined to replace the inner barrel, and to do this the solid breech was cut out and replaced by a common cast-iron screw plug.

"I was present when the gun was proved in this state with 27½ lb. powder and 115 lb. shot. At the first round this cast-iron plug split in half, and with my hand I could make it rattle in its berth. Fifty battering charges of 22 lb. powder and 115 lb. shot were afterwards fired at angles of from 3 degrees to 18 degrees, when, as expected, this broken cast-iron caseable was blown out, and the Ordnance Select Committee naturally reported such ordnance as unfit for battering charges.

"It may, however, be interesting to the public to learn that the 7 in. barrels of this gun were removed by Sir W. Armstrong and Co., and placed in a lighter gun than a 68-pounder, viz., the cast-iron 10 in. gun of 84 cwt., and then bored up to a calibre of 8 in.

"This time, however, there was no patchwork at the breech; it was, in fact, a converted gun on the correct Palliser system, and these identical barrels, which had been reported on as unfit for the battering charges of a 7 in. gun, were submitted to the test of an 8 in. Woolwich gun of 9 tons weight, the proof charges being 37½ lb. of powder and 180 lb. shot. I was present at this proof, and afterwards saw 50 rounds fired at Woolwich as rapidly as possible with 30 lb. of powder and 180 lb. shot.

"This gun is now at Shoeburyness, where it has since fired a considerable number of rounds. It has shot through the Warrior target at an angle of 30 deg., and there is nothing the matter with it.

"I believe I am not mistaken in saying that the Ordnance Select Committee were right in denying battering powers to guns patched up in the breech with cast-iron screws, and, further, that the question of battering charges with the *real* Palliser converted 68-pounder rests, as far as they are concerned, entirely on the possibility of so strengthening the old gun-carriages as to enable them to withstand the recoil.

"The Ordnance Select Committee have now a 7 in. converted 68-pounder at Shoeburyness mounted on a strengthened carriage. The result of battering charges on this gun and carriage will soon be known, and till then it is not possible to arrive at a final decision upon this very important question."

The bare cost of manufacture of the 7 in. Woolwich gun is given as 405*l.*, which, of course, includes neither general charges nor profits. Major Palliser's estimate for the conversion of the 68-pounders by private manufactures varies, according to his three patterns, from 195*l.* to 238*l.*

Major Palliser has accomplished wonders with his converted guns—wonders because, upon *a priori* reasoning, nearly every ordnance engineer would have pronounced such results impossible. Mr. P. M. Parsons has worked in the same field, and with not less success in respect of the endurance of his guns, although, so far, without any personal gain.

Most encouraging as are the results already attained, the action of the Ordnance Select Committee in carrying the tests to the extreme limit of endurance cannot fail to be generally approved of. What is desired is that our costly mistakes in ordnance may be henceforth avoided. Thus far it would appear that the whole history of our wrought-iron guns, whether

known as the Armstrong, the Elswick, or the Woolwich gun, has been a frightful mistake, inasmuch as these guns are apparently no better than, if as good as, converted cast-iron guns at less than half the price. Mr. Fraser's cheapened gun, which has done so well, is a great departure from the wrought-iron guns which it succeeded, and a notable return towards cheapness and simplicity.

THE EXPLOSION AT LIVERPOOL.

A STEAMSHIP, with seventy-three souls on board, was blown into three pieces and sunk in the Mersey, on Friday morning last, by a terrific explosion, of which the cause is not known. But forty or fifty of those on board were saved. This vessel, the *Bubulina*, was formerly a blockade-runner, known as the *Colonel Lamb*, and had been purchased by, and refitted on account of, the Greek Government. She was built in 1864 by Messrs. Jones, Quiggin and Co., of Bessemer steel plates, was 279 ft. long, 35 ft. broad, was 15 ft. deep, and had 350 horse paddle engines made by Messrs. James Jack and Co., and capable of driving her 16½ knots an hour.

The explosive elements on board the ship at the time of the disaster were, first, her boilers, under steam; second, 350 tons of Powell's Duffryn steam-coal; and third, a quantity of gunpowder. The magazine, however, was in the bow, and no explosion took place there. Besides, if it had, the shattering effect would have been greater than that of merely breaking the ship across. Those who heard the explosion heard three successive reports, following quickly one after the other; whereas, in all probability, but a single report would have been heard had the gunpowder exploded.

Instances of the explosion of marine boilers on board of steam-ships are fortunately very rare, so rare that we cannot here recal an instance of a true explosion of the kind, the failure of the steam-pipe of the *Parana*, at Southampton, and of the *Great Eastern's* feed-water casing being very different in the circumstances attending them. Yet there is no necessary reason why marine boilers should be more exempt than others from explosion, since they are inherently of a weak form, being nearly square, and not circular like most other boilers, and they are exposed to the chances of corrosion, over-pressure, &c., like all boilers. Nor would the fact of three boilers, of a connected series, exploding one after the other in quick succession—as might be inferred from the three reports heard—be unprecedented. Would such an explosion, however, or series of explosions, blow a ship into three pieces, or even into two? It has been stated in the papers that no boiler explosion on shipboard was ever known to break the keel. As we have already said, very few boiler explosions in sea-going vessels have ever happened at all; but we believe the keels of steamboats on the western rivers of America are occasionally broken when their boilers explode. We have particulars of upwards of forty of these disasters now before us, in many of which three, four, and even six cylindrical boilers, worked at from 140 lb. to 170 lb., exploded simultaneously, and in a few cases the boat sunk immediately. In all these cases the boilers were on the main deck, well above the water-line, while in that of the *Bubulina* they were under water. The flight of one, two, or three boilers, as boilers often do fly in exploding, against a ship's side, would no doubt break through it, even when made of the very toughest Bessemer steel, as was the vessel in question. The captain of the steamer *Ant*, who rescued many of the survivors from the bow and stern, which floated for some time afterwards, stated that a heavy bank of steam rose from where the reports proceeded.

It is stated, however, as matter of general belief in Liverpool that the explosion was caused by an accumulation of gas in the coal bunkers, and that the Duffryn coal freely and spontaneously gives off its gas. With such a quantity of coals, however, 350 tons in a vessel of 1132 tons full register, including engine-room and all, the net tonnage being 689, the bunkers must have been nearly or quite full, and but little space could have thus been left for gas. Had it entered the engine-room and boiler-room, and even had it not done so gradually and been detected, its explosion, judging from occasional accidents of the kind which happen to colliers, would hardly have been so terrific as was the case. Gas explosions happen, now and then, on these craft, but we do not hear of their being completely blown to pieces and sunk. After the tremendous explosion at Nine Elms, we have no wish to dogmatise upon the subject of gas explosions, but we have ourselves witnessed two or three where the effects would not, by analogy, support the opinion that a strong

steel steamship, with her hatches open, would be completely blown to pieces from such a cause.

We have to choose between the boilers and the coal gas, but we think the chances were fully as great that the former would blow up as that the latter would form and collect in quantities sufficient to account for such tremendous effects. We cannot absolutely know what has happened until divers get down to and into the wreck. If it prove to be the fact that the explosion was one of gas alone, we think it may reasonably create more alarm at the use of coal in our steamships than has ever been felt on account of their steam boilers.

Since writing the above, we learn from the divers who have examined the wreck that they have come upon two of the four boilers, and that they are perfect. One of them, however, was found 200 ft. from the wreck. The cause of the explosion is more mysterious than ever.

MIDDLESBORO' AND ITS FUEL.

WHILE the ironmasters of Middlesboro' pay but about 4s. 6d. per ton for an ironstone yielding 31 per cent. of iron, equal to about 14s. per ton of pigs made, they pay as high as 14s. 6d. for their best coke. The ironstone is mined within sight of the town, from inexhaustible veins of great thickness high up on the face of the Cleveland hills. The coke and coal, however, come from Bishop Auckland, 25 miles, by rail, to the west, and the rate charged averages 2s. per ton, or 1d. per mile. The large ironworks in North Lancashire also draw large supplies of coke from Bishop Auckland, a circumstance which tends to keep up its price, whereas there are mines of equally good coal nearer Middlesboro', to the north, but with which the ironmasters on the south side of the Tees have no direct communication, from the want of a bridge over, or a tunnel under, that river.

Mr. Head, of Middlesboro', lately read a paper before the Cleveland Institute of Engineers, in which he explained how, by tunnelling under the Tees and making, in all, four miles of railway between Middlesboro' and Norton Junction, six miles would be saved in the distance to Bishop Auckland, and a communication be also opened to the whole Durham coal-field. Taking the same mileage rate of 1d. per ton, as at present, this would save 7½d. on the 25-cwt. of coke and coal required for a ton of pig iron; and Mr. Head estimates, that taking the further large quantity of coal used in puddling and in the mill furnaces, besides the saving in the carriage of limestone, &c., it would amount to 2s. 6d. per ton of finished iron. Upwards of one million tons of pig iron have been made in a single year in the Cleveland district; and if only 7½d. per ton could be saved upon this alone, the amount would be 31,250*l.*, while the further saving per ton upon the much smaller quantity of finished iron would amount to nearly as much more.

Only the North-Eastern Railway Company could be expected to make the new line, the cost of which, including two curved junctions with other lines north of the Tees, Mr. Head estimates at 181,620*l.* Their existing line into Middlesboro' is already greatly overcrowded, and it is therefore to be hoped that, in the general interests of this important district, the company will undertake and carry out an improvement of such obvious importance.

A NEW FURNACE.—During the last few months there has been carried on at the works of Messrs. Whieldon, Lecky, and Lucas, 190, Westminster-bridge-road, a series of experiments on a new form of furnace invented by Mr. Thomas J. Leigh. This furnace, which is applicable for puddling, steel-melting, or other purposes for which an intense heat is required, we had an opportunity of examining and seeing in action yesterday; but, as Mr. Leigh's foreign patents are not yet completed, we have been requested to postpone giving any description of it for a few weeks, when we shall explain its construction fully. At present we need only say that the furnace is adapted for burning slack coal as fuel, that this fuel is instantaneously converted into gas as it is fed in, and that a perfect combustion and very intense heat are obtained in it. Crop ends of steel rails placed in the furnace are reduced to a perfectly fluid state in twenty-five minutes, and wrought iron is also readily melted. Mr. Leigh's first patent was taken out about twelve months ago, but he has since then materially modified his plans, and he has just taken out a new patent which embodies the results of his extensive experiments.

BLAENAVON.—At Blaenavon three new blast furnaces are in progress, and will shortly be completed, when there will be employment for a considerable number of additional hands.

A BROKEN STEEL RAIL.

THE fact of a steel rail having this week broken on the Charing-cross Railway bridge is worth recording, not only because the failure of a steel rail is a matter of extremely rare occurrence, but because in the case in question subsequent experiments have demonstrated very clearly the reason why the fracture took place. The rail referred to was one rolled by the Barrow Hematite Company—we believe, in 1864—and was a flat-footed rail, weighing 70 lb. to the yard. Like the other rails on the Charing-cross bridge, it was laid on longitudinal timbers, to which it was fixed by wrought-iron clips spiked to the timbers, and each pair secured to the rail by a bolt passing through the latter. The rail was not broken through its depth, but failed from a fracture which reached from the top of the rail down to one of the bolt-holes just mentioned, and then proceeded longitudinally to the end of the rail, passing on its way through the two holes for the fish-bolts. The fracture thus detached a piece of the upper table of the rail about 20 in. long, and this piece so detached was held in place by the fish-plates, the fracture causing no accident of any kind. On Tuesday last Mr. Peter Ashcroft, the engineer of the South-Eastern Railway, had a piece of the fractured rail tested at the works at Bricklayers Arms, Colonel Yolland being present during the experiments, and, from the results obtained, there can be no doubt that the rail was made of steel containing too high a proportion of carbon, whilst an examination of the original fracture showed that the end of the rail had in all probability been injured by punching the holes for the fish-bolts. These holes, although intended for ½ in. bolts, were 1½ in. in diameter, and there can be little doubt that these holes, punched, as they were, through a very hard steel, had injured the metal around them. The 4 ft. length cut from the rail was tested by placing it on supports 3 ft. apart and subjecting it to the blows of a "monkey" weighing 300 lb. The height of the fall and the deflection caused by the blows were as follows, the height of fall being progressively increased 1 ft. at each blow:

Fall of Monkey.	Permanent Deflection of Rail.
5 ft.	nil.
6 "	½ in.
7 "	1 in.
8 "	1½ in.
9 "	2 in.
10 "	2½ in.
11 "	3 in.
12 "	3½ in.
13 "	4 in.

We should mention that the deflections above given were measured from a straight edge extending over the whole length of the piece of rail (4 ft.), and the actual deflections between the points of support were consequently somewhat less. The blows of the monkey were delivered upon a piece of iron bar, 1 in. square, placed on the rail midway between the supports. The manner in which the rail broke was very curious. The line of fracture extended downwards from the point where the blow was received, nearly through the upper table of the rail, and then turned off sharply in a longitudinal direction for some inches. It then turned gradually downwards, and passed through the bottom flange at a point distant 7 in. longitudinally from that at which the blow was received. The fracture showed an exceedingly close and hard grain, more resembling that of good tool steel than that of a steel adapted for rails; and we trust that a portion broken from the rail may be analysed, to ascertain the percentage of carbon contained in it. Those who have seen, as we have, double-headed steel rails, weighing 68 lb. per yard, withstand, without cracking, two blows in reverse directions of a 20 cwt. monkey, falling 20 ft., and then a final blow from the same ram with a 30 ft. fall, will be disposed to wonder at the failure of a steel rail under the tests above recorded; but the fact is readily explicable when the hard nature of the material is considered. Although, however, the steel rail which broke on the Charing-cross bridge was very far inferior in toughness to the steel rails now regularly turned out by thousands of tons by our large steel manufacturers, yet we may mention that it stood a far higher test than Mr. Ashcroft even considers it advisable that iron rails should stand. Mr. Ashcroft's long experience and carefully recorded observations have proved to him that an iron rail which will bear more than about four blows of a 300 lb. "monkey" falling from heights successively increased from 5 ft. to 8 ft. is in almost all cases too soft to be durable. Mr. Ashcroft's series of experiments on iron rails, extending as they do over a number of years, are probably the most complete ever made, and they are far too important to be treated of in a short notice like the present. We shall therefore not say more about them here, but shall take the opportunity, on an early occasion, to lay before our readers some of the facts which Mr. Ashcroft has kindly placed at our disposal.

MR. HENRY BESSEMER.—The Emperor of Austria has conferred the commander's cross of the order of Francis-Joseph upon Mr. Henry Bessemer, in acknowledgment of the great services he has rendered to the progress of the iron manufacture of Austria by his important invention. The imperial Austrian Consulate-General in London has been charged to transmit this decoration to Mr. Bessemer.

SOUTH YORKSHIRE.—The iron trade of the South Yorkshire district is stated to be less active, although there is still a good deal doing. House coal is in active request for London and depôts on the Great Northern route; and there is a slight increase in the tonnage of engine coal forwarded to Lancashire. The orders received for armour plates at Sheffield are giving rise to a large amount of employment; with this exception, the iron trade of the town remains unaltered. There is a fair demand for Bessemer steel (principally for export), and a tolerably good business is being done in steel railway rails, axles, springs, and tyres.

UN-STEAM-ENGINEELY CONDUCT.—The Master of the Rolls heard a case on Tuesday, in which Caffyn White, the well-known sculler, and the landlord of a public house called The Turk's Head, Wapping, preferred a suit to restrain the defendant, who lives next door to him, from working a steam-engine for crushing dry rice and rice husks. The plaintiff's case was that the engine in question did almost everything to annoy and injure him in his business, from worrying his wife to clouding and shaking up his beer, and from driving away his customers to all but undermining his premises. The plaintiff further alleged that the injury done to him was so patent and of so dangerous a character that his insurance office had refused to continue his insurance even at an advanced premium. In answer to the plaintiff's case, the defendant produced a host of affidavits to show that the allegations of the plaintiff were greatly exaggerated, and that no vibrations were given forth by the engine which could in any way produce or account for the annoyances of which the plaintiff complained. His Lordship said that he would read all the affidavits previously to delivering judgment.

THE METROPOLITAN MAIN DRAINAGE.—With the exception of that portion of the Northern Low Level Sewer under the Thames Embankment, the great work of metropolitan drainage, vigorously prosecuted through eight years at an expense of some 4,000,000*l.*, is now actually accomplished, and both sides of the river, and the river itself, are effectually drained. Eighty-two miles of sewers cleanse an area of 117 square miles, and promote the health of three millions of people. The visible results are most encouraging. The decline of the death rate within the bills of mortality, the diminished power of epidemics, and the improvement of the public health in the low-lying districts especially, are so many testimonies to the efficacy of the new system. Nor is the air the only element which has been purified. The Thames is at last, comparatively speaking, clean; and the very fish have found out the change. They can now live in the water of our metropolitan stream, which before was too foul for life, and the purity of the river reacts upon the atmosphere around.

AUSTRIAN RAILWAYS.—Since the pacific speeches of the French Emperor, several new railway schemes have been brought out in Austria; that of the Franz-Joseph Railway, from Vienna to Prague and Eger, shortening the distance to Northern Germany, has been successful, the shares offered having been fully subscribed. Another company for the construction of the Alföld Railway in Hungary will, it is said, probably meet with an equally good reception. At present the low credit of Austria and Hungary compels them to guarantee 8 to 9 per cent. on the capital for these undertakings, and under such guarantees the companies create shares and preference shares at 5 per cent. interest, which they are able to offer with a good profit at the price of 70.

FAST STEAMING.—It is about fifteen years ago since we were accustomed to read those perplexing paragraphs headed, "*Paddle v. Screw*," showing that the screw could barely hold its own. Now the screw appears to be well ahead. The westward passage to America is always longer than the eastward passage from there, the former being retarded by the Gulf Stream current and the prevailing westerly winds. But we read in the Liverpool news that the last passage of the Inman steamship City of Paris to New York is the finest ever made by any steamer. Leaving Roche's Point, Cork, on the 21st ult., at 4 p.m., she arrived off Sandy-hook at half-past 3 on Friday afternoon, in 7 days 23 hours and 30 minutes apparent time, or 8 days 4 hours real time, being at the rate of more than 14 knots or 16 miles per hour. The news of this remarkably swift westward voyage comes, we need not say, by the Atlantic cable.

TIMBER VIADUCTS.—In Mr. Brunel's time the danger of timber viaducts was not understood as it deserved to be. Strangely enough, he, at one time the most extravagant engineer in the kingdom, afterwards took to timber viaducts as a matter of economy. Last Saturday one of his wooden viaducts fell on the Vale of Neath Railway, between Hirwain and Glyn Neath. The passage of a mineral train was the final feather that broke the camel's back. It is hoped that this event will draw the attention of the officials of the Great Western Railway Company to the state of the wooden bridges on their line at Newport and Landare, near Swansea, both of which are in such a condition that passengers who know the locality cross those structures with misgiving.

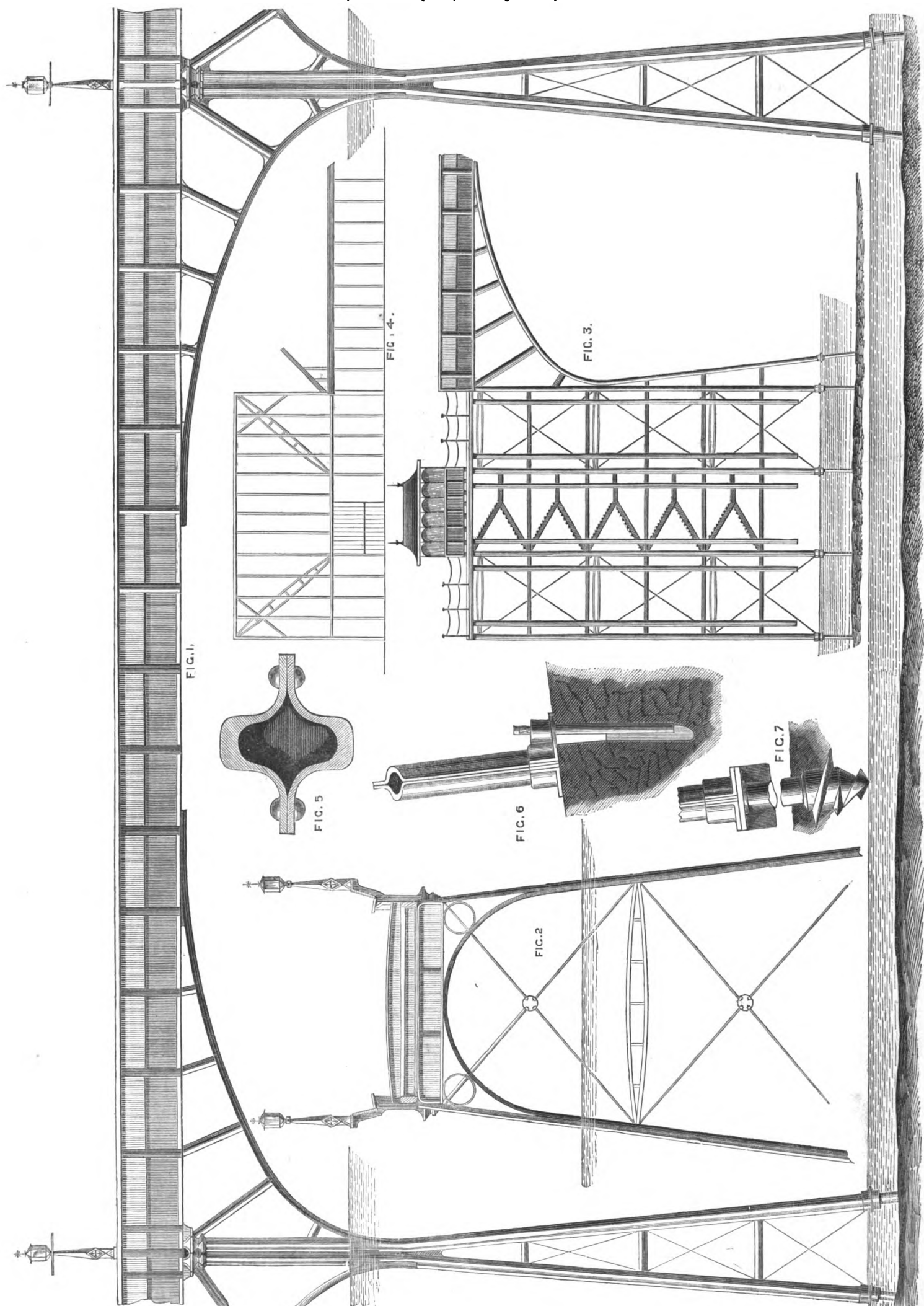
THE CALCUTTA SOUTH-EASTERN RAILWAY.—The results effected by the opening of this line prove what railways are destined to accomplish for India, and for other as yet unimproved countries. The whole of the district through which the line passes was covered with jungle prior to the railway being commenced. All the Government did was to cut down the trees and sell the land, without making a single road. The Canning Company have raised 150,000*l.*, and expended it on Port Canning. The Government lent them 45,000*l.*, which is being laid out in a most judicious manner to make the town habitable. They have also brought about 150,000 acres under cultivation as rice-fields. They have erected six or seven screw-pile jetties, which are being connected with the railway by tramways. Storehouses have been built, and a large rice-mill, which will turn out 100,000 tons of rice annually. They have also a gridiron for repairing vessels, and a large dock for country boats is being constructed.

TENDERS FOR A BRICK GASHOLDER TANK.—The following tenders have been sent in for the construction of a brick gasholder tank for the Hornsey Gas Company, Mr. Jabez Church engineer: Kirk, 4860*l.*; Mansfield, 4570*l.*; Ashly and Homer, 4490*l.*; Hill and Keddel, 4260*l.* The lowest tender has been accepted.

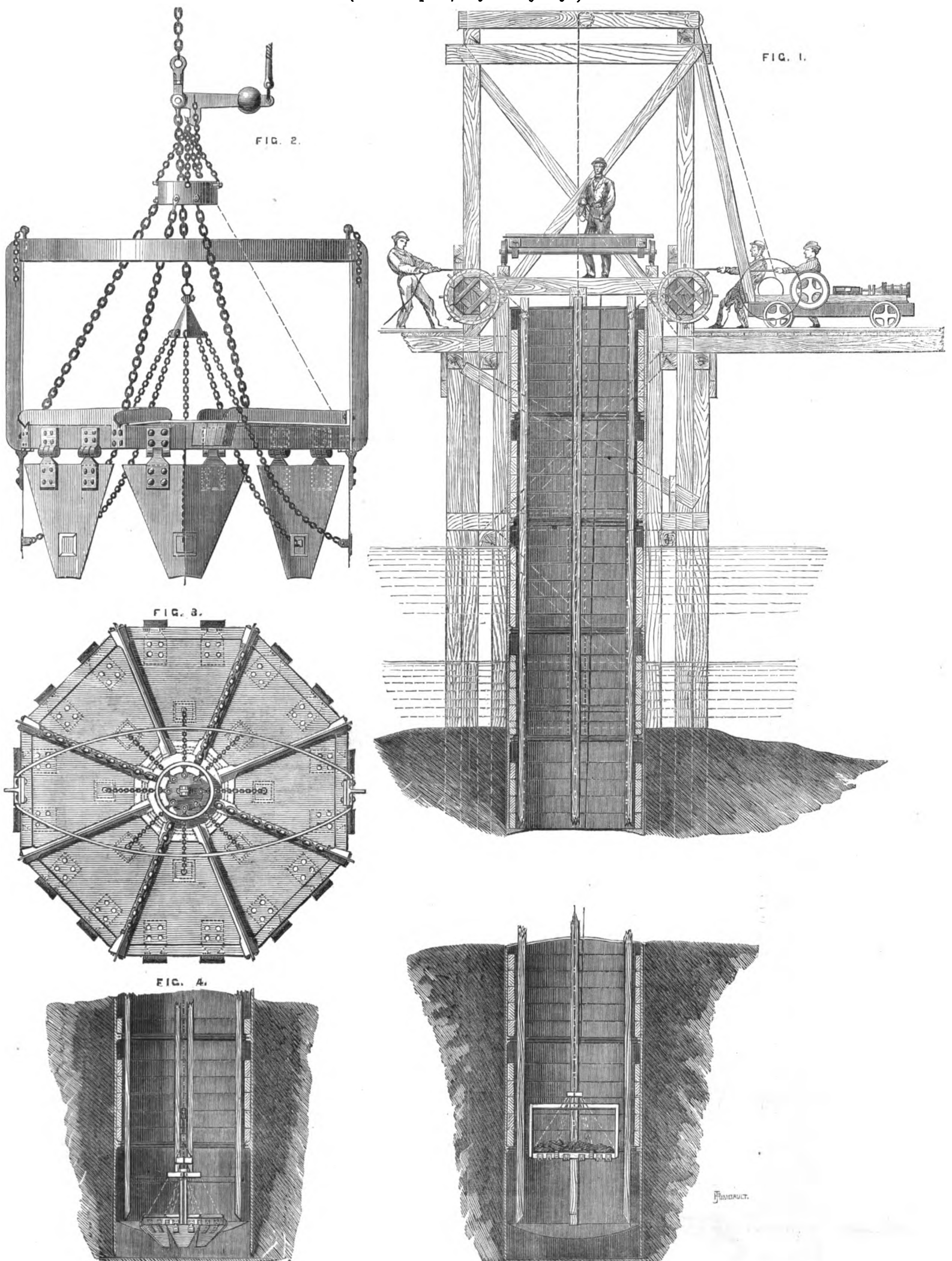
COAL IN PRUSSIA.—It appears that the production of coal in the Dortmund (Prussia) district in 1866 was 8,673,606 tons, of the estimated value of 2,185,939*l.* The average number of workmen employed was 43,936. Of the production of the Dortmund district in 1866, 1,323,424 tons were absorbed by local consumption, 451,604 tons were forwarded to the Ruhr, and 6,250,633 tons were despatched by railway.

WROUGHT-IRON PIER AT CLEVEDON, SOMERSET.

MR. R. J. WARD AND MR. J. WILLIAM GROVER, ENGINEERS.

(For Description, see Page 527.)

MILROY'S EXCAVATOR; CLYDE BRIDGE, CITY OF GLASGOW UNION RAILWAY.
(For Description, see following Page.)



TO THE EDITOR OF ENGINEERING.

TUNNELLING THE TEES.

MR. HEAD, of Middlesboro', in the course of a paper lately read by him before the Cleveland Institute of Engineers, upon a proposed railway under the Tees, to connect Middlesboro' with Norton Junction, and thus save six miles over the present route to the Bishop Auckland coal-fields, thus treated of the proposed river tunnel.

Referring first to a former scheme for a bridge, he said:

"When a plan like this was proposed, a couple of years ago, it met with violent opposition, on the ground that a bridge over the Tees would be injurious to the port of Stockton. It was said that the upward flow of the tide would be impeded, and the depth diminished. Further, it would prevent the downward passage of those large ships for the building of which Stockton has become so justly famous; and would thus affect the prosperity of the shipyards.

"The breadth of the river at the point of crossing is just 400 ft.; the distance from Middlesboro' Station to this part of the river is a mile, or 5280 ft.; and the level of the rails at the station is, say, 12 ft. above the highest spring tides. Now, 1 foot in 100 is a perfectly workable incline, and in the interval between the proposed tunnel and the Middlesboro' Station we should have a fall of 53 ft.

The height of the rails at the station above highest spring tides	12
Depth of the river at spring tides not more than	20
Interval between the bed of the river and the top of the tunnel	3
Thickness of the crown	3
Height of the tunnel	15
Total	53

The tunnel would be the lowest portion of the line, and the gradients at either side might be similar. The momentum gained by a descending train would, to a great extent, carry it up the opposite incline.

"We now come to consider the best method of constructing the tunnel. I propose that it should be a single wrought iron tube, but divided into two passages by a water-tight web, or bulkhead. This division should be strong enough to resist the pressure of the water, and preserve, at least, one side for traffic in case of accident to the other.

"As to the construction of the main tube, I would recommend something on the same principle as that exhibited in the hull of the Great Eastern steamship, i.e., an outer and inner shell, for security and strength. The bottom should be made flat, or slightly arched downwards. The whole section would thus resemble that of a gas-retort or culvert.

"The best plan for placing the tube in position seems to be as follows: As near as possible to the point of crossing it should be constructed by the river side, in a temporary dry dock formed by earthen embankments, and at such a level that the tide would float it, if admitted by the removal of a dam. The tube should be erected upon timber baulks placed crosswise at intervals of 5 ft., and bolted to the structure.

"These would be floated away with it, and afterwards serve as sleepers.

"Meantime, the groove in which it was intended to lie would be cut across the channel of the river by dredgers. It is no new thing to dredge to an increased depth of 30 ft. It is, in fact, the cheapest method of excavating in all cases where it can be applied. The new Suez Canal has been greatly indebted to the use of dredging in the formation of its approaches. Dredgers have even been made to cut their way into the solid shore, the water following to float them as they made a channel for it.

"In the bottom of the groove so prepared concrete must be tipped from barges, and spread to a level by the aid of diving-bells.

"When the tube was completed it would be necessary to cover over the ends temporarily to make it water-tight. It would then easily be floated out of the dock to its permanent position. To let in sufficient water to sink it would not occupy many minutes more. The interval between the ebb and flow, which at spring tides is about an hour, would be ample to accomplish everything necessary. Concrete might then be tamped at the sides and over the top, and in this way, assisted by the natural tendency to silt up, it would soon become permanently fixed. Embankments of clay would now be thrown out from the shore on each side of the line of the approaches, and would join across the end of the tube. As soon as they were made water-tight with clay puddle, the water between must be pumped out and the approaches built in the intervening space.

"In order to avoid the tunnel becoming a drain for the surrounding district, it would be necessary to cover in a certain distance of the approaches on either side. Such portions would be, in fact, brick tunnels. They would be lighted from the top by shafts at frequent intervals. The land above might be made available for standage, sidings, or other purposes. The tube with the covered portion of its approaches would form one continuous tunnel. If they were covered in for a distance of half a mile, their under side would have risen 26½ ft., or somewhere about the level of the outfall of the drainage of the neighbourhood.

"The only water which could then get into the tunnel would be that which might filter through the brickwork. This would run down to a well or sump-hole at one end of the tunnel, and a small steam pump would easily deliver it thence into the river.

"We now come to consider the question of cost. In the Britannia Tubular Bridge, each length of 400 ft. weighed 1200 tons. The length of our proposed tunnel is also 400 ft., but, inasmuch as it is designed for a double instead of a single line of rails, we will reckon it as being double the weight per foot of the above tubular bridge, which gives us 24,000 tons as the weight of the tube. This, at 15½ per ton delivered, is 36,000. Suppose we allow 16,000 for erection, and material and expenses connected therewith, we have 52,000 as the cost of the tube when fixed in place. Let us

now estimate for the casing in of the approaches. If the brickwork were 27 in. or three bricks thick, and were carried under as well as above the tunnel, the sectional area would be about 38 square yards. Brickwork of this description would be, say, 10s. per cubic yard. At this rate, therefore, the casing would amount to 19½ per yard run, or 33,620 for a mile. Adding this to the 52,000 already obtained, we have 85,620.

SMALL PUMPING-ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—Our own charity covers such a multitude of our own sins that I have long since cultivated that virtue, in a humble way, by omitting to read a certain contemporary of yours, lest I should think uncharitably of the paragon of engineering genius who evidently conducts it. An apprentice, however, who, but fourteen years of age, is perhaps less critical than older engineers, has shown me the following profound dictum in a leading article in *The Engineer* of Friday last:

"It is urged that this latter form of engine (the beam) is more costly than any other. If by this it is intended to convey that more money can be spent on this than on any other form of stationary engine, we shall not attempt to dispute the proposition; but we can assure our readers that it is quite possible to construct a beam-engine as cheaply as any other."

Indeed! And what must be thought of such an assurance? The beam-engine must necessarily contain all the parts of a horizontal engine, and numerous heavy parts in addition. Probably every mechanic who has worked upon steam-engines knows this. A striking case in point was instanced in the very paper under notice, July 24th, 1863. Messrs. Mirlees and Tait, of Glasgow, make, for a certain sized sugar-mill, a 22 in. cylinder non-condensing beam-engine, with a 4 ft. 6 in. stroke, or a horizontal engine having the same sized cylinder and 4 ft. stroke, according to order. Both engines, as designed by the same makers, for the same work, are proportioned for equal strength and stability. The beam-engine, however, weighs 44 tons 9 cwt., and the horizontal engine less than 20 tons! The difference of 6 in. in the stroke does not account for more than 6 or 8 tons, if as much, in the weights; and it may therefore be said that the horizontal engine weighs less than two-thirds as much as the beam, and this difference of weight of course represents a considerable, although not a proportionate, difference in cost. I may tabulate these differences in weight as follows:

	Beam.	Horizontal.
	tons. cwt.	tons. cwt.
Bed-plate	7 14	4 13
Columns (six)	5 2	none.
Entablature	3 5	none.
Beam	2 5	none.
Fly-wheel	13 10	9 0
Cylinder and covers	2 10	1 13
Other parts	10 4	4 12
Total	44 10	19 18

Your readers will hardly need to be told that the difference in the weight of the fly-wheel and cylinder is not due to the difference of construction; but, allowing the same weights in both cases, we shall have, say, 44 tons in one case against, perhaps, 27 in the other.

The horizontal engine, taking the most advanced patterns, like Messrs. Galloway's or Mr. Ramsbottom's, is wholly self-contained. The beam engine, on the contrary, tends to lift its cylinder off the bed-plate by the full pressure of the steam (less the weight of the cylinder and the parts fixed to it) at each stroke, equal to a force of perhaps 10 tons in the beam engine named. This pressure is doubled at the main centre, and is again repeated at the journals of the main shaft. To resist these strains by its own transverse strength, the bed-plate would require to be enormously heavy. They are resisted, however, by other means, viz., by strong holding-down bolts, reaching deep into massive masonry, and the foundations of beam engines are necessarily costly.

It is true, as your astute contemporary observes, that the columns of the beam engine cost comparatively little; but the remaining extra parts, and the extra cost for foundations and for the loftier engine-house required, render the beam-engine nearly twice as costly as the horizontal engine of the same power.

I am, Sir, yours truly,

A JOURNEYMAN.

Manchester, December 3, 1867.

PROFESSIONAL FEES.—Professional gentlemen need not expect to be reasonably paid for any trouble they may take on the occasion of inquiries, if Professor Rogers's case may be taken as an index of what the authorities will do. On the inquest upon the death of Elizabeth Stainsby, who died in a train on the Metropolitan Railway, Professor Rogers was requested by the coroner to analyse and report upon the air of the tunnel. In the coroner's accounts, submitted to the committee of the Middlesex sessions, 10½ was charged by Dr. Lankester, on account of Professor Rogers, of the London University Hospital, for examinations and attendances on three occasions at the adjourned inquests held on Elizabeth Stainsby. Now, the committee, having taken the opinion of counsel some years ago, had no power to allow any sum not mentioned in the schedule of fees set down by Act of Parliament, and therefore they deducted from the charge on behalf of Professor Rogers the sum of 7½, leaving it 3½ only, and asked the court to sanction that disallowance. Mr. Kemshead mentioned incidentally that Dr. Lankester's accounts generally were high when compared with those of Mr. Humphreys, and that the coroner's charges cost the county annually a sum of not less than 12,000, which was a very serious item in the county expenditure. He moved that the sum of 10½, included in Mr. Lankester's accounts for the services of Professor Rogers, Professor of Toxicology at London University Hospital, at the inquest held on the body of Elizabeth Stainsby, be not allowed. The motion was put and unanimously agreed to.

METROPOLITAN TRAMWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—It seems that the Metropolitan Tramway Company (Limited) are preparing our minds, what with placards, &c., posted all over the metropolis, and by their petition to Parliament, would claim a monopoly of our leading thoroughfares. Well, I wish them success in their endeavours, for undoubtedly we require a more rapid mode of transit through London. I have no objection to tramways so as to suit all conveyances, but I have a decided objection to a tramway having the wheels of the carriages flanged, and I think the generality of engineers are of the same opinion, and I may add, from our former experience in such a mode of transit in our crowded thoroughfares, that all, from the costermongers to the Hansom cab drivers, voted it a complete nuisance. If we are to have tramways, by all means let us, but not in the way proposed. A tramway must be so constructed that the vehicles can leave the metals and traverse the streets. What would we think of an engineer that would propose running our locomotive railway system through and across our streets? and is the speed that the cars were driven at five years ago calculated to reduce the amount of accidents that daily occur? The London cabdriver is certainly the nearest shaver that we know of. Indeed, it may be said that the machines are lubricated to pass one another; but not so—it is the facility they have in evading each other. If our streets were formed so that the vehicles moved to and fro in a straight line, then the flange wheels would probably suit, with careful driving. But how often is a cabman asked to drive at a great speed in a locality he is not well acquainted with? If he were to cross a line of tramway, and a car rushing past at the same time where he did not expect it, how could the car get out of the way? And do we not see such collisions daily with the present system?

Their programme includes some streets having cab ranks in the centre of the streets, and they propose to run the line in the centre of the street, and, I suppose, the cabmen to shunt to the side. Here is a monopoly—two-thirds of the street taken up with a railway and a cab rank, and costermonger Joe and the "elite" of the land must be contented with one-third share. Some will say, not so; carriages can proceed on the same line of rail. Yes, they may do so with the wheels in the groove, and the coster's narrow wheel may do so; but how are they to get out of the groove when once in? They are going to petition Parliament, are they? The flange rail at Westminster-bridge was rather near the "big house," but it had soon to be cropped of its fair proportions, and I trust their bill will meet the same fate, at least so far as the crowded thoroughfares of London is concerned.

Yours truly,

OBSERVER.

London, December 2, 1867.

ROUND THE WORLD.—M. Behm, a Prussian author, has contributed to Petermann's *Mittheilungen* a statistical account of the means of transport and locomotion existing in the world at the present time. Beginning with the circumnavigation of the world, the oldest company is the Peninsular and Oriental Steam Navigation Company. Its voyages are thus estimated:—To Bombay, twenty-three days from Southampton; to Ceylon and Point de Galle, twenty-six days. The Messageries Impériales steamers go to the same destination. In the Transatlantic routes, England, Germany, and France compete. The voyage from Southampton to New York is given at twelve days, and to Panama at nineteen. During 1865 the voyages from Liverpool to North and Central America numbered 308. In order to make a voyage round the world by existing steam routes, M. Behm says the shortest course would be: From Marseilles to Alexandria, Suez, Aden, Point de Galle, Melbourne, Sydney, and Wellington. Thus the traveller would find himself at the antipodes in fifty-five days. The bi-monthly steamers to Panama would carry him thither in twenty-eight days. From Colon to St. Thomas occupies five days; thence to Southampton fifteen, and thence to Marseilles forty-eight hours. Thus in 104 days, or 3½ months, we might make the tour of the world. The route, *via* Ceylon, Singapore, Hong Kong, Yokohama, and San Francisco is two days longer. M. Behm puts the cost of such a journey at 277½ l. The railways of the world are 80,600 miles long. Over one-third the total length is found in the United States, or about 30,000 miles; England has 13,072; Germany (Austria included), 13,000 miles; France, 8400; India, 3200; Italy, 3080; Spain, 2020; Russia, 2600; Canada, 1810; Belgium, 1500; Sweden, 950; Switzerland, 730; Holland, 650. It appears that the railways of Prussia have cost just about half as much per mile as those in England.

THE CUNARD CONTRACT.—At a time when the Peninsular and Oriental Company have obtained a subsidy practically double that which they have heretofore enjoyed, viz., 400,000 l. per annum, and, in case of a certain probable event, 500,000 l., where they have before had 230,000 l., the Cunard Company have offered to renew their mail contract, which terminates on the 28th of the present month, for much less than their previous subsidy. Four other steamship companies have offered to carry the American mails, receiving therefor the sea postage; but no one of these would undertake to start their ships from England on Saturday, the favourite day for American correspondence, nor to call at Queenstown.

SHEATHING IRON SHIPS.—In answer to a question by Sir G. Stueley, as to whether the method of sheathing iron vessels with copper, invented by Captain Roux, and adopted in the French naval service, had been tested by the naval authorities in England, and with what success, Mr. Corry replied, in the House of Commons, that as far as the Admiralty had been informed the method invented by Captain Roux had not been applied to any iron vessel of war in the French navy. It had, however, been applied to a wooden corvette, and the principle was well known to our professional architects. In their opinion our system was greatly preferable to that of Captain Roux. He might add that the question of coppering iron vessels had been for some time under the consideration of the Admiralty.