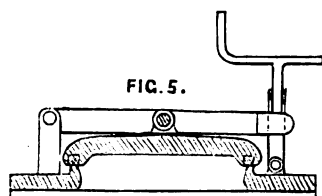


longitudinal section. The boiler is fed by a pair of long-stroke pumps worked from the crosshead, and by an injector arranged as shown in the engravings. The engine is fitted with a brake acting on all the wheels.



The cylinders of the St. John's Wood locomotives being 20 in. in diameter, with 2 ft. stroke, and the wheels being 4 ft. in diameter, the engines will, by the well-known rule, be capable of exerting a tractive force of

$$\frac{20^2 \times 2}{4} = \frac{400 \times 2}{4} = 200 \text{ lb.}$$

for each pound of effective pressure per square inch in the cylinders; and an average effective pressure of 50 lb. per square inch throughout the stroke would thus give a tractive force of 10,000. On the other hand, the engines are intended to take up the incline of 1 in 27 trains consisting of three of the Metropolitan railway carriages, these carriages weighing about 14 tons empty, or about 18 tons loaded; and the resistance due to this load would be about as follows:

Gravity of engine and train (99 tons) ...	8213
Engine resistance (45 tons at 18 lb. per ton) ...	900
Train resistance (54 tons at 10 lb. per ton) ...	540

9653

This load would therefore be well within the power of the engines, and considering that when starting from a station nearly the full pressure of the steam in the boiler can be exerted on the pistons throughout the greater part of the stroke for the first few strokes, there seems to be no reason for doubting that the engines will "get away" with their trains readily, even when the boiler pressure does not exceed 80 lb. The adhesion weight (45 tons) will also doubtless be ample for the work the engines will have to perform, the tractive force of 9653 lb. above estimated as required being less than $\frac{1}{10}$ th of this weight, and it being certain that an adhesion of, at the very least, double this amount could be readily secured at all times by the use of sand. In conclusion we must state that we are indebted to Mr. Burnett for the use of the working drawings from which our engravings have been prepared.

LEAD-INCASED BLOCK-TIN PIPE.

[Abridged from the *American Artizan*.]

To obviate the disadvantages attending the use of leaden pipes, the skill and attention of many ingenious men have been exercised for more than seventy years to produce a pipe which would possess the mechanical properties of that made of lead, and at the same time contain none of its poisonous qualities. There being, however, no other known metal which possesses the same degree of flexibility and durability as lead, it was suggested that to obtain the most important desideratum would be to give a lining of tin or other innocuous metal to the interior of the leaden pipe, which would not impair its flexibility or other valuable properties. It has long been known that tin more nearly than any other ductile metal fulfils the required conditions, and hence it is almost universally employed in chemical laboratories in preparing distilled water. The chief obstacle to the introduction of tin pipe into general use is its costliness and certain difficulties in working it, for, as compared with lead, it is less pliable and less easily soldered.

In 1804 a patent was taken out in England for coating the interior of a pipe with tin, which consisted in casting the lead pipe and then casting a pipe of tin inside of it, around an iron mandrel. In 1820 a similar patent was issued; and in 1832, Thomas Ewbank, of New York, took out American and English patents for coating leaden pipes with tin by passing them, when drawn, through a bath of the fluid metal. Lead pipe has also been electro-plated with tin. This was really no improvement upon the method previously named. Several other plans have been practised; but while some have been attended with such difficulties in the manufacturing as to make the pipe expensive, all have been imperfect; for, tin and lead differing in hardness and ductility, considerable difficulty was found in drawing the two together so as to get them sound in every part, frequent cracks and flaws occurring in the tin, which would not so readily yield as the lead to the forcible extension they underwent. From this circumstance, and the greater rigidity of the tin, the two metals could not be made to sustain the bending to which lead pipe is necessarily subjected by the plumber.

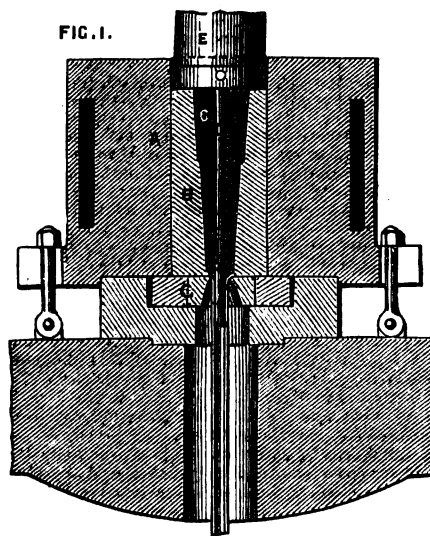
A few years ago, M. Tresca, in experimenting on the flow of solids, found that a number of leaden discs, when pressed out of a central hole in the bottom of a cylinder, formed a rod which, when cut, showed that it was made up of concentric cylinders, the inner one being solid and formed from the top disc, and the outer one formed from the bottom disc, and the others from the discs in the order of their positions. He also found that when a solid nucleus was surrounded by a hollow cylinder, in the pressure cylinder, there was a rod or wire produced with a solid centre surrounded by a pipe, the proportions being in accordance with the proportions in the solid ingot in the pressure cylinder. In a strong cylinder, with a circular hole in the bottom, he put a lead cylinder which fitted it. Pressure was applied, and the lead flowed out as a rod; but this

did not enable him to trace the movement of the molecules; but, in a second trial, instead of the solid cylinder, he put twenty discs of lead, 4 in. in diameter and $\frac{1}{8}$ th of an inch thick; the orifice was 1 in., and after a certain part of the metal was forced out, the rod, on being cut, was found to consist of twenty concentric cylinders, the external ones being formed from the lower discs. The jet or rod was 5 ft. long. With a smaller orifice, a wire 23 ft. long was projected, having the same disposition of concentric parts.

While M. Tresca was engaged in these experiments, as a matter of philosophical study, the Colwells, Shaw and Willard Manufacturing Company, of New York City, whose factory is at the foot of West Twenty-seventh street, North River, were practically applying the principle in the manufacture of a tin-lined lead pipe. This invention was made prior to M. Tresca's experiments, the first patent being issued to W. A. Shaw, March 10, 1863. This was followed by patents issued to W. A. Shaw and Gardner Willard, bearing date January 26, 1864, July 25, 1865, April 3, 1866, July 24, 1866. The pipe as manufactured under these patents differs in several respects from any other of its kind. The incased tin tube is made of any thickness desired, perfectly uniform throughout the whole length of the pipe, and in coils of any required number of feet. It may be termed a "union pipe," consisting of two pipes so thoroughly soldered together that separation or secession is impossible. This soldering causes the whole pipe to comport itself as homogeneous not only during its construction, but also when applied to the various uses for which it is designed. It has sufficient pliability and the other qualities required by plumbers, and its strength to resist strain and sustain pressure is ample; the chemical properties of its interior warrant its full indorsement for general use.

The hydraulic process, as used in the manufacture of the common lead pipe, is used in the manufacture of this tin-lined lead pipe, or, as it may be termed, lead-incased tin pipe, and consists of a framework at the base of which is an iron bed-plate supporting a die, from which the metal is forced in a solid state through an orifice, a steel mandrel or rod being placed in such a manner as to form the core of the pipe. In the bed, at each of its four corners, are inserted the ends of four wrought-iron pillars, eight inches in diameter, supporting a water cylinder with walls of fifteen inches thickness, and in this cylinder works a piston twenty-two inches in diameter, capable of a vertical movement of five feet and of exerting a pressure of four tons to the square inch. This cylinder is lined with copper, and the piston is packed with a cup of leather, which makes it perfectly water-tight as it travels up and down in the cylinder. The water to exert the pressure is conducted through wrought-iron pipes, and forced alternately, by means of powerful pumps driven by steam, to the top and bottom of the piston, as it is designed to depress or elevate it. Two of the hydraulic presses, with an interposed furnace and lead-melting pot and the steam pumps for working the presses, are in regular use, and a detached sectional view of the die and mandrel and their appurtenances is shown in Fig. 1.

In the centre of the cast-iron cylinder, A, Fig. 1, which rests upon the bed of the press, directly under the water-cylinder, is a cylindrical receiver of about six inches in diameter, which is to receive the charge of lead and tin. In this receiver is placed an ingot, C, of pure Banca tin of the shape of a frustrum of a cone, and this ingot forms the

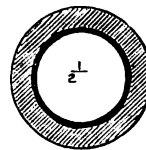


lining of the future pipe. The ingots are cast and then turned to the proper shape in a lathe, and have a hole through the centre. The tapering shape of the ingot is to give uniform thickness to the tin lining, for if it were of equal diameter the flow of the solid metal under the pressure of the ram, E, which is attached to the piston and which fits the cylindrical receiver, would give an irregular thickness. This ingot of tin is frozen by being placed in a refrigerator and surrounded with ice, the object being to prevent a too great fusion of it when the molten lead, B, is poured around it in the receiver from the adjacent melting-pot. The heat of the lead slightly melts the outside of the surface of the ingot, and the lead and tin form, when cooled,

a solid cylinder by the fusion together of their surfaces in contact. A steel mandrel, D, of the size of the bore of the pipe is attached to the lower end of the ram, E, and is inserted in the hole of the ingot; water is forced to the top of the piston from the pumps and the piston, slowly descending and carrying with it the ram, E, causes the latter to force the lead and tin together through the annular opening of the die, G, which is interposed between the receiver and the bed. The tin and lead, being thus forced out together, form a continuous pipe with a lining of tin depending on the size of the ingot of tin.

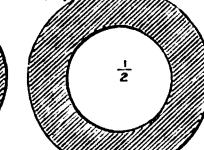
Fig. 2 is a section of the lead-incased block-tin pipe, the heavy line on the inside of the figure showing the tin as incased by the lead. Fig. 3 is a section of lead pipe of the

FIG. 2.



Burst at 1650 lb. pressure square inch.

FIG. 3.



Burst at 1200 lb. pressure square inch.

same bore as Fig. 2. The superior strength of the tin enables the lead casing to be made with a much less thickness of metal, and consequently much lighter; and although the cost of tin is much greater than that of lead, it can be afforded at about the same price as the common lead pipe.

The Colwells, Shaw, and Willard Manufacturing Company also manufacture tin-plated sheet-lead, which is designed to accomplish a great service in offering a cheap and safe material for the lining of tanks, baths, evaporating-pans, or other vessels for holding water, or for use in distilleries and sugar refineries, and other places where lead would corrode. This tin-coated lead plate is fabricated by the aid of a pair of huge iron rolls, being nine feet in length between bearings, and twenty-four inches in diameter; the pair weigh about fourteen tons, and the rolls and fixtures altogether weigh about forty tons. The lead and tin are first cast in a slab, which is afterwards passed back and forth between the ponderous rolls a succession of times until it is of the requisite thinness. Notwithstanding the great weight of these rolls they are easily managed, being raised and lowered by means of gearing attached to the top of the framework in which they rotate.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.

TO THE EDITOR OF ENGINEERING.

SIR,—Having just read Section IV. of the By-laws and Regulations of the Institution of Civil Engineers, as amended and enlarged at the general meeting of members held on the 26th of June last, concerning the creation of the new class called "students," I, for one, think it a most admirable arrangement, and only regret that it was not started long since. For the institution not admitting any candidates under 25 years of age, all the younger members of the profession and pupils, to whom admission to the general meetings and library would have been most beneficial, were precluded from doing so, except occasionally, when able to get a ticket from any member or associate they might know.

Consequently, in 1859, a number of junior assistants and pupils formed themselves into a young engineers' society for the purpose of holding meetings for the reading of papers on scientific subjects and for the discussion of the same, in order to gain engineering knowledge, and to accustom themselves to speak in public, &c., until they were qualified for election to the Institution.

This society, which is called "The Civil and Mechanical Engineers' Society," is still in existence, and is now in a very flourishing condition, and my object now is to call the attention of young engineers and the "student" class of the Institution to it.

The meetings are held on alternate Wednesdays, from October to June inclusive, so that students of the Institution could attend the general meetings on a Tuesday in Great George-street, and also those of the Civil and Mechanical Engineers' Society at the Whittington Club on a Wednesday. And I think, speaking from my own experience, that the younger pupils would learn more at first from the latter society, where they could ask any questions, and make any remarks, than they would at the Institution or at the Society of Engineers, where many of the terms used they would not understand, and many of the subjects they would perhaps hardly know the elements of. And if such was the case, they would really confer a favour on most of the members and associates of the Institution, who regularly attend the meetings, by going to the Civil and Mechanical Engineers' meetings instead, sometimes, as there would then be more room in the Institution.

Last session, on several occasions, the theatre was so crowded that many were unable to get a seat. It is far too small for the members and associates only, being between 1300 and 1400 in number, and yet every one of these can introduce a friend with him.

Although, as I have stated, the above society was originally intended only for juniors, at the present time they do not compose more than half its numbers. For many of the members, after being duly qualified and elected to the Institution of Civil Engineers, still remain members of the young society, and we have now many men of experience among us.

Our papers, which you have been so good as to publish from time to time in your journal, have always been practical, well written, and generally illustrated. We are never at a loss for a paper, and the discussions are usually carried on with great

animation. Nearly all our honorary members are members of the Institution.

Should any of your readers wish to have copies of the rules, list of members, or any information concerning this society, either Mr. Roberts, the secretary, of 10, Adam-street, Adelphi, or myself, will be most happy to give them any information they wish for.

If you can find space in your journal for the above, you will oblige,

Yours, &c.,

J. G. CROSSIE DAWSON.

Engineer's Office, Euston Station, N.W.,
24th July, 1867.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF ENGINEERING.

SIR,—Thanks to my "keeper" in this discussion, whom your readers must recognise to be the Editor of ENGINEERING, I am allowed to give vent to my "curious lucubrations." And as they still force me to apply the searing iron to their flesh, I were no true knight did I raise my visor, and gain any amount of credit in unravelling such dirty schemes as they wish to be introduced into our houses. Fifteen years ago I had occasion to be in Hamburg, and I am now sorry to hear that cleanliness, so far as conveniences are concerned, is still in a backward state. I have taken up Mr. Liernur in the primary steps of his scheme, and let him answer it, with or without the assistance of his coadjutor, Mr. Krepp. The latter I will now meet in the open field. The barrels will contain 5 cubic feet, equal to laying on a layer of manure 720 ft. long, on a stream one square inch thick; or, take half a square inch, it will manure a furrow 963 yards long. It occurs to me this "lout" of a farmer's lad will require to be well up in judging distance by the eye, so as to know how long the manure will last, going over irregular fields. The flow is very even, I will say, passing through a pipe 1½ in. in the bore, and will lay the manure in a sluggish manner to the extent of 963 yards; but at times, before he has got over one-fourth of the space, the paper pulp, rags, &c., choke up the hole. Probably your correspondent will suggest a hand-lever, having a jointed end and vertical rod, to clear the obstruction. Were this to be made self-acting, there is some possibility of the flow being even; and when the flow ceases altogether, in the middle of the field, is the ploughman to suspend operations, and go and assist the boy in raising 345 lb. in another barrel upon the cart, or does he continue ploughing, and may he not overtake the point of cut-off, left by the lad, before the callant has time to replenish his cart? And supposing they both start afresh, it is very evident that the manure will just last 963 yards, and here the ploughman must stop, and wait for further supplies. Now, this is supposing the boy to be ahead of the plough; but his education must be so far advanced of the age, that he must never presume to go first. It may be argued that he is still at the tail end; but I am thinking the modern steam-plough has put roundabout ploughing with horse labour at a discount, and even with the old ploughshare, the boy will be driven foremost, and will never be able to keep a few yards in the rear of the ploughman; consequently, he will require to bide his time, or probably your correspondent will suggest a train of small carts, so as to keep up the supplies. The sluggish stream will require to move somewhat quicker than what will flow out of a barrel, to keep pace with one of Fowler's multiple steam-ploughs. I leave that for farmers to understand. When the refuse of the stable and byre is heaped up in some remote corner of a farm, sometimes sewage refuse is added thereto, placed in pits formed in the heap. It is covered with quick-lime, and stable refuse heaped over. Now, such liquid flows through the mass until it is quite rotten, or the straw reduced to a manure consistency, and farmers generally cart it to their fields, and leave it there in heaps. Now this is done when ploughing cannot be carried on; but when the ground is in a fit state for the ploughshare, it is then scattered about. Now this is what may be termed the division of labour, which all farmers know more about than your correspondents can inform them. I have entered so far into farmers' practice. To point out to agriculturists what Mr. L. wishes them to do is to throw away "farm manure and cast it into the sea," and use house refuse instead. I am thinking the British public are not so easily gulled.

And now I would like to see whether Mr. Menzies and the unknown "O. O." agree on this subject. I must find my way in the dark, as I know nothing about the details of his scheme, so I will put it thus: Does Mr. M. recommend dry closets? I don't. He forms the drain from house of small cast-iron pipes. I quite agree. And when all the slops, &c., from house are carried away and precipitated into a main sewer (of, say, cast iron) of sufficient capacity, so that the sewer can never become full, or be subjected to hydrostatic pressure, then I consider the scheme is good, and the sewage will be of sufficient commercial value. But should (as Mr. Krepp says) the pipes be subjected to hydrostatic pressure, then I say the scheme is an abortion; for pipes thus laid from Highgate-hill down to the outfalls, would, I consider, disgorge the contents up the closets into our houses.

Respectfully yours,

O. O.

P.S.—I have not answered Mr. K. about the vacuum, as half an inch bore will destroy a vacuum formed in reservoirs. And when the stuff is drawn out of the bend, Mr. L. allowed it fell to the bottom, and the air rushes through at the top of pipe, and ceases to become a propelling agent in the small pipe.

TO THE EDITOR OF ENGINEERING.

SIR,—In my letter that you were so good as to publish in your journal of the 12th instant, I threw out a few remarks about the waste water from towns, and the method of dealing with it in order to prevent the pollution of rivers and streams. I agree with what Mr. Liernur says in reply, so far, that carts must anyhow be kept on a town to remove ashes and household refuse, and I think that all that can be done in this way to remove solid matter separately from liquid is a step in the right direction. For although flowing water will carry a great quantity of finely comminuted matter along with it, and is a cheap way of removal, still I think it is a mistake to make our sewers do this double duty, because any slackening in the speed of the

current from a bend, change in the inclination, or diminished flow is liable to cause a deposit, and more water must then be poured down the sewer to clear this away, setting in motion (for it probably has to be pumped) an amount of water perhaps ten or twenty times the weight of the substance to be removed, thus wasting a great deal of mechanical force. Wherever it is proposed to construct a system of sewers, a question arises about the water supply at command to keep them in working order. Ratepayers are deterred from carrying out their designs, from the fear that their water supply will not be sufficient, and that their sewers will in consequence have a sluggish flow, giving off noxious gas. The present system of sewerage depends for its efficiency upon the water supply; should that fall short, the other part of the machine (the drains) is immediately out of order: whereas, if we were to commit liquids only to our drains, we should not run the risk of having the flow impeded during dry summer weather, when, most of all, we want this liquid to flow away as fast as possible, before it has time to decompose and line the sides of our sewers with slimy deposit. Previous to being discharged, all waste liquid might be passed through a strainer; house pipes would not then require to be half the size, and would not be liable to get stopped with paper, rags, &c. The sewer gas nuisance also would be reduced to a minimum. I feel convinced that some scheme could be contrived without much difficulty for removing all the dry refuse regularly, and without causing offence, for there are always ashes at hand with which so small a quantity might be covered till the time of removal. With what Mr. Liernur says about the nature of waste water from towns, after what he calls the *sewage proper* has been withdrawn, I do not at all agree. I have frequently observed the nature of this liquid—in one case from a town where cesspools and middens still prevail. And where it is not permitted, as far as the authorities can prevent it, to discharge any such matter into the public sewers. This liquid, I do not think, would be purified by being passed through a bed of Spencer's magnetic carbide. I wish it could. As I said before, I do not know any plan equal to the irrigation system to effect this. I am open to conviction; but have witnessed the effects produced by the latter, though not as yet those by the former.

I am, Sir,

Your obedient Servant,

Novia Scotia House, Ipswich,
July 24, 1867.

CHARLES F. GOWER.

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—When I presumed to address you in the simple narration of a fact, since confirmed by your able correspondent "Anonymous," I was under the impression that such a fact would be acceptable, and might assist the argument on the *tapis* to a correct conclusion. If in error on this particular, I imagine I need not be anxious to be undeceived. As I find my assertion is challenged for an explanation, I will, with your permission, confine my reply to one feature only, albeit an interesting one.

The common short slide of the previous engine, to which I alluded, of course cut off the steam at some definite part of the stroke, as usual in other engines of common construction.

In the Corliss engine the connections between the governor and the steam-valves were so delicately adjusted, as to release the valves at any part of the stroke, from the open position in which the eccentric had placed (either of) them, thus completely shutting off the steam at the proper time. Although the work of that extensive ropery was ever varying—now the spinners and the laying of ropes, and now the heaviest cable was laid up, and as suddenly finished—still that engine preserved the utmost regularity of speed.

At times the steam might be completely shut off—not throttled—from the cylinder, say, at one-eighth of the stroke; and at unusual times of greatest resistance the steam might be entering the cylinder in full force, say nearly the whole time that the piston was travelling over its path. It will be seen at once that this expansion was not, as in the other engine, a fixed quantity, an unvarying fraction of the stroke, to remain so to the end of the chapter, under all circumstances, involving occasional deficiency of power or a waste of steam. On the contrary, here the steam-power most admirably adjusted itself to the working requirements, and that superior to any other "adjustable cut-off" I had seen in England, America, or elsewhere.

I respectfully submit that we may here discover the clue to the greater efficiency and the greater economy of the Corliss engine, with the same diameter of cylinder and same length of stroke as its predecessor.

There are other points worthy of notice, particularly the locality and efficiency of the steam, and the education valves, but I need not go into these details now.

Sir, yours respectfully,

W. E. GILL.

75, Herbert-street, N.

TO THE EDITOR OF ENGINEERING.

SIR,—In your last number Mr. Pinchbeck states that I agree with him that the increased power developed by the Corliss engine referred to by Mr. Gill could not have been due to the superior cut-off valves. Now this is not exactly the case. What I said was, that the result might not be due to the greater degree of expansion.

That the Corliss engine referred to was able to do the work which the old engine was not able to do was no doubt due to several causes. I think that in the new engine the initial pressure of steam on the piston would be as great, or greater than in the old one, notwithstanding that the boiler pressure was less. This could be accounted for by the absence of the throttle regulator, and of all wire-drawing action in the valves, and by the short and direct steam-passages. The back pressure on the piston of the new engine would no doubt be less than in the old one, on account of the exhaust-valves opening more quickly, and also on account of the short and direct exhaust passages from the cylinder; and this advantage would be more marked when the engine was working up to its greatest power.

* I am not prepared with precise proportions, and accept extremes for better illustration.

No doubt, in the instance referred to, the load on the engine was irregular, and it might be only occasionally that the old engine was brought up by the increase in the resistance. When this occurs with the Corliss engine, the steam-valves are acted on at once, and an increased supply of steam, always at practically the boiler pressure, admitted to the cylinder, or if the resistance is so great as to tax the engine to its utmost, then, without any sensible decrease in the speed, the steam is admitted during the whole stroke, and without increasing the back pressure from the exhaust. The prompt and efficient action of the Corliss engine in this respect alone, I consider, enables it to maintain a uniform speed, and to do the work which an ordinary engine of the same size, and working under the same conditions as to boiler pressure and speed, will fail to accomplish.

I am, yours truly,

WILLIAM INGLIS.

Manchester, July 24th, 1867.

THE RUTHVEN HYDRAULIC PROPELLER.

TO THE EDITOR OF ENGINEERING.

SIR,—As the value of this propeller, as compared with the screw and paddle, has, for the present at least, been brought to a question of fact as shown by the relative co-efficients of the vessels, I think you have not done justice to the hydraulic (in your remarks on the letter which you inserted for me in your last number), by quoting the co-efficients of the Waterwitch obtained at the trial on the Thames on 14th October last, viz., for displacement 101, and for mid-section 293. You cannot be aware, I presume, that said trial was merely the contractor's first trial of engines, and came to nothing, by reason of the excessive priming of the boilers; and it never was intended or received as a trial by the Admiralty. In fact, many parts of the machinery were still in an unfinished state. The co-efficients then taken were therefore set aside by the Government. When the vessel was tried at the Maplin, the co-efficients, as worked out by the Admiralty, were, as I stated in my last, viz.:

Waterwitch ...	Mid-section 342;	displacement 118.9
Vixen ...	299;	102.7

These are certainly not high co-efficients; you may even call them "miserably low" in comparison with the co-efficients for larger and better-shaped vessels; but I venture to say that you cannot show a higher co-efficient for any other vessel of same class. And relatively to the sister vessels, Viper and Vixen, the Waterwitch shows a much higher co-efficient, and so far as co-efficients go, proves the hydraulic greatly superior to even the double screw.

W. B.

London, July 22, 1867.

LLOYD'S ESPARTO MILL.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to your notice of the Esparto mill exhibited by me at the Bury Royal Agricultural Society Show, Mr. Lloyd's process of paper-making from Esparto grass, &c., is patented.

Yours truly,

W. P. WILKINS.

Ipswich, July 20, 1867.

SLEEPING CARS OF THE CHICAGO, ALTON, AND ST. LOUIS RAILWAY.—The *Tourist's Guide* gives a very good account of the sleeping cars built by Mr. George M. Pullman for this company, and states that they are, without doubt, the most elegant and luxurious palatial cars ever constructed in the United States, and cannot be excelled in the world. Each car is 63 ft. long, 10½ ft. wide, and 11 ft. high from floor to ceiling, and is divided into 16 sections, or 32 sleeping berths, accommodating sixty-four passengers, and resting upon eight pairs of wheels, so constructed that when in motion, even in turning a curve, but the slightest motion is perceptible; in fact, when running at the greatest speed, one can write easily and legibly upon a table. The exterior is beautifully painted and finely finished, while the interior presents an appearance of grandeur (?) which baffles description (1); the wood-work is of black walnut, finished in oil, highly polished, and richly carved (1); the ceilings are ornamented with rich fresco paintings; the upholstery is of the costliest Brussels carpets, with curtains of heavy damask; the metal work is all silver-plated. Each section contains a mirror of heavy French plate glass tastefully carved (1); and when the car is well lighted up, it presents a gorgeous spectacle (11). The upper berths fold back so as to present an arched and panelled ceiling, finely decorated with fresco work. The design is original with Mr. Pullman, and gives the appearance of one made specially for day passengers. Nothing of the sleeping arrangements is visible. The passenger can ride all day long, surrounded with all the luxury and comfort wealth can afford, and not until night, when he witnesses the sudden transformation of elegant furniture and sofas into comfortable beds, can he realise that he has been travelling in a sleeping apartment. There are six sofas, which, like the seats, can be transformed into berths.

HARBOURS OF REFUGE.—The annual reports of the engineers show that at Portland the quantity of rough stone deposited in the breakwater mound, and the foundations of the heads, has reached 5,627,654 tons. With the exception of some temporary damage to masonry in the gales of January and March, the works have stood successfully the storms of the winter, and large numbers of vessels have taken shelter within the harbour. At Dover the expenditure upon the breakwater, or west arm of the harbour, has reached 611,277l., the estimate being 725,000l. At Alderney the expenditure at the end of March, the period to which all these reports are made up, had reached 1,140,513l., the estimate being 1,800,000l. At Holyhead, at that date, a length of 7037 feet of the superstructure of the north breakwater had been built to its full height, and a length of 7124 feet was built above high water; the inner or harbour wall was built to its full height, and a length of 5930 ft. In the year ending the 31st of March, 3647 vessels sought the shelter of this harbour. The expenditure had reached 1,371,155l.

AMERICAN STEAM SHIPPING.—An undertaking has been projected at New York which aims at the establishment of regular lines of steamers between ports of the American Union and the Antilles. An agent has been despatched in order to secure the adhesion and financial assistance of the various Governments concerned.

THE AMERICAN LOCOMOTIVE AT THE PARIS EXHIBITION.

CONSTRUCTED AT THE GRANT LOCOMOTIVE WORKS, PATERSON, NEW JERSEY, U.S.

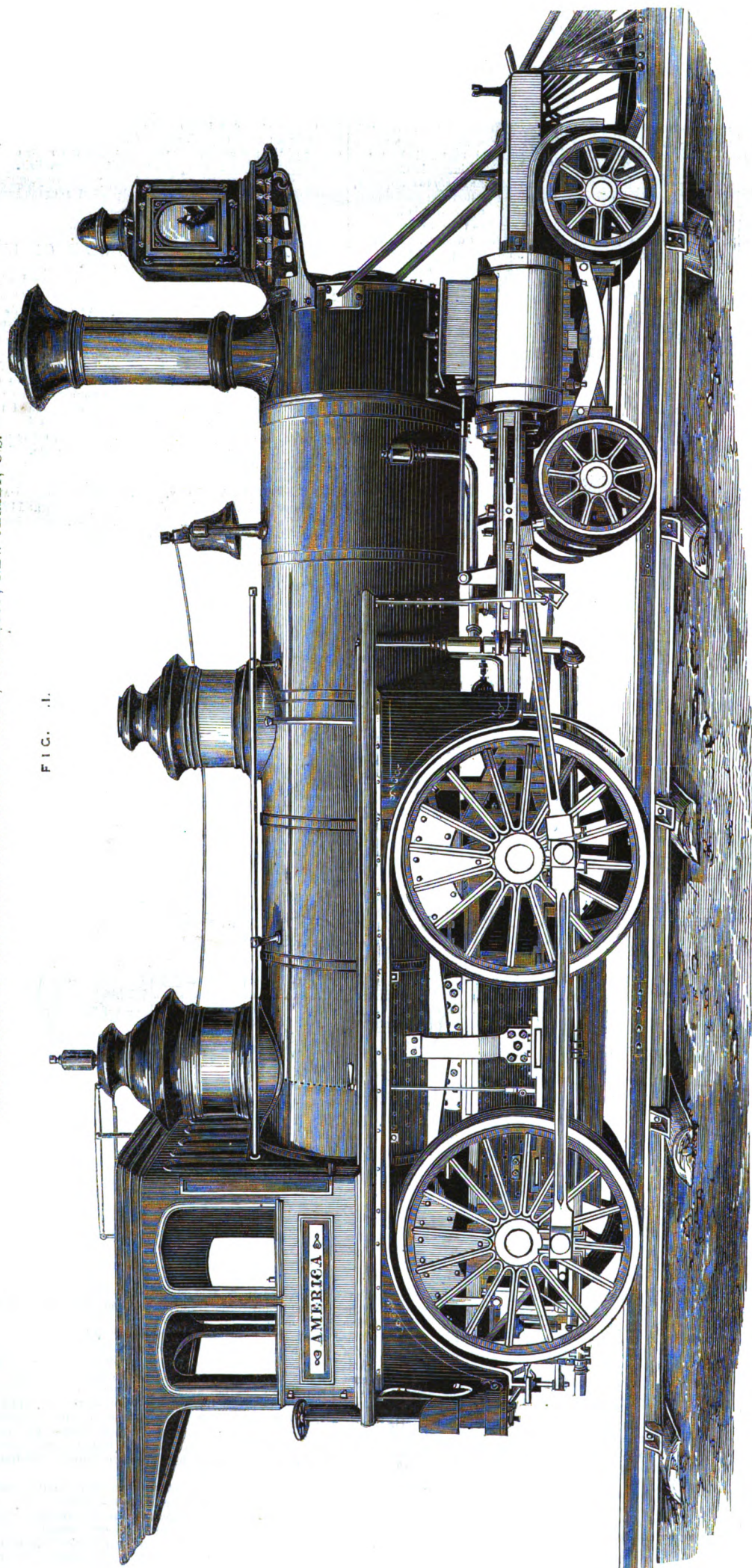


FIG. 1.

THE AMERICAN LOCOMOTIVE AT PARIS.

The locomotive America, at the Paris Exhibition, like so many of the most interesting features of that vast display, stands in an out-house, politely called an *annexe*, and which forms the upper end of the English agricultural shed. It is undoubtedly the most remarkable for its finish and ornamental features—in short, for what the French engineers neatly describe as the *toilette* of an engine—of any in the whole Exhibition; and in this respect, indeed, it even out-Yankees the Yankee engines themselves, as seen on the American railways. There are many engines on the Northern Railway of France, and on some of the other French lines, of which the boilers are covered with rolled brass; but we never saw an engine, until we met the America, wearing a coat of brightly polished German silver, not only upon the boiler, but even upon the chimney. We shall not quarrel with the taste of the designer in this matter, nor shall we applaud it. There is the engine to answer for itself, and it is beautiful or ugly, like certain foreign ladies, according to the fancy of the astonished beholder.

The present writer (Z. C.) must do his best to speak impartially of the America, but he is bound in truth to say that, so long ago as the year 1854, he was himself the engineer of the very works at which this engine was built, then known as the New Jersey Locomotive and Machine Works, and now

styled the Grant Locomotive Works, a water-driven establishment of moderate size, at that chief seat of the American locomotive trade, Paterson, in the State of New Jersey, about sixteen miles from the city of New York. A few features of the engine now under notice, not of especial importance perhaps, are indeed of his own design, as embodied in his own engines of thirteen years ago, and since generally adopted in American practice. But we shall endeavour to look upon this engine, neither with an American nor an English eye, but in the cosmopolitan spirit of the true engineer, unfettered by prejudices of any kind.

Many have said, and we believe the Prince of Wales, when he lately mounted the foot-plate of this engine, made the same remark, that it is of great size. It is of very moderate dimensions, however, and its apparent bulk is due to the volume of the "cab," or engine-driver's house, the enormous head light, and partly even to the cow-catcher, and, besides all this, the rails upon which the engine stands are laid a little above the floor of the annexe. The cylinders are 16 in. by 22 in., the coupled driving-wheels 5 ft. 7 in., and the boiler is in no respect remarkable for its size, the allowance of heating surface being even less than in English practice. In most respects, beyond the German silver boiler casing, the astonishing marquetry of the "cab," and the bright finish of the truck frames of the tender, the engine very nearly represents the ordinary every-day

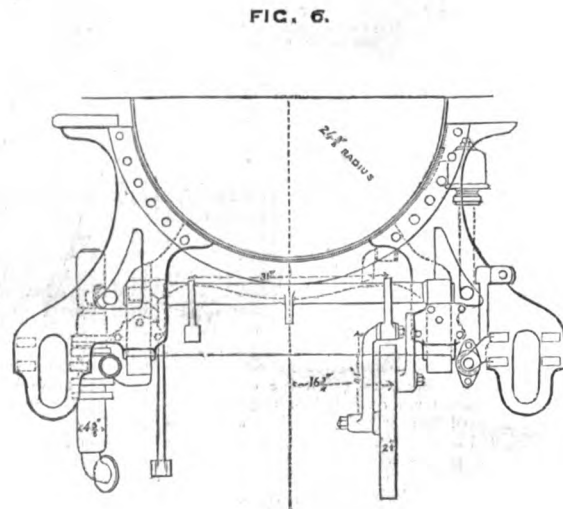
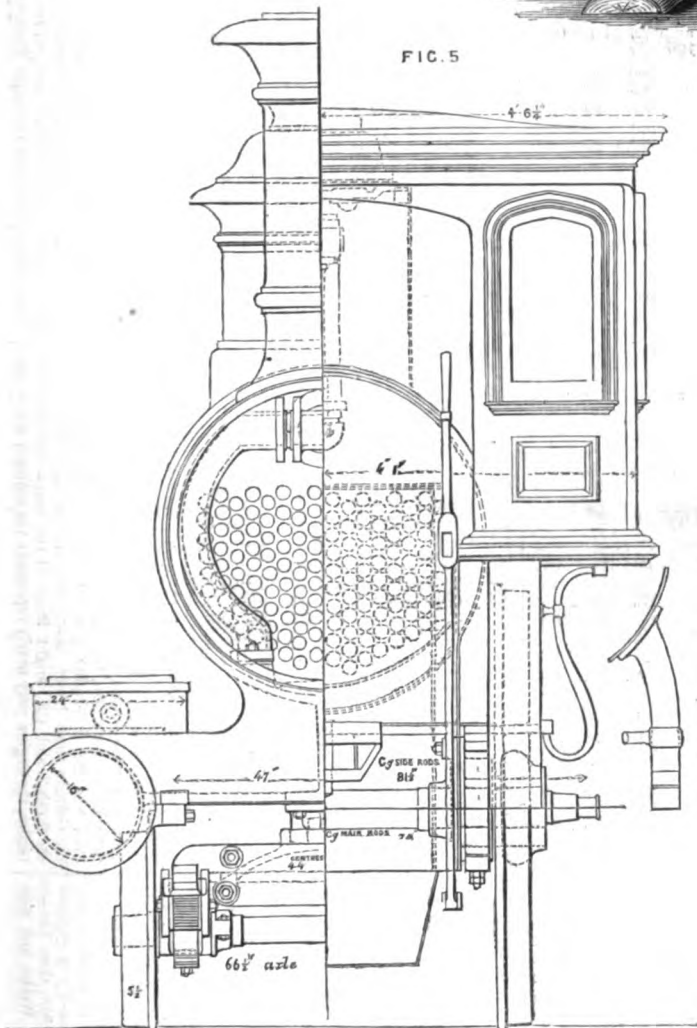
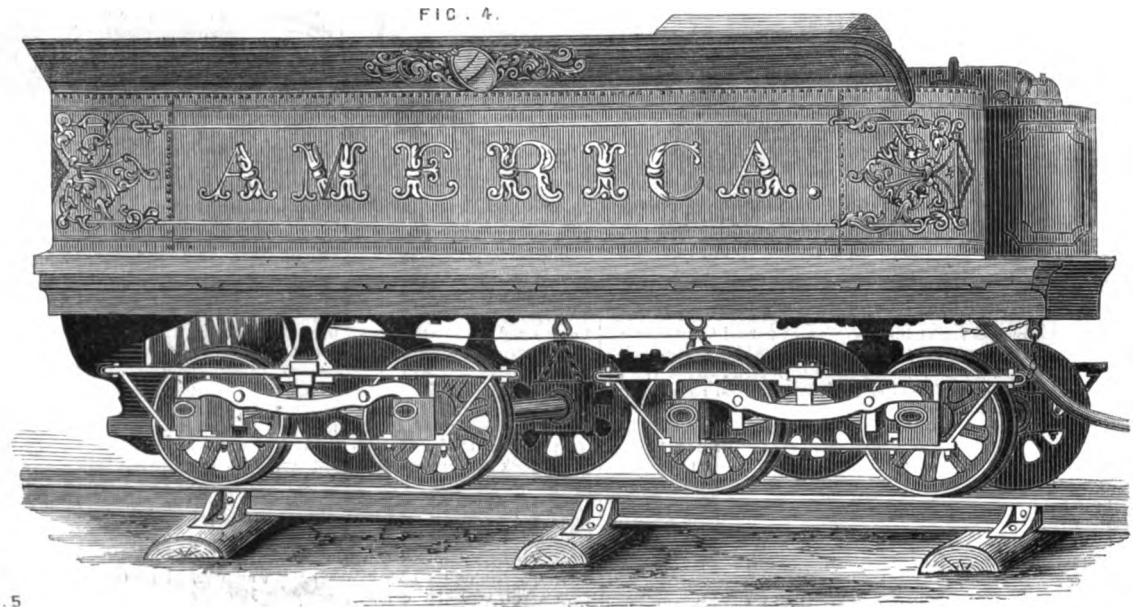
type of American locomotives for passenger service, while with driving-wheels 6 in. or 1 ft. smaller it would equally represent the ordinary goods engine of the country, six coupled engines being not nearly so generally employed as in England. At one time larger wheels were in favour for passenger engines, 6 ft. being the usual size on the leading lines having moderate gradients, and even 7 ft. coupled wheels were occasionally employed, and a few engines, with a single pair of driving-wheels, were somewhat of the Crampton kind, with 8 ft. wheels. But nearly all the larger sizes have been replaced by 5 ft. 6 in. to 6 ft. wheels, and 5 ft. 6 in. is indeed the diameter now most liked. The speeds, of course, are lower than in England, yet the engines often go at 40 to 45 and sometimes even 50 miles an hour between stations, the average through time over long journeys, and including stops, being, however, seldom more than 30 miles an hour, and on most lines very much less. The trains, too, are heavy, especially since Mr. Pullman has introduced so many of his twelve-wheel and sixteen-wheel sleeping cars, weighing from 20 tons to 25 tons each, and there is no continuous run of more than 40 (or, to be exact, 41) miles on any American line, and most trains stop at all stations. It is in getting away with a heavy train from a station that the 5 ft. or 5 ft. 6 in. wheel has so great an advantage, just as on the Metropolitan and North London lines, where 5 ft. 9 in. wheels are found to be better than any larger diameter. It is (and we need

not say this to the engineer) merely a question of leverage, for with the same stroke, and same pressure of steam, a 15 in. cylinder engine, with 5 ft. wheels, is very nearly as strong, on a slow pull, as an 18 in. cylinder with 7 ft. wheels.

We believe that no inside-cylinder engines are now made in the States, nor have we known of their being made for several years. Having in all cases coupled wheels, and being worked with sandboxes, and the free use of sand on the rails whenever needed, the wrought-iron cranks of the inside-cylinder engines were often breaking, and we are not sure that steel cranks have yet found their way to America. The American outside-cylinder engine, as exemplified by the engine at Paris, has its cylinders always level, or nearly so, and the cylinder fastenings, although of considerable weight, are very strong and stiff. In the engine under notice, the pair of cylinders are bolted directly together under the centre of the smokebox, a hollow box-like projection from the side of each cylinder, and cast in one with it, being formed for the purpose, as shown in cross section. A broad curved flange is also formed upon the cylinder casting, as shown, to receive the underside of the circular smokebox, to which the cylinders are also bolted, and they are further secured to the framing, the frame bars having each a long sunk opening or recess, into which the flange of the cylinder is bedded, while a vertical flange comes down on the outside of the frame-bar, and is strongly bolted to it. Thus bound together, as if cast in one,

THE AMERICAN LOCOMOTIVE AT THE PARIS EXHIBITION.

CONSTRUCTED AT THE GRANT LOCOMOTIVE WORKS, PATERSON, NEW JERSEY, U.S.



and firmly secured to the framing and smokebox, the cylinders never work loose, and the outside-cylinder arrangement is as stiff in this respect as the inside cylinders of English engines. The weight of each finished cylinder (the single casting) is nearly one ton, or exactly, in the case of the America, 2210 lb.

The framing, so different from that of English engines, is of much the usual American type. A pair of bars extend from the buffer beam to the axle-guards, or "pedestals," as the Americans call them, of the driving wheels or, to speak in American phrase, of the forward drivers, since all coupled wheels are called "drivers." These bars are $3\frac{1}{2}$ in. wide and $2\frac{1}{2}$ in. deep, and are laid flatways. They are intended merely to transmit longitudinal strains, those between the cylinders and axle-boxes, and are purposely made without reference to vertical stiffness. The axle-guards or pedestals are formed in a separate framing, a pair of somewhat elaborate forgings, 15 ft. 6 in. in length, the lower ends of the axle-guards being tied together in the manner shown in the engraving on page 69. The upper and lower portions of each of these forgings or "shapes" embrace the forward frame-bars, as shown, and these bars are carried each through to the driving axle-guard, and the whole is held together by bolts. This precise pattern of framing was first used by William

Mason, a successful locomotive-maker of Taunton, Massachusetts, and some of whose engines were once running on the Alexandria and Cairo Railway, where many of our Indian readers have no doubt seen them. All the bars of the framing are planed all over, the finish being the same, in fact, as that of the guide-bars. To an English eye this appears to be a rambling structure, with too many pieces and bolts, and we cannot attempt to explain why the solid slab type, as first introduced, we believe, by Mr. Beyer, has never gained headway in the States, one firm only having adopted it there, and they are no longer in business. It will be seen that the axle-boxes have adjusting wedges on their hind sides, the wedges being of cast iron, and having flanges embracing the leg or horn of the axle-guard, the flanges of the axle-box bearing upon the flanges of the wedges. The cast-iron surfaces not only wear well upon each other, but the wedges can always be cheaply renewed. There are wedges also on the forward sides of the axle-boxes, but these are not adjustable, being, in fact, only wearing pieces. The boiler being fixed firmly to the smokebox, the allowance for expansion, say $\frac{1}{8}$ in., is made in a sliding fastening on each side of the firebox. A broad angle iron, 3 ft. long, is screwed to each side of the firebox, and rests upon the upper bar of the

frame, and it is held down by a bridge strap, 3 ft. 6 in. long bolted firmly to the frame at each end, while the angle iron may slide under it, through the range of the expansion. The bridge strap is fastened to the frame by nine bolts in all, seven of which pass through oblong holes in the angle iron. The angle iron is lipped on its lower and outer edge, so as to grasp the frame, and to prevent any lateral movement. Shorter "expansion braces," as they are called, connect the firebox also with the lower bars of the frame. The frame-bars are bound together transversely, much as in English engines, by the buffer-beams, the cylinders, the firebox, and by a transverse tie just in front of the driving axle-guard, and the motion plates, carrying the outer ends of the guide-bars, are each bolted to the framing and to the boiler.

The driving axle springs, each carrying about 3 tons (besides 1½ tons nearly under each spring resting directly on the rail), are 3 ft. long between the centres of straps, and are each formed of ten plates of ¾ in. by ⅝ in. steel. They are connected by compensating levers, and at their outer ends they have india-rubber blocks between the ends of the spring straps and the frame, these blocks being nearly enclosed in cast-iron holders recessed to receive them.

The wheels are of cast iron, the truck wheels chilled, while the driving wheels have Krupp's steel tyres. Can English engineers believe it that wrought-iron wheels, of the best English makes, have been tried again and again on American lines, and abandoned as not being equal in strength and wearing qualities to cast-iron wheels? But it will be said that these wheels are enormously heavy. They certainly look so, but every one of those thick spokes, and the rims also of the driving wheels, are hollow, a network of cores being placed in the mould in casting them. The driving wheels of the America, 5 ft. 2 in. across under the tyres, weigh each but 1250 lb., or a little over 11 cwt., irrespective of the counterweights, which weigh 270 lb. Thus the whole wheel is but one-half heavier than the 2½ in. tyre, which weighs 835 lb. Why is it, for such is unquestionably the fact, that English engineers no sooner go to Canada than they become firm converts to cast-iron wheels? Nearly all the traffic of the Grand Trunk and the Great Western of Canada railways is now run on cast-iron wheels. Of the former line, Mr. Richard Eaton, formerly Mr. Beattie's principal assistant on the London and South-Western Railway, is the locomotive superintendent, and neither he nor Mr. C. J. Brydges, who is the general manager, and well known in London, will have anything but cast-iron wheels. There are a few of wrought iron still on the line, but they are getting rid of them as fast as possible. Curiously, the complaint is that wrought iron will not stand the winter climate, or rather the discipline of a road bed frozen as hard as if it were a bed of granite. We are speaking both of engine driving wheels, with wrought-iron or steel tyres, and of chilled truck wheels for the engines, tenders, carriages, and wagons. We have copies of letters from the above-named and other Canadian engineers and railway managers now in our possession, all speaking very strongly upon this point, and we do not doubt that when Captain Tyler goes out, in September, on the invitation of the Grand Trunk shareholders, to inspect and report upon their line, he will look closely into this question of chilled wheels, about which there is certainly great misconception in this country.

"But," it will be said, "we object to such small wheels," 2 ft. 6 in. to 2 ft. 9 in. in diameter, and few truck-wheels over 2 ft. 9 in. are ever used in the States or in Canada, while the cast-iron chilled truck-wheels of the America, an engine intended to run over somewhat rough lines, and in all weathers, and sometimes to do its 45 or even 50 miles an hour, are but 30 in. in diameter, and at the higher speed just named would spin around at the rate of 560 revolutions per minute. But it is to be remembered that these wheels carry, each, less than one-half the weight upon each leading wheel of many English engines, the general load on the truck-wheels of American engines being 2½ tons each, or 10 tons on the whole. It has been our business to ride much upon these American engines, often at tolerably high speeds, and we can only say that the motion is steadiness itself, as steady, we are bound to say, as the best and fastest English engines, upon the buffer beams of which we rode nearly 1000 miles, in the year 1863, taking indicator diagrams. The smallness of the American wheels is compensated for by the easy action of the widespread truck, the load being carried upon its centre only, instead of at the sides. The whole framework of this truck is, in fact, a compensating apparatus, and the centre bearing is furthermore carried, in the engine under notice, upon Bridges's swing beam, the latter always used under American passenger carriages. This swing beam, so far from being unsafe, as might be imagined, enables the carriages to go smoothly round curves where, without it, they have actually got off the line. It is shown in one of the half sections on page 65. The whole truck frame is indeed a study for its lightness and strength, the whole load being taken directly upon the centre, and transferred thence through a pair of short strong transverse bars to the middle of the springs, of which a single pair serve for the four wheels. The truck frame is a flat bar 3½ in. by 1½ in. only, with the axle guards bolted on and tied together at their bottoms, as shown. Not only does the wide spread of the truck axles, 5 ft. 9 in. apart, admit of the cylinder being laid level between the wheels, but this wheel-base gives increased steadiness. The general design of the truck (with the exception of the swing beam, introduced more recently into engines) is the same as has been adopted by nearly all American locomotive engineers since 1854, and it was first, we believe, introduced by the late Mr. Thomas Rogers, who was for years the leading locomotive builder in the States, the works at Paterson bearing his name, and under the superintendence of Mr. W. S. Hudson, an English engineer long resident in America, being still the largest of the kind in the country.

It is time that we took a look into the boiler, for we have so far dealt with a few of the external features in much the same order as they would strike the eye. The boiler is of ¾ in. plates, double rivetted along the horizontal seams, and the firebox is also of iron. The tubes are of copper, and the firegrate is formed of 2 in. iron water-tubes, with a mud-plug in the firebox-casing opposite each end of each tube. The top of the outside firebox or firebox-casing is flush with the barrel of the boiler, although most other American engines have the top of the outer firebox several inches higher than the barrel, and connected with it by a long sloping or flared plate, similar to, only more inclined than, that shown on the underside of the boiler in our section. Most American engines, too, have two steam-domes, and draw their steam, in part, from each. The tube-plate, it will be seen, is slightly set back from the firebox, nearly 6 in., and this is considered a protection to the ends of the tubes, while it gives also more room for combustion. The water-grates were first successfully used by Mr. James Milbolland, while locomotive superintendent of the Reading Railroad, and were specially designed for burning anthracite coal. They are much liked by all engineers who have used them. The firebars ordinarily used previously, and, indeed, more generally used still, are of cast iron—never of wrought iron. It will be observed that the rings forming the barrel of the boiler are arranged telescopically, as it is only thus that any boiler can be completely drained of water when blown off; and the front end of the boiler is always, too, carried a little higher than the firebox end, partly with the same view, and partly to assist the draught through the tubes, just as every portable engine driver knows that he can raise steam quickest when he has the hind wheels in a trench a few inches deep, or even a foot or more, for that matter. The tubes are set in remarkably thin

tube plates, seldom more than ¼ in. or ½ in. thick, and with ferrules at the firebox end only. The tubes are disposed in vertical instead of in horizontal rows. The boiler, as it came from the boiler shop, weighed but 4 tons 4 cwt. 3 qr. 8 lb., or, in American notation, 9500 lb., without the copper tubes, the weight of the latter being 2344 lb. This weight does not include the ash-pan (490 lb.), the water-tube grates (135 lb.), the fire-door (80 lb.), nor the chimney, steam-pipe, or any fittings.

In the smokebox it will be seen that cast-iron branch steam-pipes are employed, one to each cylinder, the pipe communicating with a passage cast in the box part of the cylinder casting, and the steam rises into the slide-valve box or "steam chest" through a rectangular port, on the face of the cylinder to one side of and just below the valve face. Each cylinder has its own blast nozzle, about 3½ in. diameter, and rising about only halfway up the tubes, or to 7 in. below the centre of the boiler. We don't quite know why, but the single blast pipe has been always considered a mistake by the American engineers; they once tried it and gave it up. We think, however, we can discover the explanation, in the fact, that with the necessity for a sharper blast than we use in England, and consequently a greater back pressure on the piston, the two exhausts interfere with one another to a greater extent than in our engines. When we (if David Pennington, the driver, will pardon us) ran the Lady of the Lake in full gear, while getting away from a station (anywhere between London and Manchester), and it was the same with Aleck Keir's and Charley Rick's engines (poor Charley! since killed) on the Great Eastern line, and with Tasker's engine, the "Express" on the London and South-Western, our indicator diagrams were shoe-shaped, with a distinct hollow under the instep, and we have known several engineers, first-class men, too, to wonder what the devil the hollow meant. And yet it was clear that the rise in back pressure, at that point, coincided exactly with the escape of steam, into the same blast-pipe, from the other cylinder. So the American engines with their smaller blast-pipes, and sending out a whole cylinder full of steam of nearly boiler pressure at a stroke, show this hollow in an aggravated form. We show an extraordinary illustration of this in an indicator diagram on page 71 of our present number. Here there were a pair of 18 in. cylinder, carrying 130 lb. steam almost to the very end of the stroke, and exhausting in common through a single blast pipe only 3½ in. in diameter, this small size being required to obtain the necessary draught. There was a big hollow, or kick, on the under side of the diagram, corresponding to the exhaust fighting its way in from the opposite cylinder, a kick representing a sudden accumulation of back pressure equal to 2 lb. or 3 lb. over the whole stroke. There is something, but not much, in this matter of double blast-pipes which English engineers should look into. We say not much, for our engines cut off so much earlier than Yankee engines, and, what is more to the point, work with so much larger blast nozzles, that the kick in the underside of the diagram is only seen when the cylinder is taking a good deal of steam in full gear.

Then how is it that the exhaust-nozzle is so low? Simply because when they were formerly much higher it was necessary that they should be much smaller, smaller even than they are now. The writer has measured the blast-pipes of many 15 in. cylinder engines only 1½ in. in diameter (!), and for years 1½ in. was the standard diameter in the States for 15 in. cylinders. These tremendously sharp nozzles made no end of a row, each steam stroke going off like a rifle, or the roar of a Mississippi steamboat; but nobody in the States ever used the indicator in those days, and there was no knowing what was going on inside the cylinder. At last the nozzles of the blast-pipes were lowered to the top row of tubes, then a little lower, and at last nearly to the bottom row, and with every change it was found that a larger nozzle could be used, merely because the draught was then more equalised through all the tubes. We have pushed out, with a 12 ft. pole, the cinders and wood ashes from the lower rows of tubes of many American engines having high and small blast-pipes, but with lower blast-pipes the lower tubes were clear, and we could measure the length of the lowest tubes as readily as the highest. But with our large blast-pipes, as in English engines, no advantage would accrue from greatly lowering the blast-nozzles; indeed, Mr. Adams, on the North-London line, has tried this purposely to ascertain if there were any gain, and found none.

The chimney is fitted to a cast-iron saddle weighing 218 lb. (!), and the smokebox door, with a great hand-wheel to loosen the catches inside, weighs 174 lb.

The regulator is a double-beat or equilibrium valve, worked by a pull-out-lever, and no American engines ever have swing or crank handles to the regulator.

We are not half done with the engine, and must have another look at the outside. The connecting-rods and coupling-rods are grooved out to an I section to lessen their weight. This was done by Thomas Rogers in a few of his engines, made thirteen years ago. The rods have the straps, collars, and bolts always used by American engineers. They won't have solid ends at all. They have tried them, and stick to it that they do not give sufficient bearing surface for the flanges of the brasses. Where the writer served his apprenticeship, solid end rods were made for several locomotives, and, after a year's trial, were cut up for scrap. The brasses of the coupling-rods are so made as to enclose the end of the pin. The halves of the brasses fit closely together, and require to be filed down when they are set up, to allow for wear. The finish is a very neat one. It was schemed by one Thomas Dougherty, formerly locomotive superintendent of the Macon and Western Railway of Georgia, and who showed a sketch of it to "old Tom Rogers," who handed him seventy dollars there and then, and at once adopted it, and all other American locomotive builders have since followed him.

The guide-bars, of cast steel, are placed at a few inches higher level than the piston-rod. This looks very odd to an English eye, but mechanically it is attended with no disadvantage whatever, and its purpose is merely with level cylinders to get the guide-bars out of the way of the truck-wheels. It is a dodge first resorted to by William Mason, of whom we have already spoken, and who has engrafted many little features, generally very neat ones, upon American practice.

And then there are the rocking-shafts, or "rock-shafts," to work the valves. English engineers don't like them, and their American cousins don't like the vertical valve face inside of the frame, not but that the direct connexion is of itself preferable.

The rock-shaft is a single forging, both arms being welded on, and the bearing 10 in. long is carried for its whole length in a pair of what, although made of cast iron, we are always apt to call "brasses." The wear is exceedingly slight, practically nil, and the valve face is more accessible than in our own engines. The ports are long, 16 in. for a 16 in. cylinder, and the valve has but ¼ in. outside lap, all American engines working their steam much further on the stroke than do ours.

The eccentrics, of cast iron, have cast-iron straps, not for cheapness, but because they wear better than gun-metal, and do not spring. The links are balanced, not by a clumsy counterweight, but by a volute spring in a neat little brass case under the middle of the boiler. Some form of counterbalance spring, either a plate spring or a volute, is always used for the links of American engines, the counterweight having been abandoned some years ago. Mr. John V. Gooch employed a counterbalance spring for the valve-rods of his engines, many years ago, upon the Eastern Counties Railway, and no doubt the Americans have taken the hint from his practice in this respect, as represented in one of the plates of Mr. D. K. Clark's *Railway Machinery*.

The piston packing is Dunbar's patent, greatly liked in the States, and illustrated a few weeks ago in our columns.

The slide-valves move on Bristol's anti-friction rollers, now extensively used in American locomotives, and introduced into this country by Mr. Daglish, of St. Helen's. Messrs. Maudslay, Sons, and Field have already tried them for marine engines, and with success, and they are used in all the new steam sloops built and building for the United States Government.

Look at the cow-catcher. It is made of 1 in. round wrought-iron rods, and is pretty stiffly braced back to the smokebox. But it does not look strong enough to our eyes, and we have seen a full-grown ox knocked thirty feet by our engine, and we have also seen engines which had been thrown from the line, and the drivers killed, by the doubling up of a cow-catcher, such as the one shown in our illustration, and this from striking a yearling steer.

That head light is of the usual American pattern, with a silvered parabolic reflector 22 in. in diameter and 15 in. deep in its full concavity. A good head light is expected to show in a dark night sufficient light to enable the time to be seen on a watch, the observer standing 1000 ft. or nearly a quarter of a mile, in front.

The cab, made of curled maple and walnut wood, is more than usually smart, but the cabs of American engines are generally showy, sometimes very much so, and we have seen them decorated with prints and photographs, as if they were the offices of professional gentlemen rather than the posts of duty of hard-handed engine-drivers. The battery of handles and cocks within the cab is something marvellous. There is a polished casing on the top of the firebox, with a cock turned by an ivory wheel to admit steam within it, and four other ivory wheels of smaller size and placed symmetrically around it, two to let steam into the feed-water pipes when necessary in cold weather, and the other two for lubricating the cylinders, we believe.

The sand-box is worked from the foot-plate. Its weight, big as it looks, is but 128 lb. The bell, with its supporting columns and saddle, weighs 220 lb. It is always used, instead of the whistle, about stations. The whistle itself is a howling reservoir of sound, with an unearthly roar instead of a shriek, and it actually weighs 28 lb.

We have extended this description to a great and unexpected length, and must dismiss the America, which received a gold prize on the 1st inst., with the following table of dimensions. The engine is for the 4 ft. 8½ in. gauge.

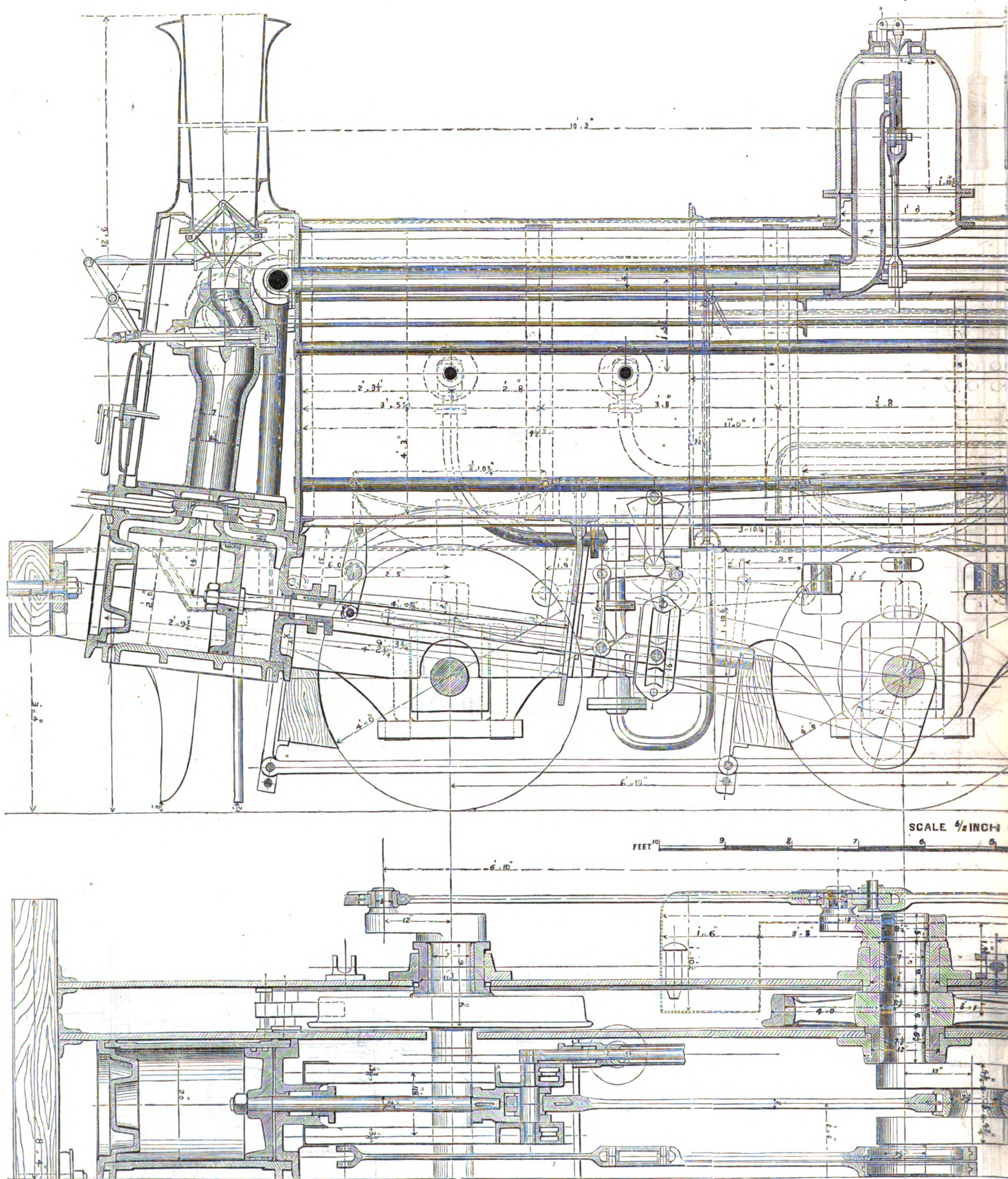
Diameter of cylinders...	16 in.
Length of stroke...	22 in.
Diameter of coupled wheels...	5 ft. 7 in.
" of truck "	2 ft. 6 in.
" of tender "	2 ft. 6 in.
Total wheel base of engine...	22 ft. 3½ in.
Distance of driving wheels apart...	8 ft. 6 in.
" of truck "	5 ft. 9 in.
" from trailing-wheels to centre pin of truck }	19 ft. 5 in.
Mean diameter of boiler...	4 ft.
Number of copper tubes...	142
Diameter of "	2 in.
Length of "	10 ft. 11 in.
Length of firegrate...	5 ft. 6 in.
Width of "	2 ft. 10 in.
Maximum depth of firebox...	4 ft. 11½ in.
Tube surface...	812 sq. ft.
Firebox "	84 sq. ft.
Grate area...	15.62 sq. ft.
Transverse distance apart of cylinders...	6 ft. 2 in.
Length of connecting-rods...	7 ft. 3 in.
Inside diameter of main steam-pipe...	5½ in.
" of branch pipes, oval section }	4½ in. by 3½ in.
Length of steam-ports...	16 in.
Width of "	1½ in.
" of exhaust ports...	2½ in.
Lap of valve outside...	¼ in.
" inside...	¾ in.
Lead of valve in full gear...	½ in.
Diameter of two blast nozzles...	3½ in.
" driving axle...	6½ in.
" truck "	4½ in.
Driving-axle journals...	6½ in. by 7½ in.
Truck "	4½ in. by 8 in.
Diameter of chimney...	15½ in.
Height of do. above smokebox...	5 ft. 7 in.
" above rail...	14 ft. 1½ in.
" centre of boiler above rail...	6 ft. 4 in.
" top of cab, about...	13 ft.
Extreme width over cornice of do.	9 ft. 1½ in.

THE DANUBE.—Prince Charles of Roumania has descended the Danube by the Kilia branch as far as Wilkow, the point of intersection of the different arms of the great river. His Highness examined in detail the embouchure of Kilia, and studied the various projects proposed in order to facilitate the navigation as far as the sea.

LOCOMOTIVE ENGINE FOR THE METROPOLITAN

DESIGNED BY MR. ROBERT H. BURNETT, C.E., AND CONSTRUCTED BY THE METROPOLITAN RAILWAY COMPANY

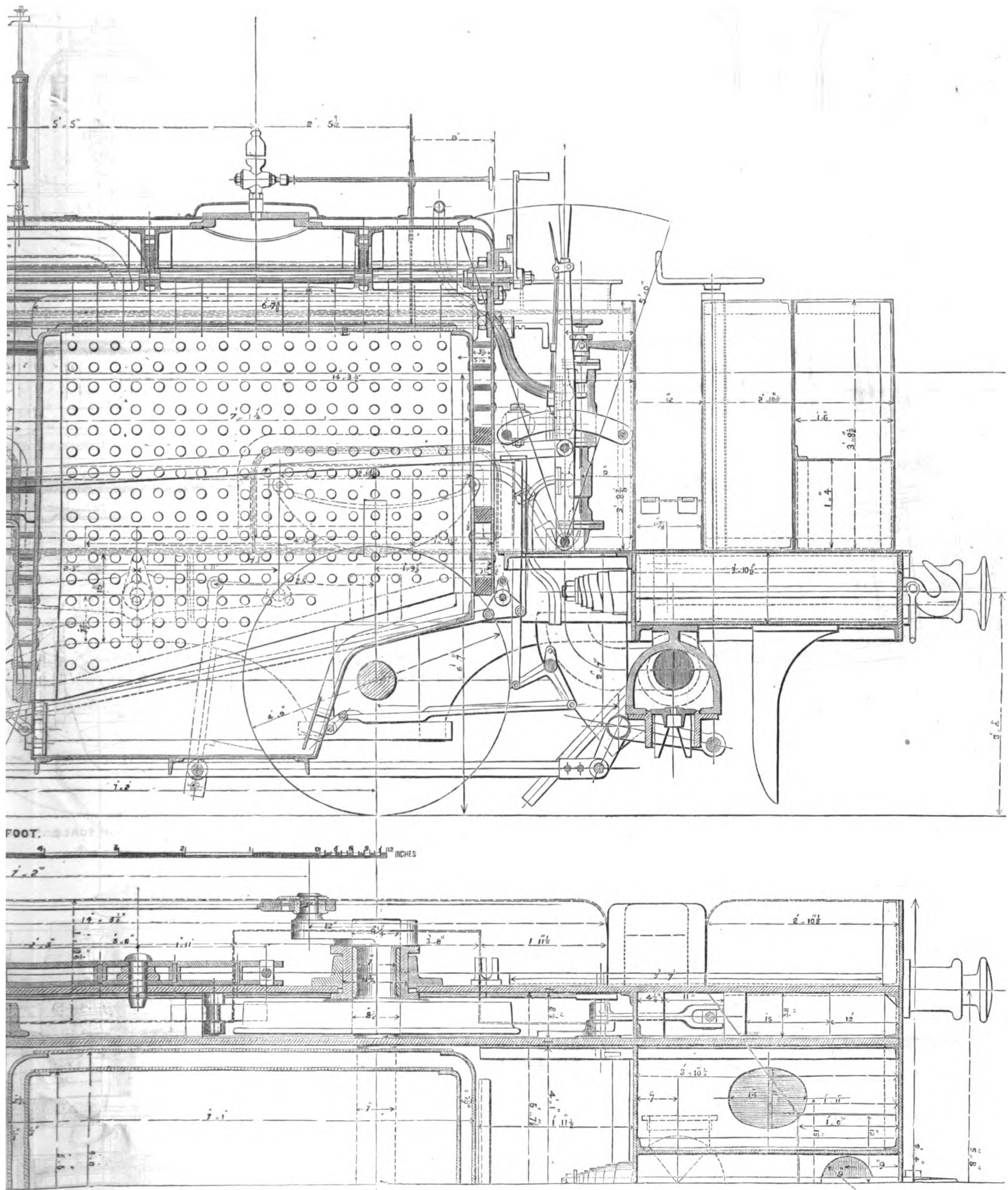
(For Description of the Engine)



LITAN AND ST. JOHN'S WOOD RAILWAY.

DESIGNED BY THE WORCESTER ENGINE COMPANY, WORCESTER.

(see Page 61.)



PUBLISHER'S ANNOUNCEMENT.

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

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

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

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

ENGINEERING is registered for transmission abroad.

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

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

ENGINEERING.

FRIDAY, JULY 26, 1867.

TECHNICAL SCHOOLS ABROAD.

THE question of technical education has at last obtained its due prominence in the minds of our professional public, and, under these circumstances, we believe it will not be amiss to bring before our readers some few notes about the public institutions existing in the different European countries for the education of engineers. On the Continent the title and profession of an engineer is considered to be unattainable except through a course of regular scientific schooling, similar in nature and form to that which in England is passed through for obtaining a position in the legal or medical profession. The number of self-taught engineers is, therefore, smaller on the Continent than in England, and the number of highly educated men in all the inferior positions connected with engineering works of all kinds is disproportionately greater than with us. As a rule, no apprentices or pupils are accepted in engineering offices or works except those who have successfully passed the schools or colleges for their respective branch, and such schools, of greater or less excellence and celebrity, exist in every large town all over the Continent. In France, civil, mechanical, and mining engineering are separated, and each has its own principal college at Paris. The Ecole des Ponts et Chaussées is considered the first school for civil engineering all over the world. It is a Government institution, and specially intended for the education of Government engineers; still the lectures are open, also, to a limited number of students who are not destined for Government service, and a considerable number of foreigners from all parts of the Continent avail themselves of this opportunity. The mechanical branch is represented by the Ecole Centrale, and also by the Ecole des Mines, one of the most celebrated institutions of its kind. The French schools for mechanics and mining are, from different causes, much less frequented by foreign students, most probably because the excellent schools for these branches in Germany offer greater facilities. The first German engineering school, at this present moment, is the Polytechnic School at Zurich, in Switzerland. There are the celebrated professors, Clausius, Zeuner, and others, whose researches and writings are sufficiently well known in England, and whose testimonials serve as a professional passport for a beginner in every office on the Continent, and in many a first-class office in this country as well. Next in rank, although of a declining reputation, is the Polytechnic School in Karlsruhe. This is the institution where Professor Redtenbacher taught mechanics, and wrote his excellent works on machinery. Many of the first engineers in Germany, Russia, and Austria have passed through this institution, but at present, in consequence of the death of Professor Redtenbacher, it has lost much of its prestige. The school in Hanover stands next in merit. Its leading men are Professors Karmarsch and Kühnmann, both celebrated in Germany, and well known in France and in England. In Berlin, Professor Renleaux teaches mechanics, but his school, as a whole, has not that fame of either of the three first named, and the engineering school in Vienna, although recently improved to some extent, is far under mediocrity, so that those Austrians who can afford to study engineering abroad visit the schools of France or

Germany in preference to their own. For mining and metallurgy, the first German school is that at Freiberg, in Saxony, with Baron Beust, the brother of the present Austrian minister, as its director. Next in standing, and certainly equal to it in merit, is the school at Leoben, in Austria, where the Chevalier de Tunner, one of the greatest authorities in this branch, is director and professor. The Bergakademie in Berlin and Professor Wedding we have noticed already. The schools of second rank are copies of these institutions, in a small or more or less imperfect style. All these institutions are maintained by the Governments of the respective countries. The professors are paid a fixed salary, and their lectures are, practically, free to every visitor. There are certain payments taken from the students which go to a variety of funds, but these payments are very small (say, for instance, 5l. per annum), and even these are remitted to the poorer students. The education obtained in these colleges is purely scientific, but with strict reference to the requirements of actual practice. In the generality of cases, however, the reproach has been frequently made to all these schools of engineering that they do not teach their pupils "to work." They show them practice, as it were, through a telescope from the distance, and move too far away from it in abstract theory. How far this may be correct or not is for us to tell at this moment; certain it is that these schools afford advantages in actual practice, and that something may be learnt from their arrangements which will be useful to us.

THE SOCIETY OF ENGINEERS.

WE believe the only objection to the application of the Society of Engineers for a royal charter, empowering them to sue and to be sued as a corporate body (and this is the sole privilege enjoyed by the Institution of Civil Engineers in virtue of their charter) is that the name "The Society of Engineers" is too nearly alike to that of "The Institution of Civil Engineers." The similarity, if there be any, can have occurred to but few. Few, indeed, could embrace both societies in the same thought, although, as an impassable condition, both societies enjoy, and must ever enjoy in common, the right to the word "engineers." The Institution has surely no primary claim to the word "engineers," although the choicer spirits of the Institution are united in a club known as the Smeatonian Society of Engineers. But except for the exclusiveness of the title (and no thinking man cares twopenny to be admitted to its mysteries nor even to its dinners), they might as well be known as the Archimedian Society or the Marquis of Worcester's Society. The Smeatonians are banded together for dinners and for friendship, but not for work, and they have no public status. As for the Institution, who will mistake it for the humbler Society of Exeter Hall? None, we think.

Whether the society gains its charter this year, or twenty years hence, it is a *sine quâ non* that it shall never change its name, the name which it has borne for more than twelve years, and which has gained it nearly five hundred members. No body of men can be allowed to monopolise the title "engineers," and although the Mechanicals, the institutions in Scotland and in Ireland, the "Civil and Mechanical Engineers' Society," and other various bodies of our sort, stick to the word "engineers," as they have a good right to do, no one of them, nor even the Institution in Great George-street, can put in a claim for exclusive possession. We must still be permitted to call every man an engineer who likes thus to describe himself, no matter to what body of brother clips he may belong. The Duke of Richmond, as the President of the Board of Trade, and bothered with an application which is ridiculously out of place at his board, will, no doubt, see that no association among a widespread family of engineers can be allowed to monopolise that one word which is so fitly represented in the Latin tongue as *ingenium*, meaning art, abilities, mind, genius, and which would, indeed, apply to other professions than engineering although it best applies to our own, the most valuable profession, *par excellence*. There is no necessity that all engineers, young and old, and of all ranks, should be banded together in one society, and it would indeed be well-nigh fatal to the best interests of the profession if they were. Let no one think too much of the title, M.Inst.C.E. It is easily won, and counts for but little, unless to empty minds, when attained. It is not what the ambitious expectant embryo may have thought it, gratifying as it may be to him to receive his diploma. He possesses no qualification *with* the title that he did not possess before, unless it be to bamboozle a foreign railway

company, and here the leverage of the mystic initials is often tremendous. The Institution of Civil Engineers has no royal or legal rights or privileges whatever, beyond that of suing and being sued as a corporate body, and that of holding property of the value of one thousand pounds a year.

If, during the present inquiry into the advantages of technical education, one of the best agencies of this education—that of the Society of Engineers—is to be burked, it is time to put on all the pressure that can be applied, and to bring the matter, as it easily may be, before Parliament. It is one of a series of the most fatal blunders of the council of the Institution, and individually and collectively they have committed many lately, to oppose, as they are doing, the grant of a charter to a junior society for merely pecuniary rights, these being all that they themselves enjoy. Of course, there is every reason to expect the grant of a charter, to the Society, for, now that the subject has been raised, the matter cannot rest until so obvious a measure of justice is allowed; but it is simply certain, that in opposing it the Institution is alienating much of the most available talent and good feeling, and contributing to the establishment of a powerful rival, where, if unopposed, no rivalry would have been thought of.

THE LATE MR. OLIVER W. LANG.

THE late Mr. Oliver Lang was the son of Mr. Lang, formerly master shipwright of Woolwich Dockyard, who, among others successful achievements, designed and built the famous paddle-wheel frigate *Terrible*, which always was, and still is, the largest and finest paddle-wheel ship in this or any other navy.

After serving an apprenticeship to his father, and passing through some minor grades, Mr. Lang became a foreman of shipwrights, after an assistant master shipwright at Chatham, then master shipwright at Pembroke, and finally master shipwright at Chatham, from which onerous position he found himself obliged to retire, about three years ago, on account of declining health.

After superintending the practical building of very many of the finest wooden vessels in our fleet, Mr. Lang, as master shipwright at Chatham, inaugurated the building of iron ships in H.M. dockyards. Beginning with a yard in which neither men nor machinery existed, he got together the proper staff and plant, and the result of the first effort in this direction was the famous ironclad *Achilles*, built entirely of iron, of 6079 tons burthen, and clad with armour from end to end.

Besides his ordinary duty as a builder of iron ships, Mr. Lang has met with great success as a designer. He was associated with his father in the designing of some of Sir W. Symonds' earlier ships, and he afterwards designed, amongst other vessels for H.M. navy, the *Banshee* and *Vivid*, which, as paddle-wheel dispatch vessels, have never been surpassed, and the *Nankin* sailing frigate. In the two former ships, in fact, he exhibited, in a very marked manner, what seems to have been his special forte, viz., the designing of very fast light steamers. It is understood that he was largely concerned in the designing of some of the *Holyhead* packets, and some of the most remarkable ocean and river steamers in private services have been built from his designs.

It has been supposed by some that Mr. Lang was a member of the former School of Naval Architecture; that, however, was not the case; as above stated, he served his apprenticeship as a shipbuilder and naval architect to his father.

THE BROADSIDE SHIPS AT SPITHEAD.

LEAVING the turret ships out of account, there is much to be learnt now by a comparison between the various types of broadside ships at Spithead. If those troublesome turrets had never been invented, and if Ericson had never shown how rolling might almost be got rid of by the low freeboard of his monitors, we might well be proud of our fleet. So we may still, if we can guarantee its having nothing but broadside ships to fight against.

Regarding our ironclads as ships for the line of battle, it is necessary to discard the three armoured gun-vessels, *Viper*, *Vixen*, and *Waterwitch*, and the sloop *Research* (1253 tons). All these are disqualified by their low speed from taking part in the evolutions of a fleet, while the guns of the first three are only protected so long as the ship is end on to the enemy. The *Enterprise*, a still smaller sloop (993 tons), now serving in the Mediterranean, is likewise disqualified on the ground of speed.

First in order of time come the *Warrior* and *Black Prince*, still the admiration of those who have not

voted the overhanging figure-head a cumbrous relic of the past, neither graceful nor useful. The length of these ships between perpendiculars is 380 ft., and their unhandiness very great. The plating extends only along the central portion, with transverse bulk-heads in the "central box" style; but there is no belt round the whole water-line, and such plating as there is is only $\frac{1}{2}$ in. thick. The Warrior is now being put in commission for the second time, without the smallest attempt being made to improve her either by giving her a fighting bow or by carrying a belt of armour round the water-line. Of course these ships are perfect models for speed, and the famous 15 knots of the Warrior will never die in the remembrance of the old school—for there is already an old school—of iron-clad shipbuilders. These two ships are of 6109 tons.

The next ships launched were the Defence and Resistance, of 3720 tons. Neither was at the review. Except that they have ram bows of the nearly perpendicular pattern, they are nothing but small Warriors without the speed. They are very slow, and only armoured amidships with $\frac{1}{2}$ in. plates.

The next attempts were the Hector and Valiant, of 4089 tons. The former is just put out of commission, and will probably be replaced by the other, which took part in the review. These are quicker ships than the Defence and Resistance, and differ from them in the arrangement of their armour in a rather remarkable way. Indeed, they are now curiosities, and (fortunately) the only remains of an exploded idea. They are plated (with $\frac{1}{2}$ in. iron) all round the main deck, but only in the central part of the water-line. This is so exactly the reverse of modern ideas that one must needs go back a little to understand it. It proves that ten years ago our authorities foresaw so little the use of large guns at sea, that the loss of a ship by perforation at the water-line scarcely occurred to them, nor did they understand that the central part of the main deck would give room for quite as many modern guns as the Valiant could carry. As it is, she has an enormous fighting deck, which the Admiralty think must be filled anyhow, so they scatter a dozen $\frac{1}{2}$ ton guns about it, with one pair of 9-ton 8 in. rifles.

None of the five converted liners with which Lord Palmerston, perhaps wisely, so quickly doubled our small force are here represented. The Ocean is in China; the Prince Consort, Caledonia, and Royal Oak in the Mediterranean. These are simply plated all over. They roll heavily, will doubtless shake off their plates before many years are over, and carry nothing very heavy in the way of armament—four 8 in. guns and sixteen 7 in. Nevertheless, they are better than nothing, and can take their place in line-of-battle as well as any. The speed of all these ships is moderate, about 12 knots at the mile. The fifth, the Royal Alfred, recently gone as flagship to the North American station, is of quite another style, and marks the accession of Mr. Reed to office. She carries a belt of 6 in. plates, a central battery 100 ft. long, and is plated over the bow and stern as well. Like all partially plated wooden ships, she is likely to be set on fire by shells, but she carries larger guns than any other wooden vessel afloat on this side the Atlantic—ten 9 in. and some 7 in. guns. As a high-sided ship, she is a fearful roller, and was nearly lost in the passage out. The Zealous and the Favourite are smaller and weaker specimens of Mr. Reed's style of conversion, partly plated, and carrying nothing larger than 7 in. guns. Both are abroad.

The first ship present, of which there is very much good to be said, is the Achilles, laid down at Chatham Dockyard as a kind of cheek upon the Warrior and Black Prince, built in private yards. The original plans were altered in accordance with Mr. Reed's well-known ideas. She has, in fact, a belt and a long central battery. Long and unhandy she is, like her weaker sisters; but she is a ram, which they are not, and her water-line is protected. Perhaps her best feature is her remarkable steadiness. Between this improved specimen of the old style, and the ships built after Mr. Reed's own plans, the main difference is in length. Less length means less tonnage, and this, if the old lines were adhered to, would give a smaller weight-carrying power. But by flattening the floor Mr. Reed is able to carry on a given length, not only a greater weight of guns and armour, but a greater proportionate engine power to make up for the less favourable form. When a wave runs up a high-sided ship, tending to lift up that side of it, or when any other force is applied to it sideways, it depends mainly upon the form of the bottom (assuming the weights to be well distributed) whether the attendant roll shall be great or small. The section of the Bellerophon approximates nearer to the circular form—at any rate, at the ends—than that of the Achilles, and, therefore, is

more favourable for rolling. The deep roll of the Great Eastern is well known. As well known, it may be said, is the easy rolling of the cigar ship, which is absolutely circular in section. True, but then practically the cigar ship has no broadside whatever. The waves have so little to run up, that they exert no lifting power worth mentioning. The cigar ship is a sort of monitor drawn out into a long yacht, and only proves that a low freeboard secures steadiness whatever be the shape—a point we have always maintained. The case may almost be put thus:

War ships must now be built of full section, in order to carry the requisite weights within the requisite limits of size.

High-sided ships must roll, moderately when of sharp section, but immoderately when of full section.

Low-sided ships are steady, whether sharp or full in section.

Therefore war ships should be low-sided, or, in other words, monitors; and where special requirements forbid the plain monitor type, the departure from that type should be as small as possible.

When comparing the short ships of Mr. Reed with the long ones of his predecessors, there can be no doubt of the superiority of the former in *everything but steadiness*. That exception is not important enough to induce us to retrace our steps, and to abandon the advantages of the short and full-bodied hull, but it is important enough to justify us in cutting all alike down to monitors.

The Achilles may be called the transition ship of the fleet, for the grand Minotaur (representing also her absent sister, the Agincourt) is quite one of the old school. Covered all over with plates, nearly everywhere $\frac{1}{2}$ in. thick, an admirable ram, abounding with sail power (having five masts), carrying a large number of guns (four of 9 in.), and of immense speed and comparative steadiness, she is indeed a superb vessel. But the Bellerophon's plates are still thicker, her guns, on the whole, heavier, and her speed nearly as great; while, as for handiness, she could simply dance round her, "ram" her almost as she pleased, and always get out of her way when hard pressed, and all this with three-eighths less tonnage. A heavy sea alone would give the Minotaur the best of it, and even that can hardly be affirmed without trial.

The Lord Clyde and Pallas are the remaining large ironclads present, beside the Bellerophon. Of the two first, one can only say that a skilful designer has done the best he could with an unsuitable material. Mr. Reed, left to his own judgment, would be the last man to build *new* ironclads of wood. The Lord Clyde is indeed better beyond comparison than the converted liners before mentioned, both in strength of frame and in thickness of plating. The water-line is covered with $\frac{1}{2}$ in. iron, the battery with $\frac{1}{4}$ in. outside, and $\frac{1}{4}$ in. skin on the frames. The plating is continued over the raised fore-castle, whence two 7 in. guns fire straight ahead, and the same number straight ahead from the main deck, which carries fourteen other 7 in. and four 8 in. guns.

The Lord Warden, not present, is similar to the Lord Clyde, but carries only 8 in. guns on the main-deck. The Lord Clyde is a handsome full-rigged ship, but not much of a sailer.

Quite the reverse is the Pallas, which spreads a fair proportion of sail for her tonnage, and in the Channel squadron trials usually beat everything under sail. She is not fairly a ship for the line-of-battle, but her large guns (8 in.) and high speed fit her for anything. She has a very small battery, just large enough for four guns, which can be fired nearly fore and aft by means of the peculiar notches in the side, introduced by Mr. Reed. A great mistake as regards appearance has been made in the upper deck of this ship, which *ought* to have gone straight along as usual, bridging over the notches. Instead of this, the bulwarks have been made to follow, very nearly, the notched shape of the main deck beneath, so that there are two parts of the upper deck narrower than the rest. This is a quite unnecessary blemish in the ship's appearance. The Pallas is, of course, plated all round the water-line, and the bow is armed and protected; but the remainder is of wood, and liable to be set on fire. The plating is $\frac{1}{4}$ in. For a fast cruiser, thoroughly sea-going, and of moderate power, the Pallas is probably unequalled, but hers is not a type likely to be repeated.

Of the Bellerophon there is no need to speak. If any ship is thoroughly well known to every reader of ENGINEERING, it must surely be the Bellerophon, of which more has probably been said and written than of any craft launched since the days of the ark.

In alluding to the absentees from Spithead, as well

as those present, we must not omit the Northumberland, an improved Minotaur, in which the armour has been disposed central-box fashion. The saving in weight is applied to carrying a battery of 8 in. instead of 7 in. guns; but it is hard to see why the Minotaur and Agincourt cannot stand that trifling additional weight nearly as well as the Northumberland.

Such is the British broadside fleet. With all its faults, it is by far the finest in the world. Where almost every ship differs from the rest, it is difficult to draw any general comparison between them; perhaps the only safe division is into ships which are Mr. Reed's and ships which are not. Of the comparative merits of these two classes there cannot be two unprejudiced opinions.

To touch upon the few imperfect turret-ships lately anchored at Spithead would lead to a discussion, for which we have no space; but, poor specimens as they were, it is much to be doubted whether they might not have engaged the whole broadside fleet, with credit to themselves and advantage to the country—if, by so doing, they might have awakened it to a sense of the immeasurable importance of the turret question.

CIRCULATING EXHIBITIONS AT GERMAN MUSEUMS.

THE industrial museums of the towns Stuttgart, Karlsruhe, and Nurnberg, in Germany, have recently made an arrangement which is worthy of attention, both for private manufacturers who desire their products to become publicly known abroad, and for men connected with similar institutions in this country, as an example inviting imitation. The museums of the three above-named towns, the first erected and maintained by the Royal Board of Trade in Wurtemberg, the second belonging to the Government of the Grand Duchy of Baden, and the third under the management of the Municipal Council of Nurnberg, have arranged to receive goods from exhibitors of all countries for the purpose of their being exhibited in turn at each of the above-named cities. The exhibitors can send their goods to any one of the three towns, and they are shown there first for a time of about four weeks; after that they are sent on to the other two places at the joint expense of the three institutions and free of all charge for the exhibitors. The applicants for space may address any one of the three boards of directors at any time convenient to themselves: they must describe the objects, stating weights, sizes, and selling prices, the names of the firms or agents from whom similar articles may be ordered, and what patents have been granted for the inventions connected with the articles sent for exhibition. The board then decides upon each application whether the objects are admissible, and those articles which are admitted enter duty free for the purpose of exhibition. The freight to one of the towns must, as a rule, be paid by the exhibitor, but occasionally exceptions are made with regard to this point. The objects exhibited are kept in proper order and insured against accidents by the directors of the museum, the goods may be sold, but cannot be delivered to the purchaser until they have passed all three museums. In case of exhibited goods being sold in the respective countries, the usual entrance duty must be paid for them; but if the goods are returned, they pass through the same custom-house through which they have entered free. The local papers will publish a register containing the description of each article exhibited, and some of the articles will be purchased occasionally by the museums in question for remaining there permanently exhibited. For the information of those of our readers who are desirous to avail themselves of these exhibitions, we annex the three addresses of the respective councils, who may be written to in English.

The Board of the Royal Industrial Museum of Wurtemberg, Stuttgart.

The Board of the Industrial Museum of the Grand Duchy of Baden, at Karlsruhe.

The Board of the Industrial Museum of the City of Nuremberg, Bavaria.

ENGINEERING CONTRACTS.—There has been little improvement in this branch; contracts are scarce at home and the subject of much competition abroad. The Bommel bridge was adjudicated by the Dutch Government to a German firm at a price some 20,000*l.* under the lowest English tender. The iron, as we stated above, will be drawn largely from Belgian sources of supply. The Dutch parliament has just voted the necessary sum for the Moerdyk bridge, which will put the Dutch lines in uninterrupted connexion with the French and Belgian railways, and facilitate still more the trade intercourse of those countries. Some few orders for locomotives, carriages, and wagons have been given out as renewals for both home and foreign lines, but the aggregate amount is inconsiderable.—*Messrs. W. Bird and Co.'s Monthly Circular.*

THE ENGINE TRIALS AT BURY.

WHAT hempen homespuns have we swaggering here?

What, a play toward! I'll be an auditor;
An actor, too, perhaps, if I see cause.

Midsummer Night's Dream.

Bless thee, Bottom! Bless thee! thou art translated.
Ibid.

BOTTOM and Smug, the editor-in-chief and editor-in-little, respectively, of one of the metropolitan mechanical newspapers, last week, visited bucolic, beautiful Bury, on the Lark, the latter, however, a stream of ignoble width and depth, and not the lark upon which the friends apparently sat out. And Puck, that Robin Goodfellow, who visited Bury for this occasion only, seeing the

Crew of patches, rude mechanicals,

and that upon a midsummer's (St. Swithin's) night, fitly adorned

The shallowest thickskin of that barren sort

with an ass's nowl—not that the guise was new—and wrapt him in a dream, Bottom's dream, because it hath no bottom. "The eye of man hath not heard, the ear of man hath not seen, man's hand is not able to taste, his tongue to conceive, nor his heart to report" what this dream was. And yet is it not written, and printed too, 3 inches in width and 13 ft. in length, in the journal in question?

In the journal, edited-in-chief by Bottom, is it not Bottom's account of the Royal Agricultural Show, and of the engine trials, at Bury St. Edmund's?

Saith Bottom's dream, and we quote from the beginning:

"With the Paris Exhibition a new word, highly expressive to those who comprehend its full meaning, has come into existence. This word is French in itself, French in its origin, and totally impossible to translate—it is *chic*. A picture in which very little thought or sentiment is made to go a long way displays *chic*. In the same way if one has very little to write about he puts a good deal of *chic* into his article, and the result is the same in a sense as though he had an abundance of original matter to deal with. In those excessively dull seasons when engineers rest from their labours, and there is nothing new in the world of science to present to our readers, we throw a little of the *chic* quality into our lucubrations."

True, oh, Bottom! And there is also an English expression, *cheek*, not perhaps so distantly related to *chic*, and which signifies assumption—especially of personal or intellectual qualities—the pretension to knowledge or superiority, as if already acknowledged, but to which the pretender, as in Bottom's dream (as printed in his paper), has no title.

To Bottom's dream, despite the sweet presence of the attic Titania of the "Angel" at Bury, there was a nightmare, and this was the friction brake of the implement-yard. To Bottom this was "a tangled brake"—one of those things no fellow *can* understand. A week before he had printed that the friction brake was "provided with springs." A week later he finds this to be an error, trifling no doubt; nor, he says, are the brake straps tightened by a weighted lever, but by a weight and lever. The fact, sweet Bottom, is that they are neither tightened by a weighted lever, nor by a weight and lever, nor by a weight, nor by a lever, but by a right and left hand screw. Bottom cannot make out the business of the brake, and he is haunted with it, throughout his thirteen-feet dream, as measured by the columns of his paper. He cannot comprehend that the weights upon the brake were always adjusted by the judges (and may their ermine never need bleaching!) to the nominal power and nominal speed of the engines tried. He does not clearly understand that these weights, multiplied by the nominal or intended speed in feet per minute, of the effective periphery of the brake wheel, was always, when divided by 33,000, equal to the nominal power of the engine tried. That the weights were properly adjusted to the nominal speed and power there can be no doubt, when the names of John V. Gooch, Frederick J. Bramwell, and James Easton, jun., are mentioned as judges, and, accepting this as true, and knowing that the engines had 14 lb. of coal per nominal horse power weighed out to them, it was only necessary to divide 14 by the mechanical time, in hours, of the engines tried to know the actual consumption of coal per dynamical horse power per hour. Good Master Peascod shall scratch thine ear, Bottom, and dost understand? In the second series of trials, when the engines had 10 lb. of coal per nominal horse power weighed out to them, and were tried to one-half more than their nominal power, the dividend to be divided by the mechanical time is $6\frac{2}{3}$ lb. Thus the Reading Ironworks Company's 10-horse engine ran in the second series of trials, within a few seconds of 2 hours 40 minutes, or $2\frac{2}{3}$ hours. And $6\frac{2}{3}$ lb. $\div$ $2\frac{2}{3}$ hours = 2.5 lb. of coal per dynamical horse power per hour, the lowest rate ever

recorded, we believe, at the Royal Agricultural Society's trials.

Saith Bottom a little further on:

"If we are not mistaken, the use of maroon paint was first suggested in the pages of *The Engineer* less than a year since, and the result is all that we anticipated as regards appearance!"

And then come the figures of the performance of Clayton, Shuttleworth and Co.'s double-cylinder prize engine. But some of these figures are wholly wrong, the nominal speed of the engine being given as 130 revolutions per minute instead of 110, the total revolutions of the brake being also apparently credited to the engine fly-wheel, and the actual running time, 4 hours, being given as 3 hours 57 minutes, and, besides this, neither the mechanical time (4 hours 42½ minutes) nor the weight on the brake is anywhere mentioned, to enable us to calculate either the consumption of coal per horse power per hour, or the duty, nor are these anywhere given.

Next comes a sketch of Nalder's eccentric-rod, wholly incorrect, because the flat part, which springs to adjust itself to the varying angle of the rod, is shown, not in the eccentric-rod at all, but in the valve-spindle. Then we are informed that

"This engine actually ran for nearly two hours, the brake making in all 15,400 revolutions, the load being 86 lb. 7 oz., or, in round numbers, 86.5 lb. From this it will not be difficult to deduce the horse power per pound of coal per hour and the duty obtained from the whole quantity allowed to the engine for the trial."

On the contrary, without the measure of the periphery of the brake-wheel, or (much simpler) the mechanical time wherewith to divide the 14 lb. of coal per horse power, the calculation, so far from being not difficult, would be impossible.

We are next informed that the engines have 7 lb. of coal per horse power allowed them to get up steam. All portable engines, however, had 8½ lb. of coal and 7 lb. of wood allowed them for this purpose, irrespective of size.

Next, that the allowance of coal per horse power on trial—14 lb.—is made for every 10 square inches of piston area, this area being, it is said, taken as a horse power. Now the rule of the society's engineers allows 10 circular inches per nominal horse power for single cylinder, and 9 circular inches for double cylinders. Then, saith Bottom:

"The speed of the engine is usually in excess of that of the brake, as the fly-wheels of the greater number of portable engines are larger in diameter than the driving-pulley on the brake-shaft. In the case of Messrs. Nalder's engines, however, the speed of the engine was given at 220 revolutions, while that of the brake was 140.94, the diameters of the fly-wheel and pulley being to each other as these numbers."

Nay, Bottom, not so. The larger of two pulleys coupled together by a belt never goes the faster, unless, being the driving pulley, the belt slips. And the diameters of the fly-wheel and brake-pulley, in the case of Nalder's engine, were *not* to each other as the numbers given, although they were possibly inversely as those numbers, this engine having a fly-wheel only 2 ft. 9 in. in diameter.

Savage's engine must have been an astonishing specimen, for we are informed that "the diameter of the cylinder is, we believe, 8½ in. per horse power!" We are not told what its power was, but we can supply this omission, as it was entered as an eight-horse, and thus, according to this new rule, giving to the cylinder 8½ in. in diameter, *per horse power*, the diameter of the cylinder would be 5 ft. 8 in.! We confess it looked to us, judging from the outside only, to be a little smaller. In point of fact, it was 9½ in. diameter, the stroke of piston being 12 in. And although neither the nominal nor the actual power of the engine, nor the actual nor the mechanical time of the trial, is given, we are told that with 19,422 revolutions of the brake, with a load of 109 lb. 4 oz., and a cylinder 8½ in. in diameter per horse power, "Our readers can obtain 'the running figures from these data'!" What may be "running figures" we do not know, and beyond the gross work done in foot-pounds (for the effective periphery of the brake-wheel is given elsewhere as 17.33 ft.) nothing whatever can be obtained from these data. We happen to know, however, that this engine was the most wasteful of coal of any tried, consuming 12.92 lb. per dynamical horse power per hour, an amount which would, probably, correspond with 10 lb. or 10½ lb. per indicated horse power.

Brown and May's double-cylinder trial engine is described as a 10-horse. By the maker's rule it was 12, and by the society's rule 12½ horse power. It is added that "only 9 in. of area of piston per horse power are allowed to double-cylinder engines." Nine circular inches, it should have been said.

Of Burrell's engine we are only told that "the brake speed was 125 revolutions per minute, and that the total number of revolutions was 17,866." What of

this, except that it ought to show by division that the engine ran 2 h. 23 m., nearly, with her allotted weight of coal. But it only ran 1 h. 59 m., the mechanical time being 2 h. 5 m. The engine was intended to run at 125 revolutions, and it actually averaged 131.2 revolutions; and the brake, instead of going at 125, as reported, of course went much faster.

Of Kinsey's engine we are told merely that it ran against a brake load of 129 lb. 3 oz. for 1 h. 37 m. Nothing whatever can be calculated from this, as the speed is not given, and we are somehow reminded of the *critique* of the *Bury Free Press* upon this same engine. Said that organ of information on Saturday week, "Kinsey's fixed has a cast-iron foundation plate instead of the usual one." Just so.

Deacon and Wood's oscillating engine happened to overrun its intended speed by less than one revolution per minute, being entered to work at 110, and actually making 110.6 revolutions. Bottom, aided, possibly, by his coadjutor of the *Bury Free Press*—and both papers were peddled by the same boy in the show-yard—gives due prominence to this unimportant coincidence of the actual and mechanical time, and adds:

"This fact certainly substantiates all that the makers claim on the score of economy, and, for the rest, the engine is well made and compact."

Does it, really? Shade of Watt!

The actual time of Clayton, Shuttleworth and Co.'s single-cylinder engine is given as 4 h. 42½ m., instead of 3 h. 17½ m.

The beer of Bury, when drunk in moderation, is binocular, and not strabismic, and the best brewed there is at the large and capably fitted brewery of the borough member, Mr. Greene, the brewer being our good friend Mr. Crockford, the son of the well-known manager of Messrs. Coombe, Delafield, and Co.'s brewery, London. After a pint of Crockford's best, we found no difficulty in distinguishing the single cylinder of the Reading Ironworks Company's engine, the one which attained so wonderful an economy when tried at one-half more than its nominal power. But Bottom, bibulous of other beverages perhaps, distinctly saw *two* cylinders, with main slides, expansion-slides, and "a second pair of eccentrics." It was, he says, "a double-cylinder engine." Indeed, the account here begins to be very mixed. Underhill's engine, it asserts, has no "fuel-heater," not that any other of the hundred or more engines had any apparatus for warming the coal before placing it in the firebox. In the case of Ruston's engine, too, Bottom's eye took in even more than was to be seen, including "a separate expansion-valve" and "cut-off eccentric," neither of which had any existence! And, yet it is stated, that in altering the cut-off the *lead* is not materially affected. Were there a separate cut-off, as erroneously asserted, no alteration of it would, of course, affect the lead, since that is measurable, not on the edge of the cut-off valve, but on the main valve. The actual running time of this engine is given as 2 h. 26 m., instead of 2 h. 20 m. This engine, rated as an 8 horse by the makers, but as 9½ horse by the society's rule, was tried to 24½ horse. This experiment it is alleged was brought to an abrupt conclusion by the over-heating of the brake. So far from this, the trial was made late in the evening, and as it was not made to test the consumption of fuel, it was stopped at a late hour, and instead of the load being "then reduced to 50 per cent. more than that originally tried," the engine went upon the society's second series of trials on a subsequent day.

Ransomes and Sims's engine is said to have rings on the back of the expansion valve for taking off the pressure upon the main valve. The rings are, however, on the main valve, where they ought to be, but this is of box section, and encloses the cut-off valve within it. This engine, which was second in both series of trials, is reported to have made but 3 h. 4½ m. mechanical time, whereas it was 3 h. 43½ m.

The second series of trials at 50 per cent. above the nominal power were not considered in awarding the prizes, but the results not only gave wholly new relative positions to the engines previously tried, but some of them were remarkable for the low consumption of coal. These trials, as we happen to know, were not witnessed by the "special correspondents," or either of them, of our contemporary, and it accordingly says "little is to be gathered from the second trial, with '50 per cent. heavier loads, that may not be deduced from the first trial.'" And again, "The results, as 'as regards economy did not present, as we have said, much that was noteworthy.'" Indeed! As for the first three of the double-cylinder engines, the order of merit in the first trial was exactly reversed in the second, Clayton, Ransome, Tuxford changing

places to Tuxford, Ransome, Clayton. As for single cylinders, the order of Clayton, Tuxford, Reading, was changed to Reading, Clayton, Tuxford, and the running of the Reading engine with 2.54 lb. of coal per dynametrical horse power per hour, equal to less than 2½ lb., and probably not much over 2 lb., per indicated horse power, was thought by a few engineers to be in a trifling degree remarkable. The same makers exhibited a fixed engine which, on trial, took the second place, but of which nothing is said in the account from which we have quoted.

And this is the reporting, not of an unskilful country reporter, but of the editor-in-chief himself, well known as such, to an engineering journal. It was not the result of hasty observation, for he was in Bury for nearly a week, and he had an assistant besides. Driving pulleys going faster than the driven, the latter being of smaller diameter; double cylinders where there was but one; valves and eccentrics where none existed; cylinders 8½ in. in diameter *per horse power*; the fact that an engine happened to run nearly at its appointed speed, held to "certainly substantiate all" that the makers claim on the score of economy; and a general confusion of everything—of the principles of the friction brake, of circular inches with square inches, of the nominal speeds with the actual speeds, and general inaccuracy in the statement of times, powers, sizes, quantities, &c. And this not upon an ordinary occasion, but in a professedly professional report of probably the most important series of trials ever made in the whole range of agricultural engineering, and that by the first agricultural society in the world! Some hundreds of engineers, and thousands of farmers, who are interested in these trials will learn, on inquiry, that this report, prepared, no doubt, in the hope that it would be as widely read and trusted, is utterly worthless, and a disgrace to scientific journalism. Do we do it any unkindness in giving it its fitting name, that of Bottom's dream which hath no bottom? The dream full of *chic*. Ay, Bottom;

While we thy amiable *chic* do coy,
And stick brown thistles in thy thick smooth head.

'Twere better had'st thou played the lion, after all thy contention with Peter Quince. Thou wouldst have roared that it would have done any man's heart good to hear thee, and the agricultural engineers would have said, "Let him roar again, let him roar again!" Or to spare the nerves of the gentler sort, and to 'scape hanging on the gallows of criticism, though wouldst have aggravated thy voice so as to roar us as gently as any sucking dove; thou wouldst roar us an 'twere any nightingale. Farewell, Bottom, the editorial weaver, the weaver of engineering fustian, farewell!

AMERICAN BRIDGES.—New York and Brooklyn are separated by an arm of the sea called rather inappropriately East River. The daily circulation between New York and Brooklyn is, nevertheless, about 250,000; it is effected by means of steam ferries in a tolerably regular manner during ordinary weather, but during the winter it is subject to numerous delays, and is not without danger in consequence of fogs and ice. Grave accidents, the constant increase of the population, and the desire to overcome obstacles with the least possible loss of time, have caused the idea to be conceived of establishing one or more bridges between the two towns; and during its last session the legislature of the State of New York approved the statutes of two companies, each of which proposes to construct a bridge between New York and Brooklyn. One of these bridges will unite New York to Williamsburg or Astoria; as an intermediate pier will be placed upon the island of Blackwell, the works are not expected to present extraordinary difficulties. The other bridge, in which the art of the engineer will be really called upon to display all its power, will unite New York to Brooklyn properly so called. This immense work will involve in its realization entirely new questions. It will be a suspension bridge 1600 ft. in length, and it will be one of the boldest works of its kind in the United States. The engineer engaged is Mr. J. A. Roebling, of Trenton, under whom the Niagara and Cincinnati suspension bridges (of the respective lengths of 821 ft. and 1057 ft.) were constructed.

GOOD GRACIOUS!—A gigantic engineering project is now the sensation out West, which contemplates nothing less than tunnelling the Atlantic for a railway. The plans are already supposed to be drawn up, complete in detail, even to lighting the cars with the magnesium and electric lights. The undertaking is to employ one hundred thousand men for thirty years, and when completed it will take the trains but five days to complete the journey from Newfoundland to Ireland, via the telegraph route. The amount of capital required to carry out this project is estimated at two billion five hundred million dollars. *Scientific American*. [We are informed, upon good authority, that this is the line for which Mr. Rumble's powerful express engines were designed. The time occupied on the journey being five days, the average speed of the trains will work out about 15 knots per hour.—ED. E.]

SHEFFIELD.—Although the state of business at Sheffield is still somewhat dull, there is a good demand for most descriptions of railway plant, such as springs, axles, tyres, and rails. This demand principally proceeds from American and Continental orders, the home demand for railway matériel not being large.

LOCOMOTIVES AT THE PARIS EXHIBITION.

We give, on the next page, eight diagrams of locomotive engines at the Paris Exhibition, these diagrams forming a continuation of the series which we gave in our last volume, on pages 308 and 309. The engines shown on the next page are as follows: Fig. 1 is a six-coupled engine, constructed by the Société du Matériel Belge, for the Grand Luxembourg Railway; Fig. 2 is a six-coupled engine built by the Southern Railway Company of France for their own line; Fig. 3 is the locomotive America, which we have fully described on another page; Fig. 4 is a four-coupled outside-cylinder engine, constructed by Emile Kessler, of Esslingen, for the East Indian Railway; Fig. 5 is a four-wheeled tank engine by Krauss, of Munich, the structural peculiarities of which we described in an article on page 433 of our last volume; Fig. 6 is the express engine constructed by Messrs. Robert Stephenson and Co., of Newcastle-on-Tyne, for the Egyptian State Railways; Fig. 7 is the express engine exhibited by the Lilleshall Company; and Fig. 8 is a six-coupled engine from Carlsruhe.

The engine for the Grand Luxembourg Railway, constructed by the Société du Matériel Belge, of whose works M. Eyraud is the manager, is an ordinary six-coupled engine with inside

cylinders and outside frames. The trailing axle is placed beneath the firebox, and the latter is fitted with an inclined grate on Belpaire's system. The engine of the Southern Railway Company is the first entirely constructed at their works at Bordeaux, which works are under the direction of M. Laurent. The engine has outside cylinders, and it is intended for working mixed trains, or trains of passengers and goods combined, on the branch lines of the company. It has been designed so that it can, if necessary, be mounted on smaller wheels, 4 ft. 3 in. in diameter, and employed for working main-line goods traffic. The boiler is of steel, and the firebox is fitted with no special smoke-burning appliances, as, when the mixed trains are being worked good Welsh coal from Cardiff is used. When running goods, the coal used is that obtained in the Southern Railway district, a coal which burns freely in an ordinary grate, and has no fault except that it is very smoky. The smoke, however, is not objected to on the Southern Railway when it comes from goods engines.

Stephenson's, the Lilleshall Company's, and Krauss's engines have already been described in *ENGINEERING*, and of the American engine an account appears on another page of the present number. The principal dimensions of the engines, shown by Figs. 1, 2, 4, 5, 6, and 7, are given in the following Table:

No. of figure	1	2	4	5	6	7
Name of the maker	Société du Matériel Belge.	Chemin de Fer du Midi.	Kessler.	Krauss.	Stephenson.	Lilleshall Company.
Cylinders, diameter	17½ in.	17½ in.	16 in.	14 in.	16 in.	16 in.
" stroke	25 in.	25 in.	22 in.	22 in.	22 in.	21 in.
" distance apart from centre to centre	5 ft. 10½ in.	4 ft. 10 in.	...	...	2 ft. 6 in.	...
Grate, length	5 ft. 10½ in.	3 ft. 7½ in.	...	...	4 ft.	...
" width	21 sq. ft.	16 sq. ft.	19 sq. ft.	11 sq. ft.	3 ft. 6 in.	...
" area	21 sq. ft.	16 sq. ft.	19 sq. ft.	11 sq. ft.	14 sq. ft.	18½ sq. ft.
Height of the top-plate of the firebox above the grate:						
At the front	...	5 ft.	4 ft. 3 in.	...	4 ft. 11 in.	...
At the back	...	5 ft.	4 ft. 3 in.	...	4 ft. 11 in.	...
Tubes, number	200	223	162	160	161	186
" outside diameter	2 in.	1½ in.	1½ in.	1½ in.	2 in.	1½ in.
" length	11 ft. 10 in.	14 ft. 4 in.	11 ft.	10 ft.	11 ft. 4 in.	11 ft. 2 in.
Heating surface:						
" firebox	104 sq. ft.	93 sq. ft.	102 sq. ft.	...	83 sq. ft.	112½ sq. ft.
" tubes (outside)	1238 sq. ft.	1594 sq. ft.	1048½ sq. ft.	786 sq. ft.	955 sq. ft.	1009 sq. ft.
" total	1342 sq. ft.	1687 sq. ft.	1150½ sq. ft.	...	1038 sq. ft.	1121½ sq. ft.
Diameter of barrel of boiler	4 ft. 4 in.	...	...	...	...	4 ft. 3 in.
Pressure of steam in the boiler	118 lb.	118 lb.	120 lb.	...	...	...
Diameter of wheels:						
Leading wheel	4 ft. 9 in.	5 ft. 3 in.	3 ft. 6 in.	5 ft.	3 ft. 9 in.	4 ft. 3 in.
Driving " "	4 ft. 9 in.	5 ft. 3 in.	5 ft. 6 in.	5 ft.	6 ft. 6 in.	7 ft.
Trailing " "	4 ft. 9 in.	5 ft. 3 in.	5 ft. 6 in.	...	3 ft. 9 in.	4 ft. 3 in.
Wheel base	13 ft. 5½ in.	11 ft. 6 in.	15 ft. 4 in.	...	15 ft. 8 in.	16 ft. 6 in.
Height of centre line of boiler above rails	...	...	...	...	6 ft. 8 in.	...
Weight of the engine, empty	31½ tons	30½ tons	29 tns 12 cwt.	...	27 tons	27 tns. 11 cwt.
" " full	...	...	...	...	...	...
" on leading wheels	12 tons	11 tns. 4 cwt.	11 tns. 12 cwt.	9 tons	9½ tons	10 tns. 10 cwt.
" on driving " "	12 tons	12 tns. 10 cwt.	10 tns. 8 cwt.	9 tons	18½ tons	12 tns. 13 cwt.
" on trailing " "	11½ tons	11 tns. 0 cwt.	10 tns. 8 cwt.	...	7 tons	8 tns. 7 cwt.
" total	35½ tons	34 tns. 14 cwt.	32 tns. 8 cwt.	18 tons	30 tons	31 tns. 10 cwt.
Weight available for adhesion	35½ tons	34 tns. 14 cwt.	20 tns. 16 cwt.	18 tons	13½ tons	12 tns. 13 cwt.

RAILWAY IRON.—Although the Great Northern rail contract alluded to in our last report did not go to Wales, but to the North of England, and although some Russian and other orders also passed this district, and shipments have somewhat fallen off, nevertheless prices do not recede, and have continued firm throughout a dull month. The 10,000 tons Dutch Government rails to be tendered for on the 1st August are expected to come into this or the North of England market, as the specification is not framed to suit the Belgian works, who moreover expect to secure the Belgian State rails, of which specifications will shortly be published. Several second-hand and unused rails have been taken off the market this month, though enough still remain to confuse quotations, ordinary specifications of good make are quoted 5½, 15s. to 6½, per ton, 6½, 5s. having been paid for various small purchases of sections requiring new rolls. Exports have fallen off as compared with the preceding three months, but are still over 20,000 tons of rails alone.—*Messrs. W. Bird and Co.'s Monthly Circular*.

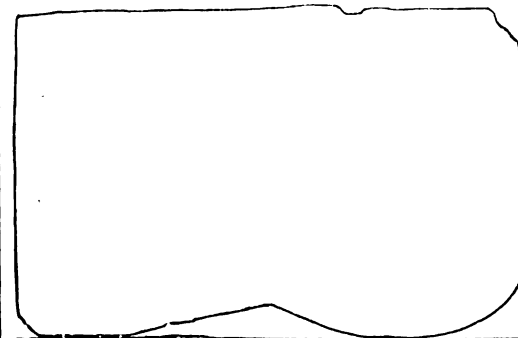
A PROPOSED NEW STEAM PLOUGHING COMPANY.—On Wednesday last a meeting of gentlemen interested in steam cultivation was held at the Angel Hotel, at Bury St. Edmund's, for the purpose of considering the advisability of either establishing a local steam-ploughing company, or subscribing to the proposed National Steam Cultivation Company (Limited) a sum sufficient to entitle the district of Bury St. Edmund's to one or two pairs of engines, to work constantly for hire in the district at a charge per acre, on the basis of the Herefordshire Company's charges, viz., 1s. per inch in depth per acre. The proposition of establishing an independent local company was that which was accepted by the meeting and ultimately a committee of twenty influential gentlemen was appointed with a view of further proceedings. At the request of Major Fuller, M. Wilson, who occupied the chair at the meeting, and some other gentlemen, Mr. J. Phillips Smith, of the Herefordshire Steam Ploughing Company, explained the manner in which the working of that company is carried on, and the Bury Company will probably avail themselves of the results of his experience.

AMERICAN RAILWAYS.—The General Assembly of Virginia has passed an act which constitutes the Chesapeake and Ohio Railway Company, formed by the consolidation of the Covington and Ohio, the Virginia Central, the Southside, and the Norfolk and Petersburg companies. Steps are being taken to secure the completion of the Covington and Ohio line, 224 miles in length. The new Chesapeake and Ohio undertaking is expected to prove a valuable one on the completion of the Pacific Railway.

BESSEMER STEEL.—We have never known trade so dull in these branches as during the past month, and even the Bessemer Steel Works are now in want of new orders. In some in-

stances foreign makes are formidable competitors to our Bessemer Works, whose prices are now so low that the patent right amounts to a very high percentage on rails and on axles. The present approximate capability of Bessemer works in Germany is given as 78,000 tons per annum for Prussia, and 33,000 tons per annum for Austria.—*Messrs. W. Bird and Co.'s Monthly Circular*.

AMERICAN LOCOMOTIVES.—We give below the indicator diagram referred to in our account of the locomotive engine "America," on the 66th page of the present number. The diagram was taken from an engine having 18 in. cylinders, carrying 180 lb. steam nearly to the end of the stroke, and both exhausting into a single exhaust-pipe with a nozzle 3½ in. in diameter.



BLAST FURNACES.—The *Pall Mall Gazette* has announced, as a new discovery, the appropriation of gas-tops and pipes to Lord Granville's furnaces at Hanley—the works of the Skelton Bar Iron Company. This common-sense means of economising fuel may, indeed, be new in Staffordshire, but it has long been known elsewhere.

THE NORTHERN RAILWAY OF FRANCE.—The Northern Railway Company of France have received from Messrs. Cail and Co. the thirty-six coupled engines of the class of which they exhibit an example in the Paris Exhibition; and ten of these engines are now employed in working express traffic between Amiens and Calais. On the 11th inst., the Sultan's special train, consisting of fifteen vehicles, which was worked by two of Crampton's engines from Paris to Amiens, was easily taken by one of the new coupled engines from Amiens to Boulogne.

LOCOMOTIVES AT THE PARIS EXHIBITION.

(For Description, see preceding Page.)

FIG.1.

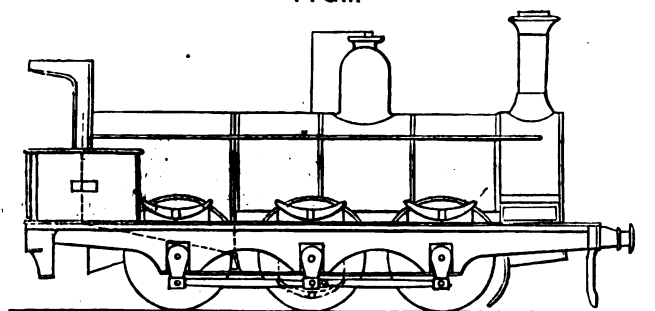


FIG.2

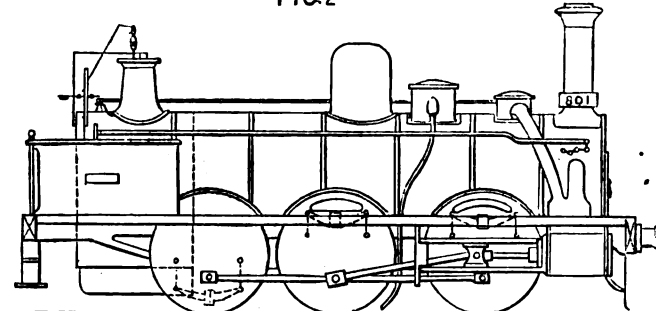


FIG.3.

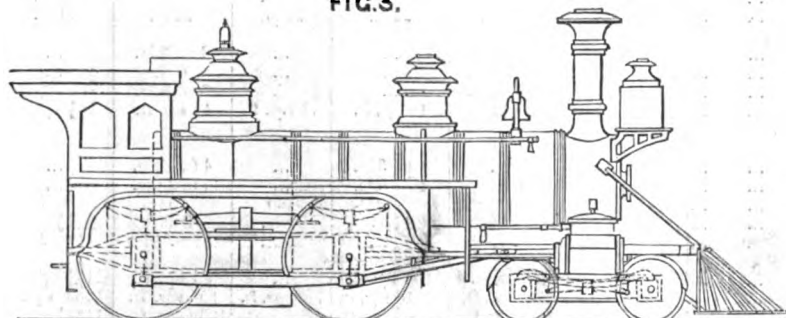


FIG.4.

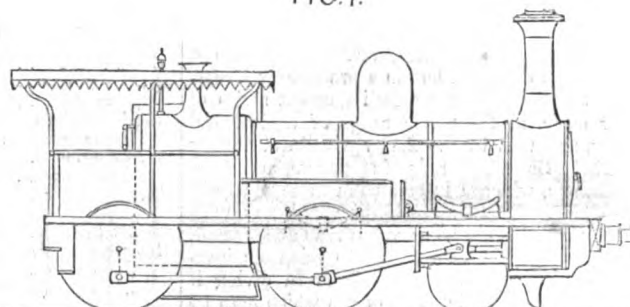


FIG.5

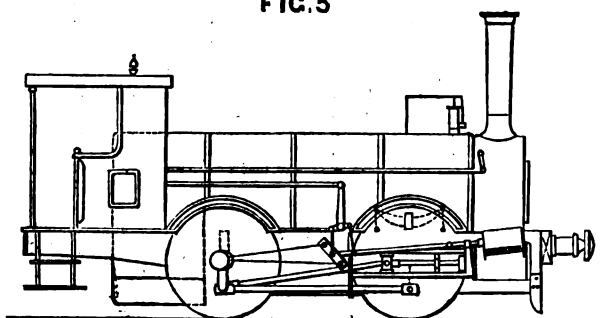


FIG.6.

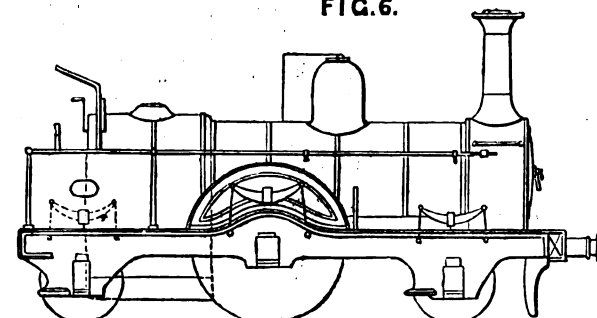


FIG.7.

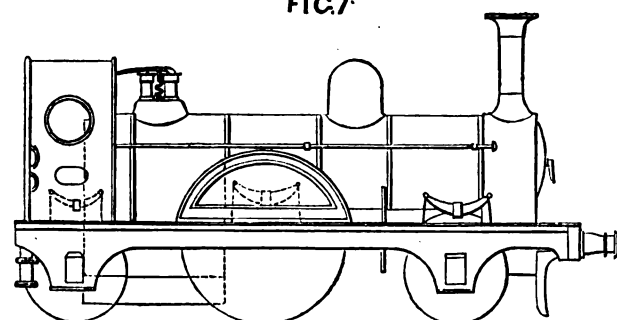
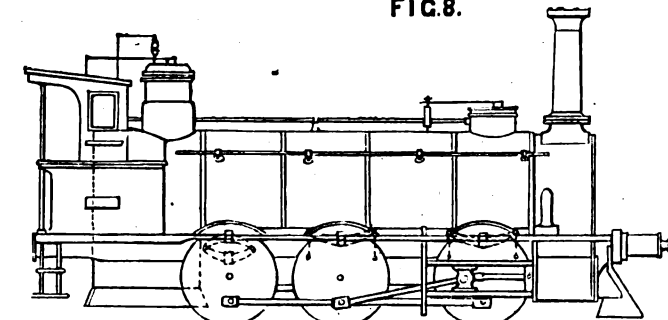


FIG.8.



GREAT BRIDGE IN HOLLAND.—A German contractor (Herr Harkort) has undertaken the construction of a great iron bridge from Waal to Bommel, in Holland. The amount of the contract is 106,370*l*.

THE IRON TRADE.—The festivities of the past month have assisted to retard improvement in the iron trade; but the depression is no longer so general, the make in all quarters, both home and foreign, continuing on a reduced scale. Various changes are mooted for the purpose of restoring the credit of our railway administration; but to the trade it becomes clear that new lines and extensions cannot be expected for some time, and thus home demand in this direction must continue limited. Whilst many here are clamorous for Government administration of railways, the Imperial Russian Government has been intent upon disembarassing itself of the burden, and has already made a provisional sale of two important lines. The replacement of iron by steel will produce great changes later on; but our markets will not be affected or disturbed by this so soon as many correspondents would appear from their inquiries to suppose.—*Messrs. W. Bird and Co.'s Monthly Circular.*

HOWARD'S SAFETY-BOILER.—Messrs. James and Frederick Howard, of Bedford, have lately supplied a 50-horse boiler, upon their lately patented and already well tested plan, to Messrs. James Cross and Co., the well-known engineers of St. Helen's. Messrs. Cross and Co. have erected it at the chemical works of Messrs. Hutchinson and Co., of Widnes, where it is now working satisfactorily. Messrs. Howards have upwards of twenty of these boilers on order, among them one for Messrs. Clayton, Shuttleworth and Co., of the Stamp End Works, Lincoln, where it will be subjected to a thorough series of trials before being put to work.

RAILWAYS IN PRUSSIA.—The length of railway in operation in Prussia at the close of 1866 was 5762½ miles, the capital expended having been 90,000,000*l*. The lines worked by the State represent about one-fourth of the whole network constructed; lines belonging to companies, but under the management of the State, another fourth; and lines belonging to companies, and administered by them, the remainder. In 1865, the return realised on the capital employed averaged rather more than 8 per cent.

THE COTTON TRADE.—The average weekly deliveries of cotton from Liverpool to the trade have amounted (to July 12), this year, to 43,520 bales, as compared with 45,440 tons in the corresponding period of 1866, and 82,870 in the corresponding period of 1865. The average of 1866 was 45,460 bales. The average weekly consumption of cotton in the United Kingdom in 1866 was 46,850 bales, as compared with 39,130 bales in 1865.

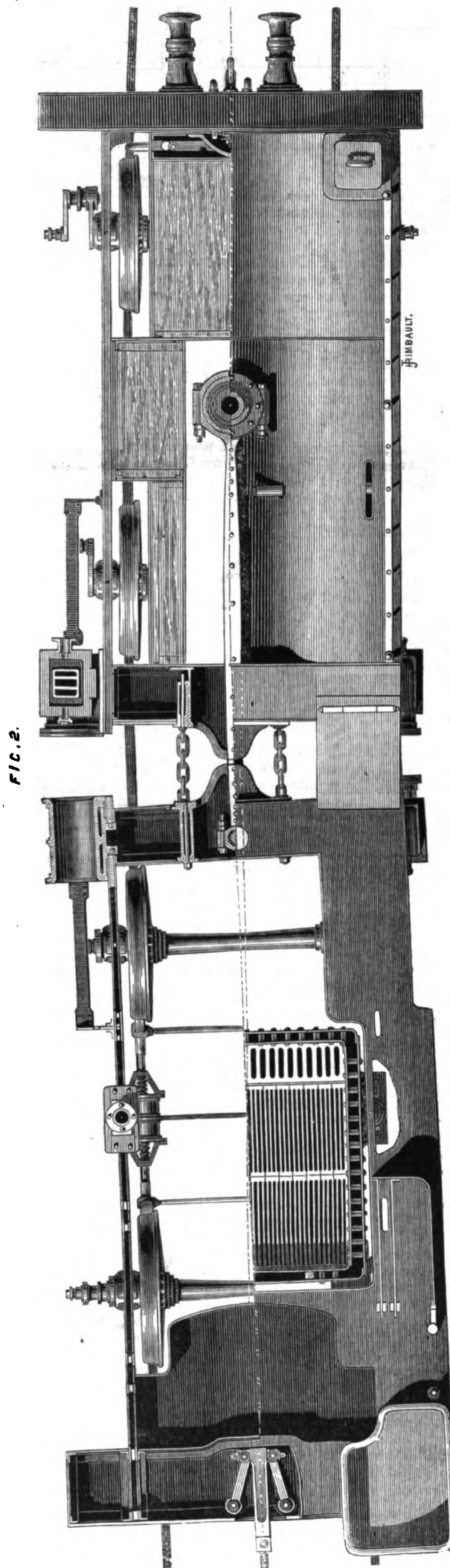
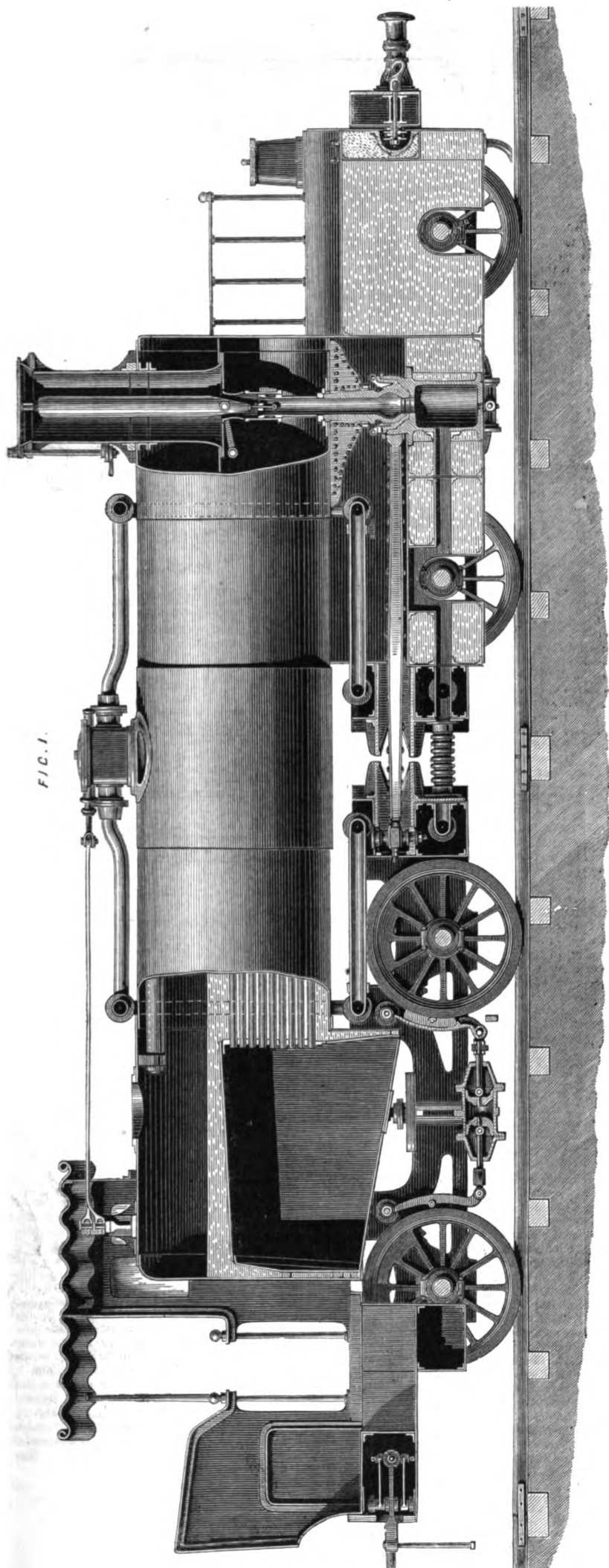
MR. DAVID METHVEN.—We regret to record the death, last week, of Mr. David Methven, engineer of the Battle Bridge works of the Imperial Gas Company, the largest gasworks probably in the world. Mr. Methven had filled his post for many years, and thus enjoyed an eminence in his profession which no amount of service in smaller works would have given him.

THE CLEVELAND IRON TRADE.—In manufactured iron, the mills and forges of the north-eastern district are at present fairly occupied with orders. The shipbuilding trade has slightly improved, and plate manufacturers are consequently in somewhat better spirits. The pig iron trade has not experienced much change; stocks at the end of June were somewhat less than they were at Christmas.

DESIGN OF LOCOMOTIVE FOR HEAVY GRADIENTS AND SHARP CURVES.

MM. J. J. AND ADOLPHE MEYER, ENGINEERS, MULHOUSE.

(For Description, see Page 76.)



HIGH-SPEED PORTABLE ENGINES.

MESSRS. NALDER AND NALDER'S engine, at the late show at Bury St. Edmund's, was intended to run at 220 revolutions per minute, its single cylinder being 8 in. in diameter, and the stroke of piston 12 in. Its actual speed on the first series of trials was 212½ revolutions; and on the second, with 50 per cent. more load, the speed was, a little curiously, much higher, viz., 250 revolutions for most of the time, the average being 249.7. Yet it will be said that no economy of fuel attended these speeds, the consumption of coal being 7.69 lb. per hour for each horse power of work on the brake in the first trial, and 6.8 lb. in the second. Fourteen other single-cylinder engines, worked with less coal in the first series of trials, and eleven worked with less in the second series, the whole number tried being respectively but nineteen and thirteen. But high speed *per se* cannot be said to be a reason for a wasteful expenditure of coal. Yet we shall presently show that, under the regulations of the Royal Agricultural Society, a high nominal speed is actually made to tell, and that most heavily, against an engine, and we wonder that Messrs. Nalder ever ventured to damage the cause of high-piston speed, to which they appear to have committed themselves, by entering upon a competitive trial under such regulations. We have often expressed our conviction of the advantages to be derived in portable-engine practice, as has been derived with nearly all other classes of steam-engines, fixed, marine, and locomotive, from a higher speed of piston; and we feel a strong regret, for the sake of a principle, that it should have been embraced under such disadvantageous circumstances, and even by engineers who appear, indeed, to have been hardly competent to deal with it; for Nalder's engine had none of the special provisions for saving fuel, so common in other engines, or at least in trial engines. It had no steam jacket to its cylinder, no feed-water heater, and instead of cutting off, like other single-cylinder trial engines, at from one-third to even one-fifth stroke, the steam was cut off as late as one-half.

By the conditions of trial, all engines competing for prizes are tied down to their exact nominal power, and this calculated only from the diameter of the cylinder wholly irrespective of the speed of the piston, being 1 horse power for every 10 circular inches of a single cylinder, or 9 circular inches of the combined area of double cylinders. When the engine goes to the brake, its allotted load is of course inversely as its nominal speed, and the slower the speed for which the engine is entered, the greater the load, and thus the greater the mean cylinder pressure permissible. In Nalder's case, however, the entered or nominal speed, 440 ft. of piston per minute, was allotted a correspondingly small load, a load so light that, by calculation, we find but 9.6 lb. mean effective pressure was obtainable upon the piston in addition to that required to overcome the friction of the engine, or possibly 12 lb. or 12½ lb. including the engine friction. Now to work an engine with 50 lb. steam, cut off at half stroke, to but 12 lb. or 12½ lb. mean cylinder pressure implies, of course, very great waste, more than half of all the steam used being wasted in atmospheric resistance, and in whatever back pressure may accumulate above that resistance. From this cause it is not too much to estimate that of all the steam which went through Nalder's engine more than half was pumped to waste by the piston and sent up the chimney.

So, too, single-cylinder engines, no matter how strongly built, are worked only to 50 lb. on trial, while double-cylinder engines, on the mere presumption that they are more strongly built, are allowed 80 lb. Such an engine as Nalder's should be worked with at least 80 lb. of steam, cut off at one-fifth at most, and this should give about 30 lb. of mean effective cylinder pressure, which is, indeed, about what the boiler would, at this rate of expansion, supply steam for. Under such circumstances, the little 8-inch cylinder would at 220 revolutions, give out 20 indicated horse power, although rated at but 6.4. And with good firing and every precaution to save heat, there is no reason why such an engine should not work at a very low rate of consumption of fuel, lower, certainly, than that of engines worked at a considerably slower speed.

It is but simple justice to Nalder's engine to say that its working, in respect of smoothness of motion, was admirable, and that it thus gave abundant proof that its makers were good mechanics, notwithstanding that they have not shown themselves fully up to all the conditions necessary to economy in high-speed engines. We shall soon illustrate some of its special features, some of which are especially ingenious.

THE CINCINNATI SUSPENSION BRIDGE.

(Continued from p. 49.)

On the 29th of November the last course of timber was secured in the Cincinnati foundation and levelled off for the reception of the first course of masonry. So far we had been favoured by the low state of the river to an unprecedented extent. But it would have been hazardous to expect a further continuance of low water. The season had now arrived when a sudden rise of 10 ft. to 20 ft. is but the result of one week's steady rain. Materials had therefore been prepared for strong timber caissons, 20 ft. high, secured upon the top course of the foundation, well braced, and embanked all around. The planks were all jointed and caulked, and so was the floor of the foundation. Thus prepared, a rise of 20 ft. could not interrupt the work. The fore part of December was mild, and we succeeded in laying down a few courses of masonry, enough of weight to secure the foundations and the caissons in such manner that they would resist the action of winter floods and the breaking up of the ice in the spring.

As the first 25 ft. of masonry are most exposed to the action of the current, it was concluded to face them with a good quality of limestone, in place of sandstone. This material was obtained from the Ohio and Indiana quarries; we also procured as samples a few boat-loads of shell marble from the quarries below Madison. This latter stone is the finest and most durable building material in the Ohio valley; it is equal to the best quality of granite. No arrangements, however, could be effected at the time to secure a full supply of this beautiful stone. If it could have been obtained in season, we should have faced the whole masonry below the floor with this material.

About 60,000 perches of masonry in all were to be built. No extensive quarries for the supply of such a large quantity of suitable material, at short notice, were located within the immediate vicinity of the bridge. Owing to the seamy nature of most of the limestone beds in the Ohio Valley, no large supply of heavy dimension blocks, measuring from 30 to 60 cubic feet, could be obtained at reasonable rates. It was therefore less a matter of choice, than of necessity, to employ the sandstone from the Buena Vista Quarries, located about eighty miles above, on the banks of the Ohio river. This stone is not equal to the old red sandstone in durability, nor is it as strong as the coarse-grained sandstone on the western slopes of the Alleghenies, found above the coal measure, but still its quality entitles it, both in point of strength, as well as durability, to be ranked as a first-class material.

With the exception of the upper offsets, which are faced with limestone, the Buena Vista Quarries have supplied all the dimension blocks above the limestone base. Large quantities of limestone from the North Vernon Quarries, in Indiana, have been used for backing, and generally of large dimensions, frequently measuring 60 cubic feet. Our machinery being of the heaviest description, and well arranged for the easy handling and rapid raising of heavy masses, these large and well-bedded blocks not only greatly added to the strength of the masonry, but they also proved more economical than stones of smaller dimensions.

All the blocks, for facing as well as backing, were laid in a heavy bed of cement mortar, mixed with enough of lime to prevent rapid setting; the joints were filled with thin grout first, and then with clean gravel and broken stones, rammed down with crowbars. I have always favoured the use of strong lime as an admixture to the cement, more or less, according to the season, for the purpose of preventing too rapid setting. Experience has fully confirmed this practice. Not only is there economy in this, but a decided improvement in the strength of the mortar, particularly in warm weather, when evaporation takes place so rapidly. Of course the masonry should be kept moist all the time, and no mortar spread without watering first. I mention this matter here because there is an opinion prevailing that an admixture of lime will spoil the cement.

The solidity and strength of our masonry was well tested on the Cincinnati tower during the interval from 1857, when the work stopped, to 1863, when it was resumed. The Covington tower had been carried up to a height of 75 ft., therefore above the reach of the highest floods. On the Cincinnati side, however, we stopped at 45 ft.—consequently this masonry was subject to overflows, and the top course had to resist the action of drift, of steamers, barges, and heavily loaded flat boats. On resuming operations, the excellence and strength of the masonry was proved by its unimpaired condition; not even a joint had washed out, and the whole top course presented an even and smooth floor.

As the appearance of the stone was made a secondary consideration in its selection, I preferred for the lower portions of the masonry the petroleum variety of the Buena Vista Quarries, because of their greater strength and impregnation with petroleum, which latter condition promised a greater resistance to the action of the water. This view seems to be borne out by experience so far, not only in the towers, but also throughout the city of Cincinnati, where the petroleum varieties are largely used for heavy pavements, flagging, and basements. The appearance of the lower masonry, however, has been somewhat injured by the oozing out of petroleum, and consequent blackening of its face.

The faces of the blocks below the floor are left rough, as they came out of the quarry, but with a heavy draft run around the margin. This feature gives the masonry a massive look, quite proper for the base of such a large structure. Above the floor the face is bushhammered, with a broad draft all around, and this finish appears to be in harmony with the architectural proportions which have been observed in this part of the tower.

Whenever the face of a Buena Vista stone is subjected to the action of the bushhammer, and to much tooling, the surface, after a few seasons of exposure, will be found loosened and scaly. This effect is to some extent observable above the floor, and also on the anchor masonry, but no trace of it can be discovered below the floor, where the rock face is left untouched. The same failure may be observed on some of the most highly finished fronts in the city of Cincinnati. But this fact need not cause any apprehensions whatever. All sandstones are sedimentary, because they have been formed by deposits, layer after layer, during long periods of time. Sandstone is composed of quartz sand cemented together, and its durability depends principally

upon the nature of the cementing material. Great durability is indicated by the chemical analysis of the Buena Vista stone, and this opinion receives additional force by the fact that it hardens by exposure to air and water. I am satisfied that the apparent lamination is solely a mechanical effect, caused by the action of the stonecutters' tools, and that no chemical action whatever is involved therein. The lamination does not extend below the effects of mechanical action. The observation of old masonry in the city of Cincinnati appears to justify this view of the case fully. I would not have spoken of this matter at such length, did I not consider it my duty to be frank, and to speak without reserve in this report.

At a low stage the base of the towers is out of water; and as all the wharf room is to be utilised, its surface is now in part, and will be entirely, paved over, so as to protect it from washing. In front of both towers a heavy rock-filling has been sunk. On the Covington side, the south channel of the river approaches very near the foot of the tower, and was left open to the scouring action of floods from 1857 to 1863. Now a comparison of the soundings, taken in 1856, with those of 1863, proves that this scouring effect has at no place extended to a greater depth than 12 ft. below low-water mark. It appears that the compact gravel found at this depth resists further action. All that is therefore needed to secure the future safety of the foundations is to maintain the heavy Rip Rapping in front of the towers. On the Covington side this Rip Rap extends nearly 100 ft. into the river, shelving off. One flat boat, filled with stone, was sunk at the lower end, and the whole is well tied together by strong crib work. A few boat-loads of heavy blocks of lime and sand stone have also been interspersed with the smaller limestone.

The stone filling on the Covington side, rising up to near low watermark, forms a very good base for the erection of a first-rate low-water wharf for the commerce of the city of Covington. A good timber wharf, extending out 100 ft., may be erected at a cost of not exceeding \$2000, which will permit the loading and unloading of large-class steamers at the lowest stage.

The most prominent features of the towers are the arches, 75 ft. high above the floor, by 30 ft. wide. The roadway passes through without any contraction, but the sidewalks, for a distance of 20 ft., suffer a reduction from 7 ft. to 4 ft. This is compensated for by a walk outside of the masonry, which is supported by the projecting cornice, and protected by a railing. As this bridge promises to be a great resort for strangers and pedestrians generally, these outside walks around the towers will be an additional attraction. The stability of the arches, which are semicircular, is insured by the massive proportions of their shafts, which serve as abutments. On top a series of heavy anchor bars, extending from centre to centre of shaft, have also been walled in. The masonry above the arch is not one solid mass, but divided by two open spaces, each 4 ft. wide and 30 ft. long, which are again closed by the last three courses, which form the roofing and coping of the tower. An open passage is also provided, which leads to the top. The ornamental turrets, which are in process of construction, together with the balustrades around the upper and lower cornices, will finish the architectural appearance of the towers. Their total elevation will then be 230 ft. above low-water mark, or 242 ft. above the first course of timber in the Cincinnati foundation.

Those who have not witnessed the progress of the work will be curious to learn what kind of machinery was employed for the elevation of such masses of material, and to such a great height. As was mentioned before, two efficient steam-engines had been erected, one on each side of the river, for the supply of power. Animal power would have been inefficient. Four hoisting barrels, worked by friction-clutches, were connected with each engine. At first it was contemplated to do the raising and setting by masted derricks, secured in their positions by wire rope guys. The Covington tower was thus carried up 75 ft. A different plan, however, had been devised for the masonry above the floor, and a great portion of this machinery had already been ordered and made in 1857.

On this plan all the materials were raised by means of a wire rope of 1½ in. diameter, winding upon a cast-iron drum of 3 ft. diameter, the rope plying in spiral grooves, to save wear. Parallel to the masonry, a strong vertical framework was erected for the support of the hoisting sheave, tracks, and trucks. Each block of stone thus rapidly raised was placed upon a truck and run either right or left to one of the setting derricks. The latter were balanced by traversing weights, and so constructed that they were absolutely safe, no matter how high they rose. The framing of such a derrick consisted of a sound white oak log, 20 in. in diameter and 38 ft. long, which served as mast, and had two booms attached, about 20 ft. above the lower end. Half-way down from this point, two cast-iron turn-tables, 6 ft. in diameter, supported by and revolving on cones, encompassed the mast, and thus allowed of an easy circular motion around the centre. The lower end of the mast served as a tail, confined in a well-hole of 3 ft. diameter, which was left open in the masonry, and thus effectually prevented any tilting of the machine. In all other respect fully equipped for handling and setting, these four safety derricks in connexion with the steam drums have accomplished a task which, without these means, would not only have consumed a great deal more time, but would also have been attended with a much greater cost and a great deal of risk. With these great facilities, however, the cost of laying the upper masonry has exceeded that of the lower but a small fraction; the difference was only in the amount of steam consumed. Towers of 1000 ft. elevation may be raised nearly as cheap per perch as those of 100 ft., and with equal safety.

For the support of the cables and saddles, cast-iron bed-plates 11 ft. long and 8 ft. wide, are carefully bedded in the upper courses. Care has been taken to spread their weight upon a large section of the masonry below, by blocks of large dimensions, and by good bonding. By the inclination and cradling of the cables, their pressure is directed inside towards the arch. By this arrangement the stability of the towers is greatly increased.

Under any circumstances I feel satisfied that the strength of the towers will be found adequate to resist even the forces of a great hurricane.

Anchorage.

The general plan of anchorage which I designed for this bridge

does not materially vary from the plan I have, during the last twenty-three years, successfully pursued on other works. In the autumn of 1844 I put down the anchorage of the suspension aqueduct I had contracted for over the Alleghany river at Pittsburgh, in place of the old timber structure, which threatened to fall down. The Pennsylvania canal, with its basins, was subsequently abandoned in that vicinity, and in consequence the aqueduct was taken down and removed in the year 1861 to 1862, after having rendered service for seventeen years. The cables, 7 in. diameter, were attached to anchor chains, in a manner similar to the mode pursued on the Cincinnati bridge. The chains curved over masonry, which brought the lowest link to a vertical position. Now these chains, together with the anchor plates, had been thoroughly imbedded in cement grout. But as during nine months in the year the canal and aqueduct was full of water, it was impossible to keep the anchor walls in a dry condition; they were always damp. But I trusted to the physical and mechanical protection afforded by the cement, which formed a solid body around the chains, closely embedding them.

Previous experiments, carried on for years in various localities, had satisfied me that faithful grouting with cement was the surest method to exclude air from the surface of the bars, and that oxidation could not take place. No dislocation or disturbance of the chains being possible, I had no reason to doubt success. An actual experience of seventeen years, and on a large scale, and under the most unfavourable circumstances, has fully demonstrated the correctness of my views. On removal of the chains, down to the plates, every bar, as well as pin, was found to be perfectly preserved. The cement had throughout taken a firm hold of the paint, and when removed with a chisel the coat of paint came off with the cement, leaving the iron as clean and bright as it was on the day it was put in. Coating the bars with zinc may be advisable, but I recommend in all cases a thorough grouting as the safest mode of protection. The chains of the Alleghany suspension bridge are embedded in asphaltum and then grouted. I adopted this plan because the lowest links on the Pittsburgh side were placed below low-water mark.

The remarkable efficiency of cement as a protection against oxidation has often surprised me, and I have had the impression for years that it was to some extent due to some mysterious and unknown or unexplained chemical action. But it appears that chemistry does not admit of any such action; and if this is so, then the protection is exclusively physical or mechanical in its nature.

By the method usually practised heretofore, anchor chains or cables, so far as they extend below ground, are rendered accessible by means of passages left open all around, down to the anchor plates. The air in such vaults being always damp, a great deal of vigilance and care is necessary to prevent oxidation. My plan is entirely free from this objection. Once embedded in grout, the anchorage needs no further protection. Every year will add to the firmness of the cement and to its adherence to the iron. But the fact that the chains are out of sight and out of reach may be considered a great objection, inasmuch as future generations, not willing to trust to the preserving quality of cement, may be anxious to examine for themselves, and with their own eyes, the condition of the metal. I reply to this objection, that after a quarter of a century or so, whenever serious doubts of this kind should be entertained, a portion of the upper masonry may be removed to an extent sufficient to examine the connection of the cables and chains. A satisfactory inspection having been made, the masonry may then be replaced and freshly grouted. Confidence being restored, the public will be satisfied for another generation, when the same process may be repeated.

The anchor walls above the floor form two parallel walls, each 75 ft. long, 12 ft. wide, and 25 ft. high. They enclose the roadway, leaving the space of 24 ft. in the clear. The distance between the cables is 36 ft. from centre to centre. On the summit of the tower, their distance apart is 50 ft. Their tendency to spread is met by connecting cables near the anchor walls, and by the inclined action of the suspenders. The cables being composed of seven smaller cables or strands, six around a centre, the last link of the anchor chain is spread out in two parts; the lower one connecting with four strands, the upper one with three. Each wire strand is manufactured upon a double shoe and held by a pin of 4 in. diameter. The adjustment of the strands was effected by segments.

Each chain is composed of nine links, of an aggregate length of 92 ft. The lower links consist of fourteen and fifteen bars, alternately, each bar 10 ft. long from centre to centre of eye, 9 in. wide and 1½ in. thick, making a solid section of 12 square inches. The eighth and ninth links are formed of seventeen bars, with an aggregate section of 190 square inches, while the lowest link has a section of only 168 square inches. The upper link is the proper measure of the strength of the chain. As the chain curves over the masonry, a portion of its tension is converted into pressure by the knuckles resting upon plates, which are supported by large and solid blocks of limestone.

A contract was concluded with the firm of Mr. Charles A. Wolf, for the manufacture of these bars. Each bar was hammered without a weld out of one pile, large enough in section to form a solid head, ample allowance being made for clipping. As the quality of this iron was of great importance, previous experiments were made with a view to obtain the greatest possible strength, and I am satisfied that this has been accomplished. The material of which they are manufactured forms a mixture of three-fourths of cold blast charcoal Merrimack pig from Missouri, and one-fourth of superior cold blast charcoal Tennessee pig. The Merrimack is noted as the strongest iron in the west. From the numerous tests which I have made with this mixture in various shapes, I should feel warranted to estimate the average strength of the bars at 60,000 lb. per square inch. I have, however, only allowed 50,000 lb., or 25 tons neat. The section of the link which connects with the cable being 190 square inches, its strength is therefore equal to $190 \times 25 = 4750$ tons. As will be shown hereafter, the ultimate strength of each cable is 4212 tons, therefore less than that of the chain.

Those who have experience in the construction of massive chains will be aware of the difficulty to obtain a perfectly even tension of all the bars which compose a link. Apparently this

looks like a small matter, but it is in reality one of the most difficult tasks which an experienced machinist may have to accomplish. It is a more delicate operation than boring out a large cylinder or cannon perfectly true. I flatter myself that the method pursued in this case has given a result, if not perfect, very nearly so. My long previous experiences in such matters have made me fully alive to these difficulties, therefore no pains have been spared to accomplish this task satisfactorily. The drilling of these bars, besides a great deal of other machine work and casting, was done in Mr. Miles Greenwood's foundry. The last adjustment of the links, however, was effected in the company's own shop, under my personal supervision.

By the curvature of the chains the two lowest links are brought into a vertical position, and are attached to massive anchor plates, cast of a superior quality of cold-blast charcoal metal. These plates are of an elliptical shape, one axis measuring 17 ft., the other 14 ft., but radiating in form, like a spoke wheel without rim, which arrangement leaves the extremities free in their contraction while cooling. Leaving the castings for one week in their moulds well covered up, made them as free from strains as is possible with such heavy and irregular shapes. These and some other heavy pieces were manufactured at the Niles Works; the metal was melted in a reverberatory furnace.

Both anchorages being laid above low water, no rock could be found available for that purpose. Solid rock, when at a convenient depth, furnishes an effective mode of anchorage. But, in most localities, this part of the work has to be formed artificially. All that is wanted is sufficient weight to resist a maximum tension. If the total resistance of the anchor masonry is equal to the breaking strain of the chains, the anchorage may be considered safe under all conditions.

The anchor walls on the Cincinnati side are 104 ft. deep, with a front of 58 ft. on Water-street. The body of masonry, which may be considered as resting immediately upon the two anchor plates, and including that portion above the floor which adds to its weight, may be estimated at 112,000 cubic feet. Most of the backing being composed of limestone, the average weight of this mass is 150 lb. per cubic foot, consequently the total weight $112,000 \times 150 = 16,800,000$ lb. = 8400 tons. The ultimate strength of the cables is 8424 tons; but this tension, when transferred to the lowest link, is, by the curvature of the chains, reduced one-third, which leaves 5616 tons as the greatest possible lift which the masonry has to resist. No allowance is here made for the additional resistance of the surrounding earth, but on the other hand there will be a reduction of weight in case of a high flood. The above considerations and calculations warrant the conclusion that the safety of the work has been amply provided for in its anchorage.

Cables.

The bridge floor is suspended to two cables. Each cable is composed of 5180 wires, No. 9 gauge, and forms a cylinder of 12½ in. in diameter. 18 ft. of this wire weigh 1 lb., and 60 wires have an aggregate metal section of one square inch. The deflection of the cables is 89 ft. at a medium temperature.

The wires composing the cables are laid parallel to each other, so that each single wire will occupy the same relative position throughout the whole length. It is easy to see the importance of this arrangement. A cable may contain a great number of wires, but if these wires do not all bear alike, each its appropriate share, their aggregate strength may be far below what it theoretically should be. In order now to insure an equal and uniform tension of the wires, their parallel position must be first secured. If the wires cross each other, or are tight at one place and slack at the other, their tension will not be uniform.

The uniformity of tension depends upon the uniformity of deflection, and this is coincident with parallelism. At first sight this appears easy to accomplish, but it is a task attended with numerous difficulties. The novice in cable-making will have to learn step by step, and when he thinks he has mastered the art, he will every now and then encounter new contingencies which will tax his ingenuity. Simple as are the principles involved in this process, its practice is by no means so simple. To produce an uniform tension throughout means to make every wire do its allotted duty.

Any attempt at the manufacture of a 12 in. cable in one process, no matter what its length, would result in a complete failure. It is simply impossible to do this. Any cable exceeding 5 in. in diameter must be made in parts, no matter whether the manufacture is undertaken across the river in situ, or on shore. I prefer to make all large cables in seven parts, or strands, as I call them, so arranged, that one occupies the centre, and is surrounded by the other six. I then proceed to make one strand at one time, and, when finished, place it in position.

The art of cable-making is of modern origin. The Brothers Seguin, French engineers, first undertook, in the early part of this century, to construct wire cables in the place of chains, for the suspension of bridge floors. A number of light structures were erected by them and others over the Rhone and other rivers of France. But owing to the light and frail character of these works, most of them have broken down or been destroyed by storms. M. Chaley, another distinguished French engineer, at the end of the first quarter of this century, erected the suspension bridge at Freiburg over the valley of the Sarine in Switzerland. This work, as the largest span in Europe, measuring 870 ft. between the towers, has for many years been an object of great engineering interest. But owing to the want of stiffness, and also of strength, its lifetime appears to be precarious.

By the practice of these engineers, a certain process for the construction of wire cables became established, and was considered the only method which would insure success, until by the erection of the suspension aqueduct over the Alleghany river at Pittsburgh, from 1844 to 1845, an opportunity was afforded to me to demonstrate on a large scale the practicability of another system, in all respects superior to the French. Previous to this undertaking, I had been engaged for years in experiments on wire ropes and cables. I had fully succeeded in the introduction of this manufacture into this country, and my ropes were then in successful operation on the inclines of the old Alleghany Portage in Pennsylvania, since abandoned, and on other planes. I was therefore well prepared to engage in a

work, which in its general plan, as well as in its execution, was considered by the profession in the light of a hazardous and unwarranted novelty. The success of that work, and of eight others, including the Niagara railway bridge, the Alleghany bridge, and the Cincinnati bridge, all constructed on my plans and under my personal direction, have fully established this new system of cable-making.

The object of these remarks is to gratify the desire of some professional men, and to explain, what I have never done before, the difference between the French system and mine. The principal feature of the French plan is to suspend the floor to a number of small cables. By my plan only two large cables are suspended, one on each side. The Cincinnati bridge is supported by two large cables, 12½ in. diameter. The cables in my bridges are always assisted by stays, and this feature is entirely wanting in the French system. The question now arises, what advantage is gained by one large cable over a number of small ones? Suppose the tension of the different wires is uniformly the same in both arrangements, and suppose both systems are caused to oscillate by a heavy gale, then the group of small cables is subject to the danger of a variableness in their individual motions. While some of them move up, others may swing down, and perfectly uniform resistance is then rendered impossible. If the small separate cables are united into one, no such variableness can exist. No matter to what oscillations the large cable may be exposed, they are always met by its united strength. In the divided system one cable may break after the other, because they cannot be expected to act in perfect unison. The correctness of this view was fully demonstrated by the catastrophe which overtook the Wheeling bridge on the 17th of May, 1864. This bridge forms a span of 1010 ft. from centre to centre of tower, the length of the floor is 960 ft.—its width was 24 ft., supported by twelve cables, six on each side, with an aggregate number of wires of 6600 No. 10 gauge. If the tension of the Wheeling cables had been as uniform as those of the Cincinnati bridge are, then their relative strength would have been as 7 to 12. No stays were employed in the Wheeling bridge. The floor was torn by the gale into three sections, the eastern portion measured 500 ft., the western 300 ft., leaving the central part 200 ft. long. All the cables but two broke loose from the anchorage, one after another. One small cable, composed of 150 wires, broke in the centre. For the want of stays and of stiffness, the floor was subjected to very considerable oscillations, and thus broken up and destroyed by its own momentum.

A divided system of cables possesses but a small degree of that inherent stiffness which is obtained by forming one single massive cable, bound up in a continuous wrapping of such strength that it approaches the stiffness of a solid cylinder. The great stiffness and rigidity of our cables was forcibly illustrated during the suspension of the beams. A temporary track was laid down over the centre of the beams for the transportation of materials on trucks. The beams being free to swing, the remarkable stiffness of this track was in part owing to the great weight of the cables, but also in a great measure to their stiffness. After the centre girders had been put in place and connected with the beams, the stability of the skeleton floor was so far increased that loads of 5 tons weight produced but little impression.

Another and most important advantage of large and heavy compact cables in large spans is obtained from their powerful horizontal action in bracing the centre of the span. Only those who have tested this matter on a large scale are able to appreciate it. I do not expect professional men to credit the statement, without seeing with their own eyes, that the centre of the Ohio bridge is not deflected by heavy gales, neither horizontally nor vertically. This remarkable horizontal stability is in a great measure due to the powerful bracing of the cables. This admirable feature of a well-built cable bridge cannot be introduced into a chain suspension bridge, without involving details of great difficulty.

The French system was first introduced into this country during the construction of the Schuylkill river bridge, at Fairmount, Philadelphia, by the late and much-lamented Colonel Charles Ellet, jun., who, like a true hero, sacrificed his life in his successful endeavours to make steam rams efficient on our western waters during the late civil war. According to this system the small cables are made on shore, or away from the bridge, then dragged to the site and elevated to their final position. But this practice is very objectionable, because the wires composing a cable, when under no strain, become loose, bulged out, and in consequence dislocated and entangled more or less. This derangement is much increased by the great abuse the cables suffer during the process of dragging, hoisting, and placing in position. No matter what care may have been taken to insure uniform tension, this uniformity will be lost by the subsequent rough handling. The hardness and elasticity of good cable wire will approach that of steel. But this elasticity may be the means of destroying the uniformity of tension if this tension is relaxed.

My earliest experiments taught me that the French system is wrong in principle, and that no good cable can be made by that process. This objection may in part be overcome by employing a continuous wrapping, but not altogether. Nor is there always sufficient room available on shore for the construction of long cables. What then is the remedy? The cables should be made across the river, very nearly in the position which they will finally occupy, and the tension of the wires must never be relaxed below a safe mark. This system, which I have applied for the last twenty-three years, with invariable success, is the only true one which will insure uniformity of tension. I admit that this system is apparently more complicated than the French; it requires more extensive machinery, also more judgment and supervision; but it is the only plan to make a good cable.

The cables of the Ohio bridge are wrapped from end to end with No. 10 wire. This wrapping gives them the appearance of solid cylinders; it has a pleasing effect, and its solid aspect inspires confidence. This wrapping, being perfectly tight, affords an effective outside protection. It is also desirable to diminish the surface to be kept in paint. This surface is less than 10,000 square feet, while a tubular or lattice bridge would present an area of several acres to be kept in paint.

About one year was consumed in the construction of the cables, including the erection of the necessary machinery. To

some persons this appeared a slow and tedious process, because looking up from below not much bulk became visible as the result of a day's work. We were able, on every day of active cable-making, to spin out from six to seven tons of wire, adjust and secure it in position; by no other process can so much be accomplished. We have often been interrupted by high winds, which greatly interfere with a proper adjustment of the wires.

Owing to the width of the Ohio valley, and its course at Cincinnati being from east to west, the line of the Cincinnati bridge is struck at right angles by the prevailing west and north-west winds, and their violence is equally felt for the same reason. I was not fully prepared to meet these prevailing winds during the cable-making, hence the delay. No other difficulty could arise from it but delay. The trouble was, of course, greatest during the winter months, and after they had passed around, I did not consider it worth while to fight the winds any more.

Before the manufacture of the cables could be commenced, a temporary foot bridge, extending from one abutment to the other, had to be thrown across. After this was accomplished and all the machinery put up, the cable-making commenced on the 1st of November, 1865. Two strands were made in one operation, one for each of the two cables. These being completed, lowered to their final position and adjusted, the next pair was commenced. This process was repeated seven times, and was terminated on the 23rd of June, 1866. Eight months were thus consumed, which included the winter months, the most unfavourable part of the season.

The total and exact quantity of wire worked into the cables, including the wrapping, is 1,050,183 lb.

Four massive cast-iron saddles, with an easy curvature for the support of the cables, are placed on the summit of the towers. Each rests upon 32 rollers, and these are supported by the bed-plates. All the working surfaces are, of course, planed off true, and the rollers are turned off to an exact size. All these parts are accessible, and may be examined and repainted at any time.

One million pounds of the cable wire were manufactured by the Messrs. Richard Johnson and Nephew, at Manchester, in England. It is but just to state here, that these gentlemen have, by the faithful execution of their contract, fully sustained the well-earned reputation of their firm.

Suspenders and Stays.

The suspenders form connecting links between the cables and the floor. Except one hundred in the centre of the main span, they are all made of wire rope. To obtain more stiffness the short ones in the centre are made of solid rods, $1\frac{1}{2}$ in. diameter. The rope suspenders are 5 in. circumference, equivalent to 45 tons ultimate strength. Those next to the towers are greatly relieved by the action of the stays, and consequently reduced to 36 tons strength.

The weight of the floor for a length of 5 ft. is 11,365 lb. or 5.682 tons. To support this we have two suspenders of an aggregate strength of 90 tons, or nearly 16 times the weight. An ordinary crowd of people upon the same area will weigh 4800 lb., equal to 2.40 tons, which, added to the weight of the floor, makes a total of 8.08 tons, or about $\frac{1}{16}$ th of the ultimate strength of the suspenders.

The attachment of the suspenders to the floor beams is effected by substantial stirrups, made of $1\frac{1}{2}$ in. diameter bolts of the best quality of charcoal iron. Their connexion with the cables is formed by means of wrought-iron sockets, and these are held by the pins, which close the cable straps. Corresponding to the suspenders, the cables are firmly clasped by these straps every 5 ft., and these not only serve to connect the suspenders with the cable, but they also form an additional means of insuring their compactness and solidity. This latter point being one of great importance, these bands have been made of the best material, and are screwed up tight.

Where the cables enter the towers on the river side, 19 wire ropes, each 24 in. diameter, will be noticed descending in straight lines to different points in the floor. Crossing the suspenders diagonally, the two are connected by wire wrappings, which keep them firmly in their position. Thus a network is formed that occupies the same inclined plane, which coincides with that of the cables. The total number of stays in the main span is 76.

The office of these stays is two-fold. They not only assist the cables powerfully in the support of the bridge, but they also supply the most economical and most efficient means for stiffening the floor. Every stay constitutes the hypotenuse of a rectangular triangle, whose short sides are formed by the tower and by the floor. The tower represents the vertical side, and is rigid and unyielding; the floor represents the horizontal side, and may be considered as equally unyielding. If now the stay, which represents the hypotenuse, is prevented from oscillating, and its straight line is preserved, then its point of connexion with the floor will be a fixed point, or nearly so. This looks like a very simple proposition indeed, and is readily comprehended by sailors, who are accustomed to stays on board of ships. But not so with professional engineers, who, as a class, do not appear to appreciate the simplicity of this arrangement of *trussing*. I have always insisted that a suspension bridge built without stays is planned without any regard to stiffness, and consequently is defective in a most important point.

One stereotyped objection against stays is that they will not act in concert with the cables. But this objection has no weight when the great object of the stays is justly considered. What does it matter, whether the catenary remains a mathematically true curve or not? The stays will act as far as the tangents extend, thus leaving nearly one-half of the span in the centre clear of stays. As soon as the stays are tightened, the cables will be relieved at those points, and in consequence sink in the centre. This central portion, free from stays, acts as a compensation. A compromise is thus effected between the stays and suspenders, and a similar compromise always takes place, more or less, in all systems of trussing, under the action of passing loads. Where the towers are made of iron, there will be more union between the stays and suspenders, or cables. But this is not an essential point. The same remarks equally apply to contraction and expansion, caused by changes of temperature. In consequence of these changes, the permanent and

MEYER'S TANK LOCOMOTIVE.

FIG. 3.

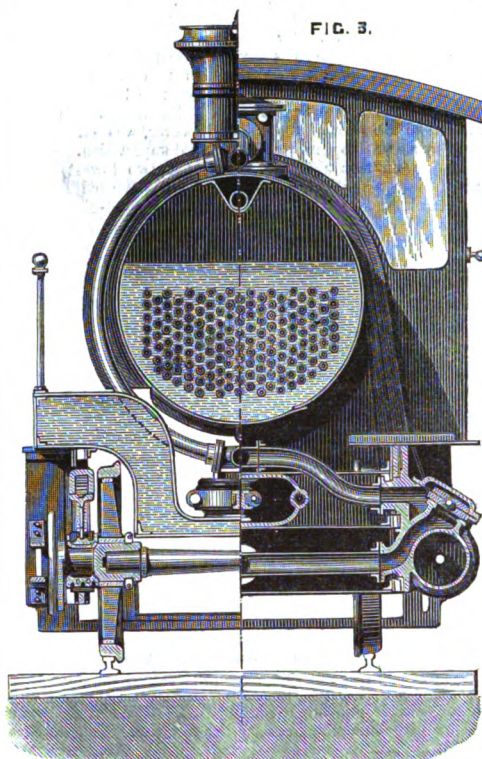
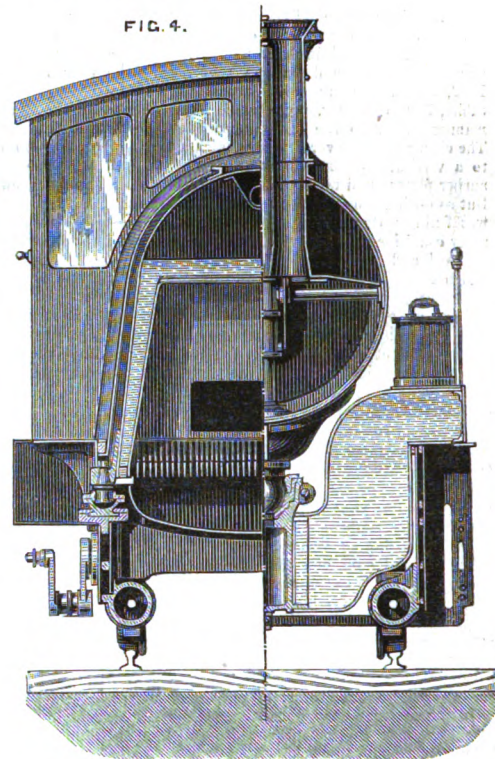


FIG. 4.



relative tension of the stays, as well as of the suspenders, will vary some; but this variation is not such that it deserves to be taken into consideration. The first stay next to the tower leaves as much space open as may safely be left to the stiffness of the trusses and girders. It is in this part where the strife is greatest, and accordingly the suspenders are left slack to accommodate themselves to these variations. The suspenders are in every case more subject to these variations than the stays, and we have to provide for them, whether stays are employed or not.

The static efficiency of every system of trussing is governed by the same principles, which determine the action of the stays. The triangle is the only unchangeable figure known in geometry, and therefore all trussing must be reduced to that principle.

The problem of a series of suspended spans can only be safely solved by the use of stays. Cables alone cannot be depended upon for the maintenance of a perfect equilibrium between adjoining spans, under the action of variable loads. To perform this most important duty, the office of stays is most efficient and direct.

The first eight stays, commencing at the tower, do not pass over its summit, but are fastened to the bed-plate, which supports the main saddle. The pull of these stays is consequently direct upon the tower, but neither their horizontal nor their vertical action is of sufficient moment to tax the strength of masonry to any undue degree.

The remaining eleven stays which stretch out towards the centre of the span, and are attached to the floor every 15 ft., are passed over the summit of the tower, and descend in diagonal lines towards the half span. Eight of these are fastened to the floor, the other three connect with an anchor bar which is secured in the lower part of the anchor walls. For the support of these eleven stays on the summit of the tower, two smaller saddles are placed upon the side plates of the main saddles which supports the cables. They rest upon different sets of rollers, which allow them to move independent of the main saddle. The efficiency of this arrangement has been frequently tested since the opening of the bridge. No motion whatever takes place in the saddles under the action of ordinary loads and of the ordinary business. But when excessive crowds are occupying one span, with little to balance the next, then a slight movement will take place, and this has the effect of equalising the difference of tension.

The suspension bridge which I have erected over the Alleghany river at Pittsburgh, forms a series of spans, whose equilibrium is maintained upon the same principle, and by the same means. Public processions and other heavy and variable loads frequently pass over it without producing any visible or injurious effects. Being one of the largest stockholders in that work, I am well satisfied with its condition and promise of future stability.

As a means of direct support, all those stays which fall within the tangent of the cables bear more, and those which extend beyond the tangent bear less, than the cables do in proportion to their relative wire section. Expressed in other terms, one pound of wire put into the cables will bear less than one pound put into the stays, provided they are *within* the tangent. On the contrary, the stays *beyond* the tangent are less economical than the cables. This proposition is easily demonstrated by the laws of the catenary. The comparative supporting power of the stays among themselves increases, of course, as they approach the tower, or as their inner floor angle increases.

When the great strength of the floor of this bridge is considered, it is but natural to inquire how much supporting power is supplied by this element. In suspension bridges *without* stays, the floor bears no part of its own weight, except a small portion next to the abutment. But the case is different in the Ohio bridge. There the floor is made a powerful element

in connexion with the stays for the support of its own weight. As the stays are tightened and exert an uplifting force upon the floor, a part of this force is expended upon the floor itself, acting either by compression towards the tower, or by tension towards the centre of the span. Statically expressed, the supporting power of the stay is represented by the elevation of the tower above the floor; its compressing action by the length of floor from the tower to the point of attachment, and its own tension by its own length. Suppose the cables removed, or their connexion with the floor relaxed, the latter, in connexion with the stays, will support itself.

(To be continued.)

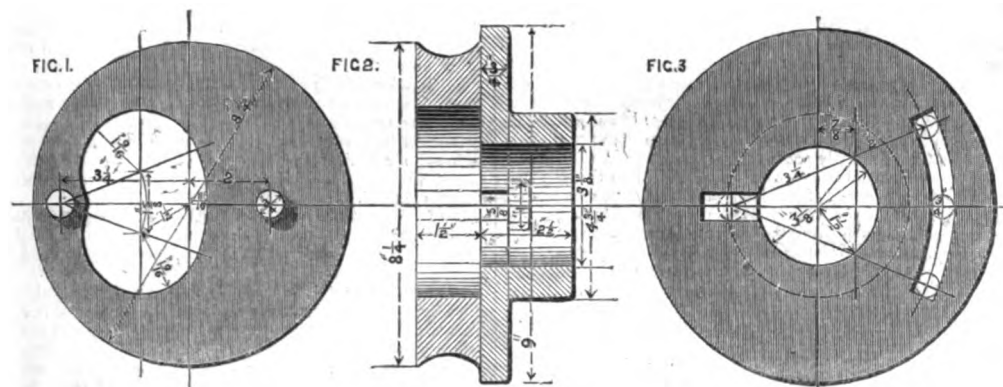
MEYER'S LOCOMOTIVE.

MANY of our readers will remember that, in our International Exhibition of 1862, M. Meyer, of Mulhouse, exhibited drawings explaining his system of constructing locomotives for working on lines having sharp curves. M. Meyer has sent a series of similar drawings to the present Paris Exhibition; and we give on the present page, and page 73, various views of one of the proposed engines. Inasmuch as in both cases the boiler is carried on a pair of bogies, each provided with a pair of steam cylinders, there is a strong resemblance between M. Meyer's plans and those of Mr. Fairlie; but the two systems were worked out quite independently, and there are in the details, by which they are carried out, many important differences. With Mr. Fairlie's engines most of our readers are no doubt familiar, as they have been fully described in the pages of *ENGINEERING*; and we shall, therefore, in the present notice confine ourselves to a description of M. Meyer's system, as carried out in the locomotive now illustrated.

The locomotive in question is an eight-wheeled engine, the wheels being arranged in two groups, two pairs to each bogie, the wheels of each group being coupled together, and being driven by an independent pair of cylinders. The cylinders are placed outside, and the steam is conducted to them by pipes of such a length that they have sufficient elasticity to follow the movements of the bogies without injury. The exhaust pipes of the cylinders on the trailing bogie are connected to those of the leading bogie by a flexible pipe, and the exhaust steam is conducted by a central passage to a chamber in the casting on which the front bogie-pin bears. From this chamber the steam passes up through the pin itself to the exhaust pipe. The arrangements of the cylinders, steam pipes, and exhaust pipes will be seen by reference to the figures.

The water-tanks are carried on the front and the coal-bunkers on the hind bogie. The boiler does not serve as a tie between the bogies, but it merely rests upon them. At the front end it is carried by a central pin attached to the underside of the smoke-box, this pin having a spherical bearing upon the top of a casting fixed in the tanks. The point in the leading bogie at which this bearing is arranged is directly over its mean centre of gravity, or the position occupied by its centre of gravity when the tanks are half full. At the hind end the boiler is carried upon two points, the supports being situated one on each side of the firebox, as shown in Figs. 1 and 4. The supports are arranged so that the hind bogie can swivel freely under the boiler. The two bogies are coupled by a connecting-rod, one end of which embraces the bearing or socket of the front bogie pin, whilst the other end is coupled by a pin to the front end of the trailing bogie. This pin just mentioned has sufficient play in the holes through which it passes to allow of the buffers between the bogies bearing fairly upon each other when any thrust has to be transmitted from one bogie to the other. The engine is fitted with steam brakes, the blocks being applied to the wheels by pistons connected directly to them, as shown in Fig. 1.

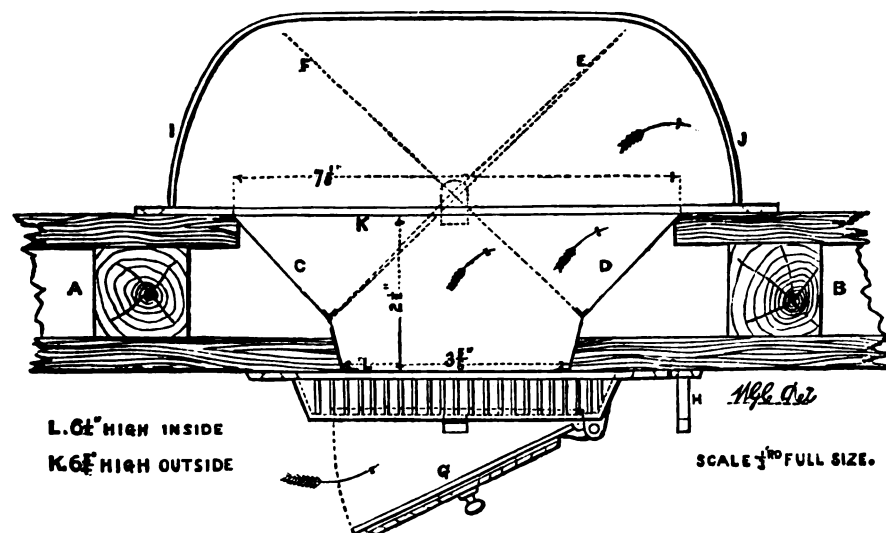
SHIFTING ECCENTRIC FOR PORTABLE ENGINES, AS USED BY MESSRS. RUSTON, PROCTOR AND CO., ENGINEERS, LINCOLN.



In our report of the portable-engine trials at Bury, in our last number, we noticed the simple arrangement of shifting eccentric applied to their engine by Messrs. Ruston, Proctor, and Co., to enable the amount of expansion at which the engine was worked to be readily varied, and we now give an engraving showing this eccentric as applied to an 8-horse engine. The principle of the arrangement is the same as that of Dodd's "wedge-motion," namely, that of causing the centre of the eccentric to move in a straight line across the crank-shaft between the positions it would occupy in, what we may term, full gear forwards and full gear backwards. This movement is effected in the arrangement we are describing in a very ingenious and simple manner as follows: On the crank-shaft by the side of the eccentric is keyed a disc, which is shown separately in Fig. 3. This disc has two slots formed in it, one of them being radial and the other curved to the arc of a circle, as shown in the figure. In these slots two studs fixed in the eccentric sheave work, the hole in the sheave through which the crank-shaft passes being shaped, as shown in Fig. 1, to allow of the necessary movement taking place. The eccentric sheave is held in any desired position by screwing up the nuts placed on the ends of the studs passing through the slots in the disc. It will thus be seen that the eccentric sheave can be set in any position between the limits imposed by the length of the curved slot in

which one of the studs work, the extreme positions of the eccentric being those for full gear backward and full gear forward respectively. The effect of the movement of the studs in the two slots is that the centre of the eccentric moves across the crank-shaft in what is practically a straight line, the throw of the eccentric being thus more and more reduced as the pin approaches the centre of the curved slot, whilst the linear advance of the eccentric, and consequently the lead of the valve, remains unaltered. The effect of this reduced travel, the lap of the valve remaining constant, of course is that the cut-off of the steam takes place earlier in the stroke. We have said that the line in which the centre of the eccentric moves from one position to the other is *practically* straight; in order that it should be mathematically so, the curved slot would have to be an arc of an ellipse; but the error produced by the use of an arc of a circle is too small to be of any practical importance. Messrs. Ruston, Proctor and Co.'s 8-horse portable engines have a single cylinder $9\frac{1}{2}$ in. in diameter, with 12 in. stroke, and the steam ports are $\frac{5}{8}$ in. wide. The slide-valve has $\frac{1}{4}$ in. lap, 3 in. travel in full gear, and no lead for the steam side. The remaining dimensions of the eccentric sheave and disc are given in our engraving, which is prepared from a tracing with which we have been favoured by Messrs. Ruston, Proctor and Co.

CREAMER'S VENTILATOR FOR RAILWAY CARRIAGES.



We illustrate, above, a form of ventilator for railway carriages, which has been designed by Mr. W. G. Creamer, the patentee of the well-known Creamer brake. This ventilator, which has already been largely applied in America, consists of a vane turning freely on a vertical axis, and fitted to an opening made in the side of the carriage above the windows. A portion of the vane projects beyond the side of the carriage, as shown in the engraving, which is a sectional plan of the arrangements, and this projecting portion is carried by the pressure of the air towards one side of the opening or the other, according to the way the carriage is moving. Thus, if the ventilator shown in the illustration was moving from right to left, the vane would assume the position shown by the dotted lines, E, and the air rushing past its outer edge would cause an induced current, as shown by the arrows, and thus remove the vitiated air from the compartments to which the ventilator is applied. If the carriage moves in the other direction, the vane assumes the position shown by the lines, F, but the action is the same. The strength of the current with-drawn from the carriage can be regulated by a neat door or valve, G, fitted to the inner side of the opening. The projecting portion of the vane is protected by a guardplate placed above it. We should think that this ventilator is particularly well adapted for use in smoking-carriages, the ventilation of which is generally very defective.

PRUSSIA.—The Bayenthal Company for the construction of machinery has fixed its dividend for 1866 at 8 per cent. The net profit realised during the past exercise was about 15,000*l*.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Shipbuilding.—Since our last, we can chronicle no improvement on the generally dull state of business in the yards on the upper part of the Clyde. During the past week there have been launched the following, viz., the Geraint, composite sailing ship, 1100 tons, B.M., by Messrs. McMillan, of Dumbarton, for Messrs. McCunn, of Greenock; the Paais, screw, 315 tons, B.M., 50 horse power, by Messrs. Wingate, of Whiteinch, for Messrs. Ker, Bolton, and Co., for their Manila trade; the Garrison, screw, of 800 tons, by Messrs. Aitken and Mansell, for Messrs. Laing and Davidson, to be fitted with direct-acting engines of 100 horse power by James Aitken and Co.; the Spindrift, composite clipper ship of 1350 tons, by Messrs. Connell and Co., for the China tea trade; the Laloo, 800 tons, also composite, by Messrs. Steel, for the same trade; and the Lagarete, twin-screw, with two pairs of direct-acting engines of 25 horse power each, by Messrs. Inglis, for Messrs. Isaac and Samuel, of London, for the South American trade. Of the three screw steamers which Messrs. Caird have in hand for the German companies, one is entirely plated, and two are framed and partly plated. The old Cunard liner, America, has been converted into a sailing ship by Messrs. Caird, and the Niagara is undergoing the same process at the hands of Messrs. Robert Duncan and Co., of Port Glasgow.

Lighthouse Illumination.—The Board of Northern Lights have been carrying on experiments with the electric light in a temporary lighthouse erected for the purpose at Granton. The particular form of apparatus experimented with is that of Mr. H. Wilde, and is in many respects similar to that of Mr. Holmes which was erected at Dungeness, and to that at Cape La Heve, near Havre. The results have hitherto been successful both in illuminating power and steadiness.

Railway Matters.—It is proposed to carry a tramway from the terminus of the Deeside Railway at Ballater (43½ miles from Aberdeen), on to Braemar. There is little doubt but there will be abundant traffic; and if it succeeds pecuniarily, it will be the precursor of many cheap feeders to the various Highland and northern lines. The Denburn Junction Railway at Aberdeen, of 1½ miles in length, constructed for the purpose of forming a communication between the Scottish North-Eastern and Great North of Scotland railways, was finished a few days ago, and awaited only the visit of the Board of Trade Inspector and his sanction for its opening on the 1st August. On Sunday evening, however, 26 ft. of one of the tunnels gave way and collapsed completely, it is supposed, owing to the accumulation of water behind. The opening of the line is thus indefinitely postponed. The Forth and Clyde Canal Company, the works of which were begun by Smeaton exactly ninety-nine years ago, has just ceased to exist as an independent concern. It has been bought up by, and the shareholders will henceforth be mere annuitants of, the Caledonian Railway Company. Unlike most recent windings up, there is a reserve of 37,000*l*. to divide among the shareholders.

Shipping Returns.—We would direct our readers' attention to a recent parliamentary return of the vessels built in the United Kingdom in 1866. The total number amounts to 917, of which 631 were built in England, 270 in Scotland, and 16 in Ireland. Of those built in Scotland, the respective classes wood:

	Wood.	Iron.	Composite.
Sailing vessels	102	80	17
Steam "	2	117	2

The number built at Glasgow was in all 121.

Iron Trade and Mining Districts.—The pig-iron market continues dull, the quotations being from 52s. 6d. to 53s. per ton. Boiler-plates have fallen 5s. per ton. The total shipments of pig iron from Glasgow for the week ending July 20th have been 1604 tons, and for the same period the shipments from all Scotch ports have been 8222 tons, being a decrease of 4939 tons from the corresponding week last year. The total shipments since Christmas, 1866, have been 845,780 tons, being an increase of 38,820 tons over the corresponding period of 1865-66. Despite the threatenings of the coal-masters, the lock-out has not become general, being confined to some collieries in the Wishaw district. On the other hand, many of the colliers have returned to work at the reduced rates. Messrs. Scott and Gilmour's strike—the *casus belli*—still continues, and their men are heartily supported by those colliers who are at work. A case of some interest to mine-owners was tried last week. The proprietor of Blairdardie Collieries was charged, under the statute, with not reporting to the Crown authorities and Inspector of Mines "an accident, attended with serious personal injury." The collier injured had had his jaw broken, and the sheriff held that this was a "serious personal injury" under the Act; and as this was a test-case, the statutory penalty of 20*l*. was modified to 2*l*.

British Fisheries Commission.—The report for 1866 of the British Fisheries Commissioners has just been issued. They insist strongly upon the necessity of improving the harbours generally on the east coast of Scotland, and also upon the necessity of pushing on the larger works at present in construction, such as the Wick harbour of refuge, &c. The whole of the 3000*l*. which the commissioners have at their disposal annually for the improvement of the fishing harbours of Scotland will be absorbed for many years to come by the Anstruther Union Harbour Works alone, and they think a much larger outlay on similar works quite indispensable for the cultivation of the fisheries and the protection of the fishermen, numbering 45,470, with 13,815 boats, the boats, nets, lines, &c., &c., representing a capital of 980,000*l*. We may as well mention in this connexion that urgent calls are being made for the improvement of the navigation of the Tay by the construction of a great sea-wall extending from Bulmerino in a north-easterly direction, so as to preserve the natural set of the current, which it is assumed would then of itself clear away the existing sand-banks and prevent such accumulations and obstructions in future.

Graving-dock Accommodation.—With reference to our remarks on this subject a fortnight ago, we would note that the matter was before the Clyde trustees at their meeting yesterday, when Mr. Duncan's report and estimates were submitted. He stated the cost of a graving-dock 500 ft. long, with a depth of 22 ft. on the sill, with all appurtenances, would be 61,000*l*. exclusive of the cost of the land. The matter was referred back to the Works' Committee to procure information as to the probable revenue to be derived from the undertaking.

DUTCH TOWNS.—At the close of 1866, the population of the three principal towns of Holland was as follows: Amsterdam, 264,498 inhabitants (123,104 males and 141,394 females); Rotterdam, 115,277 (63,397 males and 61,680 females); and La Haye, 87,801 (40,039 males and 47,762 females.)

THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.

At the meeting of the above society, held on the 15th inst., the following discussion took place after the reading of Dr. W. Smyth's paper on "Experiments Practically Demonstrating the Laws by which Birds Fly, and their Application to an Aërial Machine," which paper we published on page 66 of our last number.

Mr. Wenham said: The experiments recorded in the last paper form an interesting addition to our stock of knowledge on aeronautics, but I rise to make a remark concerning the proposed motive power, as upon this part of the question I have some practical data. Some years ago I constructed an engine worked by the explosive force of gas, and found that $\frac{1}{16}$ of an inch of gas mixed with $\frac{1}{16}$ of air was sufficient to propel a free piston 12 in., and the mean vacuum obtained during the return stroke amounted to 12½ lb. per square inch. The propulsion of the piston was instantaneous, and the whole force of the explosion was afterwards utilised. The heat given out was so small compared with the work done that, after running for ten hours, the temperature of the cylinder did not amount to 300°. From this I infer that the cellular chambers could be made to stand the heat of the explosion without being rapidly destroyed, and would make the lightest form of motive engine with which I am acquainted. The chief drawback would be the size of the reservoir containing the gaseous fuel, and bulk is one of the greatest drawbacks to the success of aerial navigation.

Mr. Bright disputed the conclusion of the author of the paper, that the screw-propeller was a means of raising or moving bodies in the air, and he again reverted to the paper he had handed to the chairman.

Mr. Wenham believed, from what he had seen of the model brought from Paris by Mr. Butler, that a machine constructed upon its principle would require a force of twelve horses to raise a weight of 100 lb. This was sufficient to show the inapplicability of the invention, which was altogether defective in principle.

Mr. Bright asserted that Mr. Wenham's objections were groundless. It could not be disputed that he had produced to the society a model which had raised itself in the air which completely negated the assumed defect of principle, and he contended that what had been effected by the model could easily be applied on a large scale.

Mr. E. W. Young quite agreed with Mr. Wenham as to the total inefficiency of the model exhibited. It simply spun itself round, and churned the air, so to speak, like a child's toy; the machine, though capable of raising itself in the air by the aid of the power stored up in the spring, could not raise the source of that power, which was a man's arm, and it would be impossible to obtain the same power continuously.

Mr. Butler remarked for the information of Dr. Smyth, that he and his brother-directors of the Lenoir Gas Engine Company had found a very efficient means of producing vacua from explosions, by using the vapour of petroleum, and it was of much less bulk and weight than coal-gas.

The Chairman thought Dr. Smyth's paper a very able one, and that the observations he had made as to the flight of birds were very interesting and original. He (the Chairman) thought that Dr. Smyth was quite right as to the limited stroke the bird made in its upward circle through the air. It seemed to be a short rapid stroke upwards, which ceased exactly at that point at which nature taught the bird that a further stroke would not only be useless, but injurious to the rapidity of its flight. The whole extent of the arc through which the stroke might extend was rarely or never traversed by the action of the wing.

Mr. A. Stewart Harrison wished to know whether it was entirely certain that the screw-propeller was useless as a means of flight. Was it as certain, for instance, as that two and two made four?

Mr. H. C. Hurry said that it was not at all certain that the screw-propeller was useless as a means of propulsion through the air, but he thought it was received on most hands that it was useless as a means of support in the air, as it was continually moving the air beneath it, and thus losing the support which an inclined plane moving horizontally would obtain. As to the motive power of Mr. Bright's machine, he thought that the observation of a preceding speaker contained the whole gist of the matter. The machine was apparently raised by the power of the spring, but the spring was merely a reservoir, so to speak, of the force communicated to it from the outside. The power required to lift the weight in the way proposed, rendered the whole machine totally inapplicable to the purpose for which it was designed.

Major John Scott Phillips read the following paper on artificial flight:

Those who have had the pleasure of hearing or reading the admirable paper by Mr. F. H. Wenham, read some months ago before a meeting of the Aeronautical Society, and since published, page 360 of ENGINEERING, April 19th, 1867, will have gleaned from that paper the interesting fact that the art of flying depends upon the relative exertion of pressure and speed, while the pressing surface is economised, in proportion to the weight to be carried, and the speed at which that weight is to be propelled.

Mr. Wenham has also ably discussed the resistance against a surface of a defined area passing rapidly through resisting and yet yielding media, dividing the opposition thereto into, firstly, the cohesion of the particles to be separated, which, in air, he says, is inappreciable; and, secondly, their weight and inertia, which require a constant power to set them in motion.

Not to dwell any longer, however, on Mr. Wenham's very useful paper, I would just glance for a moment at the third chapter of his Grace the Duke of Argyll's work, entitled "The Reign of Law," of which chapter the heading is given—"Con- trivance a necessity arising out of the reign of law, example "in the machinery of flight;" and I would notice that while his Grace says, in a note, page 174, that Captain P. W. Hutton (in the "Ibis," for July 1864) has thoroughly seized the true mechanical principles of flight, it is evident, from his own able remarks on the flight of birds, as well as from Mr. Wenham's paper, that truly we have arrived at that stage of elucidation toward the power of artificial flight, in which we are brought

face to face with the question, By what mechanical means can we develop the principles developed in the flight of birds? This is the subject upon which I now propose to enter, but remarking that it is six years since I seriously took up the subject, I would open my views by what may be termed a recapitulatory anecdote by way of placing my ideas in an old-established current of thought, that I may, if possible, begin at the beginning, run along the ground, rise from it, and carry my hearers with me into the realms of air. When I was a youth years ago in India, many were the bursting gallops I enjoyed over its sunny plains, and oftentimes coming upon a number of vultures feasting on their prey, I would urge my horse to his utmost speed to see if I could possibly get a cut at one of them with a long stick before he could rise above my reach. I little thought that I was then in the way of receiving practical lessons on the art of flying; but in the year 1861 studying the question of the art of flight, and perceiving that birds did not fly because they were so light, or their bones empty or filled with light air, perceiving also as a definite principle that the use of gas implied cross sections of voluminous shapes which never could be forced against the air, the recollection of past scenes arose before me, brought back with vivid realising distinctness, and this, in fact, was what I saw:

As I galloped fast down upon the vultures, singling out the nearest for attack, the bird at 80 or 100 yards distance would commence to run, stretching out his neck, and shortly beginning to prepare his wings for flight. This he did by holding them more and more loosely out from his body, with all the feathers hanging loose and edgewise to the wind, and so running with all his power, and just as that power of running was coming to the height he gave a final leap, and instantly commenced to flap most violently with his wings. Thus he just managed to elude me always by two or three yards in height above my stroke, and he would continue his exertions till, raised thereby some 40 ft. above the ground, he changed his tactics. Meantime I had restrained my horse and turned to look at him. With flattened breast and outstretched wings he let himself descend along a swooping curve, and then he would come fearlessly past me, every separate extreme wing-feather stiff as possible, and with a rushing mighty wind he would sweep downwards till he almost touched the ground, and then his power of flight was fully gained. He had obtained velocity and pressure on the atmosphere. He had heaped before him a mass of air fully equal to his own weight, and thenceforward all was easy. Gracefully and slowly waving his long wings, he swept upon his way, soon leaving me miles behind him, and with long years to intervene before I could even hope to understand the principles of his magnificent development.

On the same principle; the eagle from his eyrie 'mid the rocks, swoops downward ere he rises to the sun, and aloft when soaring in the heavens scarce ever seems to move his wings at all.

Steadily bearing down an exceedingly long most gradual descent upon the air, he soars by the simple combination of velocity and pressure, and gaining momentum from his weight upon this long descent his upward rise is easy; for, altering merely the angle of his wings, he turns and rises, or rises without turning, by this most simple manoeuvre. And, as a final instance of this fact, since all have not the privilege of visiting Libyan ranges or Himalayan hills, let me mention what may not unfrequently be seen when travelling by the railway, at about the speed of thirty miles, the rate at which apparently a partridge flies under ordinary circumstances. The bird, after all his whirling exertions at rising, flits steadily long distances on the wing, and coming to a hedge just seems to change the angle of his wings and rises over it, and, changing again, turns quickly down and passes out of view. It is, or will be, just the same in flying by a machine, with this important difference, that as we cannot find out the Almighty unto perfection, and make that perfect instrument a flapping, sustaining wing, we must follow at humble distance in the use of separate instruments for gaining velocity and sustaining pressure; and therefore I will now attempt to prove how readily this theory of flight may be applied to cause mankind to traverse through the air, premising that I do not aim at more than running along the ground to gain an adequate pressure on the air, then at rising in the line of least resistance, then by the increased rapidity of flapping to maintain the flight, and on the whole to pass through the air as the crow flies, direct from place to place without turning in the flight. Suppose then that we adopt a series of planes for pressure on the air, while the person who would fly sits suspended beneath them. We then require the means of regularly, steadily, swiftly propelling these planes against the air. Thus, then, take the planes—say the plane of the strongest and slightest wooden frame, strained with stout canvas, and let this plane be an oblong 20 ft. long by 10 ft. wide. At the 10 ft. ends join on, by hooks, eyes, and rods, two other larger planes, each as it were double planes by reason of their total area, 25 ft. by 20 ft. each, being supported by a middle bar, straining their wooden frames also with stout canvas, and let each of these two larger planes be furnished with a ratchet movement and pins to enable the flyer seated in a car beneath the centre or body plane to set them at an angle as he pleases. Secondly, place this apparatus upon light wheels—as light as possible consistent with strength—and let these wheels work on an axle (driven by a steam-engine) passing across just underneath the body plane, so as that the wheels shall just work truly and freely along the sides of the body plane, and between the projections of the larger planes as affixed to the body at either end.

The planes, you will perceive, are not wings for flapping, only wings for pressure. But now we come to the third chief matter (the planes and wheels being the two first), the actual flapping wings, which must be fixtures of some sort; for feathering with wood and iron at rapid speed is quite beyond the question—wood and iron would not stand, and flesh and blood would soon be crushed in making the attempt. The shape I recommend for flapping wings can be likened to nothing else that I know of but the combined inner and outer shapes of the half of a calf's hoof. Four such shapes should be made of the lightest plating brass, and, regulated in size by the radius of the wheels, should be affixed four to each wheel with their bowed

curves outward. An inspection of the shape will show how readily four of these shapes will make up into a complete self-strengthened wheel, which, with the addition of one single ring put on each wheel externally, tying as it were the shoulders of each hoof together, will be as light and strong as can well be made.

Note, then, the peculiar action of each separate hoof-shaped wing in beating through the air as the wheel bearing it rotates on its axle.

Beating downwards as the machine well balanced runs along upon its steam-driven wheels, I think it is evident that each hoof-shape or actual wing beats strongly on the air, while the strength of its beat is greatly aided by the impingement of the gathered air against the near pair of planes, and so with the successive hoofs a semicircular powerful beat directly ahead is readily obtained.

But how about the practical feathering, or passing without opposition through the rest of the circle of rotation? For if the beat should be continued, action and reaction being equal, nothing could be gained.

The answer to this is twofold: first, the centrifugal force, aided by pressure in its action against the near planes in rising from the downward beat, flings almost all the compressed air gathered in the foot right outwards, on what may be termed the horizontal line, i.e., the under sides of the near planes, and the inner and outer sides of the flapping wing or hoof prevent fresh air from entering its embrace from below; and, secondly, when the wing passes above the body plane, it comes altogether into a different current of air, even into a current of air running forward, and so offers no opposition to the hoof, part of a little travelling whirlwind behind the double plane stretched out in front. For it will be observed that the pressure of the front plane driven against the air will cause a condensed mass to meet the flapping in the downward beat, and this condensation will cause a corresponding vacuum above and behind the forward plane. Hence it will accrue that whatever air may escape from the front pressure will come over the upper edge of the front plane in a rising curve, and, when this machine is at tolerable speed, this curve, ultimately a downward parabolic curve, will be extended so far as that its reflex will fully cover and occupy the wings upon the wheels in their revolution through the upper semicircle of rotation. Hence the wheels will, with their wings, beat fully on condensed atmosphere throughout the lower semicircle of rotation, and pass clearly without opposition through the upper semicircle; and thus, I trust, I have been enabled to show how wings and planes can be combined to furtherance of flight. As far as I can judge, and as far as leading principles are concerned—omitting the details of the strict proportions and weights of all parts—the only great question remaining to be settled is, how to overcome the difficulties attending the use of any of the steam-engines hitherto invented. They are at once too heavy and, in the case of all reciprocating engines, too unsteady for use in a machine requiring perfect smoothness and perfect steadiness. I have, however, by me long-studied plans for a comparatively simple, equally working, light, and powerful engine; but as I have at this time sufficiently ventured to ask your attention, I will defer to speak thereupon till some possible future occasion.

Mr. Wenham, irrespective of the mode of propulsion just proposed, considered that the form of aeroplane is not that which will give a good sustaining effect for want of lateral extension.

It is not perhaps generally known that Henson's machine was actually constructed. He thought the two planes were in length about three times the breadth; when the machine was launched from an altitude, for want of greater length of wing, it descended only a short distance from the starting-point. He believed that the whole question of aerial support and propulsion is simply based upon the laws of action and reaction of relative weights, or that of a body supported impinging upon a great weight of air.

As it has been inferred that a body set free in air, and ever about to fall, may be continuously supported by the action of a small force, he would venture to quote the familiar example of a ball kept aloft by a fountain.

To keep a body weighing 100 lb. sustained on a jet of water of one square inch in section, the water must issue at a speed of 76 ft. per second; this represents a force of 13.81 horse power.

If now we increase the size of the jet to 10 square inches to support that same weight, the water pressure will be reduced to one-tenth, and the velocity of the fluid will be 24 ft. per second, and the power represented by 4.36 horse power.

We have here the same mechanical condition performed in the second case with the expenditure about one-third of the power required in the former.

In fact, when the total pressure is the same, the economy is in direct proportion to the relative speed of the issuing current throughout the scale downwards. He had before stated that the yielding of the abutment, either for sustaining or propelling heavy bodies in air or water, known as "slip," taken as a direct percentage is just equivalent to as much mechanical effort lost upon the weight supported or moved forward.

It has been shown by experiment, that a small jet of water issuing at a very high velocity is inadequate for propelling a steam-vessel. As the size of the jet is increased, and its velocity diminished, so do we obtain a better result. It would appear then conclusively that for the so-called principle of jet-propulsion (which in fact like any other principle of fluid propulsion is merely action and reaction of force between two relative weights) the most favourable condition would be as large a body of water as possible, acted upon in the direction nearest approaching to the vessel's course, without either turns or deflections, and that this is best to be arrived at, not by any paradoxical form of centrifugal pump, but by the direct action of a screw contained in the water channel, and the same reasoning will apply to similar proposals for aerial propulsion made to this society.

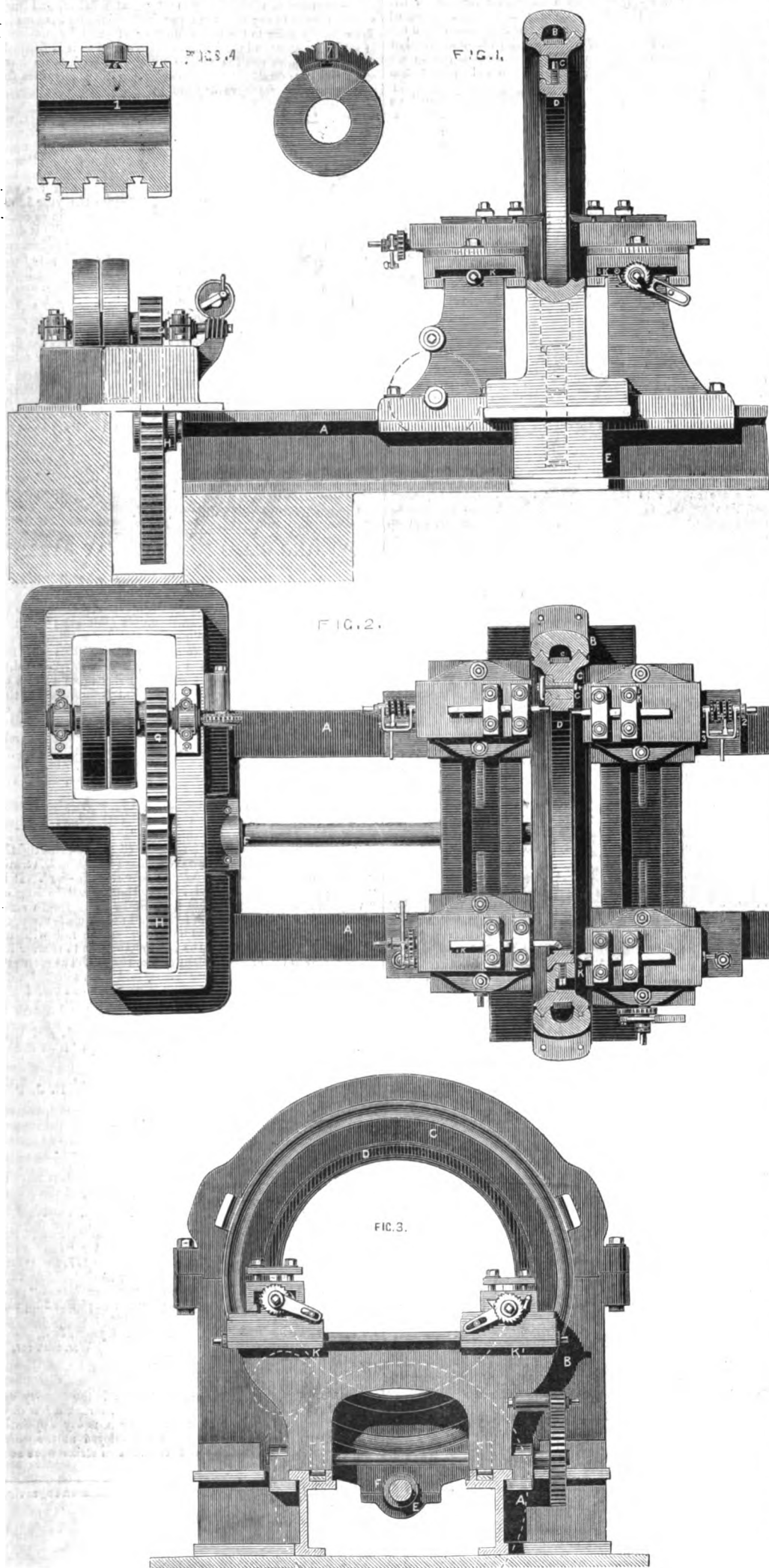
He here assumed that the screw is enclosed in an open-ended case; but if there is plenty of clear space in front, the screw will act as well or better without being so enclosed, and therefore, in spite of the costly experiments that have recently been made to revive the system of jet-propulsion, it was clear to him that the screw propeller must be much superior.

(To be continued.)

* An engraving of the figures which accompanied Major Phillip's paper will appear next week.

LATHE FOR BORING AND FACING RAILWAY TYRES.

CONSTRUCTED BY MESSRS. GREENWOOD AND BATLEY, ENGINEERS, LEEDS.



GREENWOOD'S TYRE-LATHE.

WE give, in the annexed engravings, various views of a new form of lathe which has been recently patented by Mr. Thomas Greenwood, of the firm of Messrs. Greenwood and Batley, the well-known tool-makers of Leeds. The lathe has been designed to facilitate the boring of railway tyres, by enabling the whole operation to be completed without shifting the work in the machine, the arrangement being such that cutting tools can be simultaneously brought into action on the opposite faces of the tyres, and also on its inner surface. In the engravings, Fig. 1 is a part side elevation and part section; Fig. 2 is a plan, partly in section; and Fig. 3 is a transverse section.

A is the bed of the machine, and to it is firmly bolted an arched casting, B, which is made in two parts, and is intended to carry the chuck, the inside of the casting, B, being truly turned to receive a ring chuck, C, which is intended to carry and drive the tyre, D. In the casting, V-grooves are turned to receive corresponding projections on the ring chuck, C, and between these projections the ring, C, is provided with spur teeth, c; fitted into the ring, C, is a ring, C*, provided with radial clamping screws, by means of which the tyre, D, is securely held. The chuck thus constructed is driven by a spur pinion, E, which gears into the spur teeth carried by the ring, C, this spur pinion being keyed to a shaft, F, which has its bearings in the bed of the lathe, and receives rotary motion from the main driving-shaft, I, through the spur gearing, G H. On each side of the tyre thus mounted, two slide-rests, K, K', K'', and K''', are arranged (four in all), these carrying four cutting tools suitably shaped for their respective duties, two being on each side of the chuck; these rests receive a feed-motion from an overhead rocking-shaft in the ordinary manner. When the tyre is intended to be filled with a wood interior, as in the case of Mansell's wooden disc wheels, it will require to have a groove turned in each side of it, into which the flanges or rings which clasp the wood interior are to be fitted, and it is desirable that both sides of the tyre should be turned before the tyre is removed from the chuck. The arrangement of lathe shown in Figs. 1, 2, and 3, admits of this, as the turning can be completed without removing the tyre from the chuck.

Instead of using the ordinary ratchet-wheels and clicks or pawls for giving the feed-motion to the tools where an automatic feed is required that will arrest the advance of the cutter on its reaching a given point, Mr. Greenwood employs the feed shown in Fig. 2 as applied to the slide rests, K and K'. On the periphery of a worm or scroll, 1, which is keyed to the ordinary feeding-screw, 2, are formed ratchet teeth to receive the driving pawl; upon this screw, 2, swings a forked frame, 3, which carries a round cross-bar, and on this bar the pawl, 4, that drives the worm-ratchet is free to slide in order that it may follow the helical arrangement of the ratchet-teeth. Between the coils of the thread of these ratchet-scrolls an adjustable cam-like projection is fitted for throwing the pawl out of action. It may be constructed in various ways; but the simplest form is that shown in the detached views, Fig. 4; in the helical groove of the ratchet-worm a rebated groove, 5, is cut, and fitting into this groove is the head, 6, of a screw which receives a clamping-nut, 7, that binds it firmly in place and forms the adjustable stop for arresting the action of the pawl at the proper moment. The pawl is made sufficiently wide to extend beyond the teeth of the worm, and the nut or cam-like projection, 7, is made to stand somewhat higher than the ratchet-teeth; this arrangement admits of several turns of the feeding-screw in the rest being obtained, and of the action of the pawl upon the teeth of the ratchet being arrested on the tool arriving at any desired point; the constant attention, therefore, of the attendant will be rendered unnecessary. This ingenious arrangement is applicable to the automatic feed of turning tools generally, and may be beneficially employed where from the varieties of work performed the employment of fixed stops for throwing the tool out of action are not admissible.

Messrs. Greenwood and Batley have just completed one of the lathes above described for the Leeds Wheel and Axle Company, whose plant for railway wheel-making is probably the finest in the kingdom.

EASTERN OF FRANCE RAILWAY.—The directors of this important undertaking have just opened a section from St. Hilaire au Temple to St. Menetbould. The line, which is 28½ miles in length, comprises five stations. The length of worked line on the Eastern of France system is thus carried to 1630 miles.

CHEAP RAILWAY WORKING.—The working expenses on the South Austrian division of the South Austrian, Lombardo-Venetian, and Central Italy Railway were last year very low. Thus the ratio of expenditure to receipt was only 31.10 per cent. Some of our English lines would be greatly advantaged if they could bring down their outgoings to such a proportion.

GAS IN PARIS.—The revenue of the Parisian Company for Lighting and Heating by Gas shows a very large increase this year. Thus, in the six months ending June 30, the company's receipts expanded to the extent of 58,689L, or 10.25 per cent., as compared with the corresponding half of 1866.

PANAMA.—A new arrangement has been made by the English Post Office and the British consul at Panama, which is expected to facilitate postal relations between that port and Europe. At each departure of a steamer from Colon to New York a mail will be made up at the Consulate, to be forwarded to England *via* the United States. It is expected to reach Liverpool at least as quickly as the mails by the direct line *via* Southampton.

MERSEY DOCKS ESTATE.—The Mersey Docks and Harbour Board has been authorised to raise an additional sum of 227,000L under an amended Act, which has received the sanction of a Lords' committee. This sum, together with a balance of 168,187L available under an Act of 1864, is to be applied to the construction of one of the steam docks authorised in that year, and to the providing further accommodation for the timber trade.

SHEFFIELD.—Orders for steel railway plant and Bessemer steel rails give a certain activity to the steel trade of Sheffield, which, but for this help, would be dull. A moderate amount of business has taken place in merchant's iron for export; the home iron trade is somewhat dull.

CLEVELAND IRON.—The number of furnaces in blast in the Cleveland iron district is eighty-eight. The trade has presented little change during the last few days.

CENTRAL PACIFIC RAILROAD OF CALIFORNIA.

To those who are not conversant with the rapid strides railroads are making in America, it may be interesting to know that there is now building a railroad which (in connexion with lines already completed) will cross the continent in a direct line from New York, on the Atlantic, to San Francisco, on the Pacific Ocean.

This line is called the Pacific Railroad, and is being constructed under the patronage and grants conferred by the Government of the Eastern States, and is intended to connect the railroad system of the United States with California, &c.

The distance from New York to San Francisco, *via* Chicago, Omaha (on the Missouri river), Salt Lake, and Sacramento, is about 3300 miles.

Omaha, the eastern terminus of the great national road, is about 1450 miles west of New York.

The work divided between two organisations (financially separate), one under the title of the Union Pacific Railroad, constituting the eastern division from Omaha to near Salt Lake, and the other the Central Pacific Railroad of California, extending from the tide-waters of the Pacific to near Salt Lake, where it is estimated the two lines will unite, from the east and west, during the year 1870.

The Pacific Railroad is estimated to cost one hundred million dollars. Of this sum the U.S. Government give the use of fifty million dollars U.S. six per cent. bonds for thirty years; also the fee simple of 12,800 acres land per mile along the line of the road, creating a magnificent domain for the companies, of about 22,000,000 acres of valuable land, which is rapidly becoming more valuable as the railroads are extended.

The timber on the lands in California is of immense importance to that State and Nevada. It is a common occurrence to find the sugar-pine growing 125 ft. high before reaching the first branches, and 8 ft. in diameter at the base, while large numbers of trees are found measuring 8½ ft. and 4 ft. in diameter. The supply of wood and timber in many places is becoming very scarce for mining and other purposes, and it is therefore rising in value annually.

The Central Pacific Railroad of California commences the ascent of the foot hills of the Sierra Nevada mountains seven miles from Sacramento (tide-water of the Pacific), and from thence to the summit of the mountain pass 7042 ft., and 105 miles distant; there is a continuous series of heavy ascending grades and sharp curves. The maximum gradients on this portion of the line are 1 in 46½, of which, however, there is less than six miles, and the sharpest curves are 575 ft. radius, but there are only a very few examples of this kind.

The Sierra Nevada mountains are remarkably forbidding in appearance and reality for the purposes of railway building and operating; and to those who are unacquainted with this mountain topography, and accustomed to the lesser elevations and gentler slopes of Europe and the Atlantic States, it will be difficult to convey an adequate idea of the irregularities of surface which attach to them. The general direction of this mountain range is parallel with the coast, and the western slope is intersected by numerous rivers and their tributaries, having their sources near the summit of the Sierras. The rivers run through deep gorges or canons, in many places from 1000 to 2000 ft. in depth, with sides varying from perpendicular to slopes of 45 degrees. The ridges between these water-courses are sharp, well defined, and in many places so narrow on the top as to leave barely room for a wagon road to be made without excavating the surface of the ridge. The branches of many of the rivers course through canons as deep as those of the rivers themselves, and present physical barriers to lines of communication crossing them in a northerly and southerly direction.

The short distance from the western terminus to the summit, 105 miles, and the deep canons to be avoided, rendered it necessary to adopt steep grades and sharp curves to attain the summit elevation; but all these formidable difficulties have now been nearly overcome, the line is completed and in operation to within twelve miles of the summit, and the earthworks and bridging are nearly completed for fifty miles eastward to the eastern base of the mountains; and this latter portion of the line will be completed and opened for traffic by the 1st of November next.

By the 1st of September, however, the rails will be laid to the summit of the pass, and then the locomotive steam whistle will sound its sharp notes from a greater elevation than it has ever before attained, marking an important event in the era of railway enterprise.

From the eastern base of the mountains, for about 575 miles to Salt Lake, the construction of the railroad, for its extent, is remarkably easy and cheap, the greatest cost being, equipments, cross-ties, and iron. The line follows the valley of the Truckee river down to the big bend (where the river turns abruptly to the north), and from there to the valley of the Humboldt river, to nearly its source, thence to Salt Lake, and the initial point of meeting of the Union Pacific Railroad from the east.

The following table will show the number of miles lying within certain elevations above tide-water from Sacramento to Salt Lake:

8½ miles between tide-water and 1000 feet altitude.	
14 " " 1000 feet " 2000 " "	
16 " " 2000 " " 3000 " "	
2½ " " 3000 " " 4000 " "	
480 " " 4000 " " 5000 " "	
12½ " " 5000 " " 6000 " "	
55 " " 6000 " " 7000 " "	
1½ " " above 7000 " altitude.	

726 miles total.

The construction of 150 miles of mountain road, and that, too, across one of the most formidable ranges in the world, where so few important streams are crossed, and so small an amount of bridging actually required, presents an anomaly in the history of railroad enterprise.

The company are building and equipping the road in a first-class manner throughout; their locomotives, cars, &c., are of superior materials and workmanship; and the iron rails are of the most approved American pattern, weighing 60 lb. per yard, the joints of the rails being fitted with wrought-iron plates, bolts, and nuts.

The tunnelling is not of any great extent, and the material pierced is generally of such a character as not to require lining. The longest tunnel on the line is at the summit of the Sierra Nevada, and it will extend 1658 ft. through a very hard tough granite. The progress here was rather slow in the outset, but the introduction of nitro-glycerine as a substitute for powder has enabled the company to make rapid progress since. It is estimated this tunnel will be completed by the 1st of September. All the other tunnels are completed. Whenever cuttings have occurred in constructing the mountain work, rock has been found in all conditions of hardness, from the softest slates and shales to the hardest serpentine and granite.

Wherever trestle bridging has been employed, it has been planned with a view to strength, safety, and durability, the ties, stringers, corbels, and caps being of best quality of pine from Puget's Sound (nearly equal to oak), and the posts, braces, sills, and piles of redwood. The main posts, 12 in. square, are placed perpendicularly, let into a sill 12 in. square, with mortice and tenon, directly under the bearing of the track stringers. Two posts, 12 in. by 12 in., extend down on the outside of the main posts, with a run of 1 ft. in 3 ft. to the sill, to which they are tenoned, being also bolted at the top to the main posts with inch bolts and cast-iron washers. The sills rest on piles, on stone foundations. When piles are used, they are so driven as to come directly under the main posts and braces.

The posts are capped with a timber 12 in. square and 9 ft. long, into which the posts are tenoned and pinned. Upon the caps rest the corbels, 12 in. square and 9 ft. long; upon these corbels are laid the stringers, 12 in. by 15 in., which are secured by iron bolts passing down through the stringers and corbels. The caps are notched 1 in. to receive the corbels. Upon the stringers rest the cross ties (or sleepers) securely fastened down to the stringers, and on these are laid the rails, which are secured in the usual manner. The "bents," or frames, are placed at intervals of 15 ft. from centre to centre.

Trestling constructed after this manner will last from eight to fifteen years, and when renewals are necessary it can be replaced at small cost, or filled with earthen embankment by transporting material on cars at much less cost than would have been incurred in making the embankments originally.

We are enabled to lay before our readers copies of photographic views taken on the line of this railroad, from Sacramento to the summit of the mountain pass, which convey, though in an imperfect manner, some of the engineering difficulties encountered in the construction of this great work. Nos. 1, 2, 4, 5, and 6 are examples of the trestle and truss bridging referred to above. No. 3 is a cutting, 63 ft. deep and 800 ft. long, through a cemented gravel and sand, hard as solid rock, and requiring blasting. No. 7 is a view of the entrance to the tunnel at Horse Ravine, and the retaining wall approaching to it. Nos. 8, 9, and 11 show something of the rugged nature of the country and the difficulties to be surmounted. No. 12 is a view at Crystal Lake, whose waters are the purest imaginable, as shown by the reflections beneath its surface of buildings and other objects on its margins.

The revolution in the communications with China, &c., must be great when this railroad is completed. The tide of traffic across the country from ocean to ocean is already very large, and on the increase, notwithstanding all the delays, discomforts, and terrors of a sea voyage *via* Panama, &c.

It now requires from twenty to twenty-three days to make the journey from New York to San Francisco *via* Panama; but when this line is completed the trip will be made within seven days, and then in connexion with the line of steamships already running regularly between San Francisco and Hong Kong, the trip can be made from New York to Hong Kong in less than thirty-five days.

Mr. Samuel S. Montague is the chief engineer in charge of the construction of the works, having succeeded the late T. D. Judah, Esq., who made the original surveys for the location. We are indebted for the particulars of the Central Pacific Railroad above given to Mr. George E. Grey, the consulting engineer of the line, who is now in London.

THE SOUTH WALES INSTITUTE OF ENGINEERS.

THE next General Meeting of the members of this Institute will be held at the Royal Institution, at Swansea, on Saturday, the 17th August. The chair will be taken at one o'clock P.M. The nomination of office-bearers will take place.

The following papers will be discussed:
On the "Duration of the South Wales Coal Field," by Mr. Beddington.

On the "Port of Newport and its Coal Field," by Mr. Bassett.

On the "Cornish Engine," by Mr. Loam.

The discussion of the paper of Mr. Cope Pearce, on "Mechanical Ventilation," and the paper of Mr. Vivian on the "Structure of Iron," will be resumed.

The following papers read at the last meeting will be discussed:

On "Pumping and Winding," by Mr. Cope Pearce.
On the "Coal 'Brasses' of the South Wales Coal Field," by Mr. W. Adams.

The following papers will be read and discussed:

On the "Tillery Coal Seams and Workings—Abertillery," by Mr. T. Dyne Steel.

On "Davies's Self-acting Steam Striker," by Mr. D. Davies.

On "Patent Fuel," by Mr. Bassett.

On "Bessemer Steel," by Mr. Walter Child.

On "Overwinding, and how to Prevent it," by Mr. W. Fairley.

The secretary of the Institute is Mr. E. Bridgen, of Merthyr Tydfil.

BOVILL'S CORN MILL PATENT.—There is a patent which ought never to have been granted, nor, once granted, extended. A patent which is yet likely to be defeated, and yet Mr. Bovill is just now carrying everything before him. The millers' union, numbering nearly one hundred members, combined for defence against this patent, are being sued in detail, and so far the cases have gone against them.

THE ROYAL AGRICULTURAL SHOW.

TO THE EDITOR OF ENGINEERING.

SIR,—An inquiry as to the number of engines made by us, contained in your report of the late show at Bury St. Edmunds has been pointed out to us. Permit us to answer it. Neither of the numbers on the engines you refer to at Salisbury and Bury shows indicate in any way the number of engines we have made. They simply refer to the index number of our reference-book, in which we enter full particulars of each engine as it is finished.

We cannot give you the precise number of engines we have made since the establishment of our firm, as it is only since the year 1854 that we have distinct records of them, although there are many of our engines upwards of twenty years old still in every-day work. During the last six or eight years, we consider 200 engines per annum about the average return, and we believe we have made about 3200. While we are upon this subject, allow us to say a few words upon the system of competitive trials for prizes as carried on at the shows of the Royal Agricultural Society. We have not joined in the expensive amusements of the "trial week" since the year 1859 and we are not disposed to appear upon the scene again as competitors. In the first place, we find that commercially it does not pay; the public are now-a-days so much more influenced by their own judgment of what is practically suited to their requirements than they are by the award of prizes of the Royal Agricultural Society, that the prize now carries but little weight with it. Some inexperienced purchasers there may be, who would even buy the prize engine if they could, but few makers would let them have it. These stray orders are, however, only a flea-bite compared to the general demand, and we do not find them worth the outlay required to obtain them. Many other good reasons we could show in support of our conviction as to the uselessness of these trials, but we fear to trespass too much on your space. We will only say, in conclusion, that we are fully contented with the awards which we receive from the public, and that the position we occupied at the Bury show as "non-competitors" so far met the approval of that influential body, that we should not be surprised to see many other firms veer round to our opinion before another show takes place.

We are, dear Sir, yours faithfully,

R. GARRETT AND SONS.

Leiston Works, Suffolk, July 31, 1867.

SPRING CLIPS FOR RAILWAY BARS.

TO THE EDITOR OF ENGINEERING.

SIR,—In the article on "Spring Fastenings for Rails," in your issue of the 19th ult., you illustrate a "Spring Clip," which is intended to replace the ordinary iron fish-plates. Permit me to offer you a tracing showing a cross-section (full size) of the rail and "scabbard rail-joint" now in use on the railway from Truro to Pictou, in the Province of Nova Scotia. This rail-joint was adopted by Mr. Sandford Fleming, late engineer-in-chief, and is thus described by that gentleman: "From results of experiments and investigations which I first published in the winter of 1859-60, I was led to adopt a new description of 'rail-joint' throughout the whole length of this line. This new 'rail-fastening' is simply a plate of steel enveloping the adjoining ends of the rails (the top surface excepted), and I have had them made of various lengths from 12 to 20 in. They have been severely tested during the past winter, and have stood the test far better than I ever expected."

Mr. G. Lowe Reid, chief engineer of the Detroit and Milwaukee, the Great Western of Canada, the Galt and Guelph, &c., railways, thus reports on the "clip":

"This fastening consists of a sleeve or clip which grips tightly around the bottom flange and centre stem of the rail, terminating on both sides immediately under the rail-head. It is made of spring steel of ½ in. in thickness, and in lengths varying from 12 to 20 in., but those of 14 in. in length suspending the rail-joints seem to afford all the requisite strength and support. This scabbard is driven on the rail without difficulty, the elasticity of the steel allowing it to recover its form, and to retain a very tight grip of the rail. The strength of the joint is certainly very great, and I am satisfied that no other joint at present known to engineers could stand the wear and tear which yours have done on an unballasted load-bed without any perceptible injury to it."

I may add that the rail weighs 56 lb. to the yard, and that the length of line laid with these "scabbard clips" is 58 miles, exclusive of sidings.

Yours faithfully,

H. J. P.

London, July 23, 1867.

THE AERONAUTICAL SOCIETY.

TO THE EDITOR OF ENGINEERING.

SIR,—Will you kindly insert the following corrections to your print of the first paper read at the late meeting of the Aeronautical Society of Great Britain?

Errata: line 34, for "figure" read "pigeon;" line 49, for "6½" read "7½;" line 83, for "extreme" read "return;" line 97, for "impose" read "impart;" line 104, for "sits" read "gets;" line 145, for "wing" read "will;" line 177, for "lot" read "jet;" line 194, for "Lenoir's" read "Lenoir's;" line 228, for "5 in." read "5 ft.;" line 233, for "prepared" read "preferred;" line 234, for "700 lb." read "100 lb.;" line 258, for "feeling" read "feelings."

And oblige yours, &c.,

WM. SMYTH.

1, Cottage-green, S., July 23, 1867.

SEIKING OUT OF SPIRIT.—Seventy men in the foundry department of Harland & Wolff's works at Grantham, struck a few days ago because they objected to work under a newly appointed foreman who had, however, been long employed at the works as a journeyman. The places of the men on strike were soon supplied from other towns.

The form of this clip will be understood without an engraving. 22 Ed. E.

AN ENGINEERING FACTORY.

AMONG the delightful uncertainties and the graver certainties of beginning business as a mechanical engineer, nothing save booking the first order (supposing it to be a handsome one) has more interest for the future Whitworth or Maudslay than the designing of his own works. To lay out his own acre with his own foundry and smithy and erecting-shop, and to put down the newest and best plant, may have been a dream from boyhood, and when the castle in the air has at last taken to itself foundations and walls and roofs and a high chimney, and has been duly furnished with a steam-engine and shafting and tools, and the name of the new firm has been painted on the gate, and the place is beginning to be alive with workmen, nothing but a young mother with her first baby can be compared to him. How few of our leading engineers have had such an opportunity. Henry Maudslay moved from Margaret-street, Cavendish-square, into a little shop in Lambeth, and there, dovetailed at numberless corners into the surrounding property, is still the great factory of Maudslay, Sons, and Field. John Penn has admirable works, but they have grown piecemeal out of the old millwright-shop at Greenwich. Joseph Whitworth, in his long and successful career, has never had to plan new and complete works of his own, nor has Robert Napier, nor did Richard Roberts, nor the Stephensons, nor the Hawthorns. This is a luxury reserved for but few. Charles Beyer enjoyed it to the full at Gorton, James Howard at Bedford, and Nielson, Dübs, and John Elder have had a taste of it in and near Glasgow. Designing new works for others is nothing to it, the difference being as great as that between building a house or a yacht on speculation and building one for one's own occupation.

We have now in our eye a little spick and span new factory, a sort of pocket edition of an engineering works, of which our readers will be told more in some future number. It is on the Thames, and stands, indeed, on the site of the former residence of a famous operative manager, and there is now lying uprooted in the yard the stump of an old chestnut tree—a tree once well known to oarsmen on the river, and under which the Swedish nightingale herself has often warbled. Never mind the name of the new works, nor of the owners. They are clever young engineers, and have planned and built for themselves. There is a capital river wall, with one of Henderson's derrick cranes, the latter not yet half well enough known among engineers and contractors. Here is the foundry, a little gem in its way, and full of neat dodges, new and good. The walls are very light, only a brick thick, for the roof is carried almost wholly on iron columns, and the cranes, which swing to cover every part of the floor, are tied to these by horizontal tie-rods radiating from the top spindle of the crane. The floor itself is 6 ft. in depth of moulding sand, and plenty more of fine, admirably open, and just sufficiently binding sand may be had, for the digging, on the spot. Here is one of Woodward's steam-jet cupolas, as illustrated in our third volume. It is very small, but it brings down the iron as if it were tallow, and there is room besides for a larger one. It works with but 1 cwt. of coke to 14 cwt. of pig, and this is about as good practice as is ever made, except with the freest-running Scotch irons. The top of the cupola is closed by an iron feeding-hopper (much like a blast furnace top where the gas is taken off), and the waste gases here pass off through a horizontal pipe, just below the hopper, to the high chimney. The charging of the pigs, once they are in the hopper, is hardly the work of an instant, and the top of the cupola is as quickly closed again. The cupola has, too, as all cupolas should have, a drop bottom, so that when the cast is over, down goes the cinder into a pit where it is quenched, and afterwards raked out. No founder who has once worked a drop-bottom cupola would ever again work any other. The bottom trap-door is, of course, strongly hinged and fastened, and such a thing as its accidental fall and the loss of a charge is unknown.

And pray what is this little room with iron sliding doors and a window at the end? Surely it cannot be a core oven, for who ever saw a core oven with a glass window in it admitting the full light of day? But it is a core oven after all, and yet no fire is ever to be lighted in it, and the moulders must forego the thin carbonaceous crusting of their cores with soot, so long thought the correct thing in cores. No; there are some curious hot-water pipes, heated by a little furnace outside, and they are curious indeed. They are Perkins's hot-water pipes, made to bear a pressure of a ton to the square inch, filled, each, three-fourths full

of water, and welded up or otherwise hermetically sealed at each end. These tubes are inclined, and the water end lies in the fire. The steam rises to any pressure it likes, for of course there is no safety-valve, and it comfortably condenses again as the fire goes down. They never burst; and even if they did, probably no very destructive results would follow. We fully described Perkins's pipes, as applied to baking purposes, more than a year ago; and they are now adopted by the War Office for the army bakeries. The pressure of the steam may be judged from the temperature intended to be maintained in the core oven, viz., 500°. The core oven has double-brick walls, with a 4 in. air space all round, and the window, which is not large, is also double. And the interior, like the rest of the foundry, is actually whitewashed.

The roof of the foundry is made, as are all the roofs, to allow of ventilation, a series of overlapping Z-shaped louvre boards along a step on each side of the roof permitting the free escape of air, while preventing any intrusion of wind or rain.

The smithy, with three pairs of double fires, back to back, the blast to be supplied by one of Root's blowers, whenever Thwaites and Carbott are ready to make them, is exceedingly neat and compact. About one-third of the width of the roof, on each side of the ridge, is glazed with rough glass to admit light, and this glass projects about a foot beyond the upper longitudinal edge of the corrugated roofing below, and is also a foot clear above it, leaving a clear open passage on each side for smoke, but through which rain cannot beat in.

The erecting-shop, with the tools all on one floor, has a good deal of special construction about it, and we shall, in a future number, engrave a section of it. The owners of the adjoining land had run up a brick wall about 10 ft. high along their boundary. Now it would not do to build into nor upon this wall, but it was utilised nevertheless. A range of brick piers was built against it, and arches were turned between these, at a height of 7 ft. or 8 ft., and a little brickwork carried along above to support the countershafting and a little of the weight of the roof. A good bit of brickwork was saved in this way, and "my neighbour's" wall is neatly whitewashed between the piers, and forms the veritable wall of the factory itself. As with the foundry, the brickwork of the erecting-shop is very light, the traveller and the greater part of the roof being supported on iron columns. The machine tools are ranged next the dead wall already mentioned, and are lighted from a skylight along the roof on that side. The work-benches are on the opposite side, and are lighted by side windows looking into the yard. The construction of the roof, as a whole, and the supports of the traveller are peculiar, and must be explained at some future time in connexion with an illustration. The traveller, to lift 20 tons, is formed of a pair of box girders, is worked wholly from the centre, and, by the strength of one man, is up and down the factory as if it were a locomotive. There are a few also of Richard Roberts's friction windlasses, as used by him, thirty years ago, at the Atlas Works, Manchester, fixed to the iron columns. Wonderfully handy things they are for miscellaneous lifting and holding. Ashton, who hoisted the ironwork of the great domes of the Exhibition building of 1862 into place, found them so, and we believe he received a medal or an honourable mention for Mr. Roberts's invention.

There are some capital tools here, all by Craven Brothers, a comparatively new but rising Manchester firm. There is a lathe (not a gap-lathe) of which the headstock and bed may be completely separated to admit of turning large objects, the tool-carriage and rest being also adjustable on separate supports, bedded on heavy masonry, so that a casting 16 ft. in diameter may be as easily faced as one of 3 ft., and, by the various cones, countershafts, and back gearing, no less than thirty-two speeds adapted to every size of work may be had. The planing-machine is not yet in. A radial drilling-machine has its bed fitted to take work either on its top or side surface. The drill spindle, instead of being traversed to the end of the radius arm by a screw, with which, as commonly fitted, the man must leave the drill to reach the screw-wheel, or else get another man to turn the screw while he watches the position of the drill, is traversed in or out by a pinion working in a rack on the radius-bar, the hand, wheel of the pinion being exactly opposite to the drill, so that the workman may both move his drill to any point and at the same time see its exact position. By a neat arrangement also of engaging and disengaging gearing, the radius-bar is raised or lowered, not by hand, but from the main driving gearing itself, the

height of the radius-bar not being a matter of necessarily exact adjustment, since the feed of the drill-spindle permits of exactly reaching the work after the radius-bar has been once adjusted roughly to about the proper height.

The shaping-machine has a neat quick return motion, not absolutely new, yet worked out with original detail. It is that with an adjustable crank-pin on the face of a revolving wheel, the crank-pin, carrying a block, which slides in a slotted link, the latter pivoted at one end and connected to the sliding-tool bar at the other. The crank-pin and sliding block work in the outer end of the link in making the cutting stroke, and in the inner end in making the return, the speeds varying inversely as the distance of the block from the fulcrum upon which the link vibrates, the speed being, of course, greatest when the block is nearest to this fulcrum. There is a neat little thing, too, in slotting drills, whereby an ordinary drilling-machine is almost in a moment adapted to slotted drilling, and which we would be glad to illustrate.

The countershaft brackets, instead of being bolted to the side wall of the building, are fastened by T-headed bolts, the bolt-heads taking into grooves in a line of cast-iron wall-plates extending the whole length of the factory. A countershaft may thus be fixed anywhere along the wall, according to any required change in the position of the tools, and with no trouble whatever. The same plan—and it is an excellent one—has been adopted in the new machine shop at Swindon, and, in a slightly different form, wall-plates applied in this way have long been in use at the shops of the Great Eastern Railway Company, at Stratford, and at a few other works.

The vices are of cast steel, solid throughout, with the boxes bored out of the solid. These are a new sort, only lately brought out by Ibbotson.

We have said nothing of the boiler or engine. The latter is a temporary affair of Wheatley Kirk's, and will soon be sold for whatever it will fetch, and give place to a good job to be turned out at the works. The boiler is one of Wright's, of Gosport, with the seams running spirally around it to give increased strength. The plan is not half a bad one. We saw locomotive boilers made in this way, not in England, however, twenty years ago. There is a neat smoke-preventer connected with the firedoor. There is an outer close door and an inner grated one, and when the outer door is open a rod attached to it, and which runs along the ashpit, also opens an air-door at the bridge for extra air admission there. The boiler has two gauge-glasses, one at each side, and it has Baker's magnetic anti-incrustator (which is now coming so generally into use) inside. There is one of Robertson and Gresham's patent Injectors, with a dodge or two supplimented upon Giffard's original. The overflow is taken in a tin pail beneath, and the Injector, when at work, will suck up every drop which may have previously overflowed into the pail. Then there is also one of Cameron's donkey-pumps, among the best of the fly-wheel class of donkeys, and which, unlike the abortion we lately criticised, may be safely trusted if left to run alone. The coal is shot, outside the boiler-house, into a pocket opening just above the level of the boiler-house floor, and but the least quantity of coal is ever in sight, however much be ready to come down, and the boiler-house floor is as neat as that of any well-kept kitchen. The roof of the boiler-house is formed by a large water-tank, which, filled from the river, gives a large store always ready in case of fire. The boiler-setting is excellent, the flue bricks, in Stourbridge clay, being all made to the proper curve, according to a drawing sent to the makers.

The store-room and pattern-shop form an exception to the other buildings, being three stories in height, and having the side looking into the yard formed almost entirely of large windows. The patterns—and there is quite a stock already—have all those parts which are to be faced or finished painted red as a guide to the moulder, the ends of the core prints being painted white. All other parts are black.

The store-sheds, loam-sheds, room for clearing castings, urinals, &c., are all admirably arranged. Of the offices and general system of working, and management of the workmen, we shall not now say anything, beyond this, that none of the workmen are union men, but that they have a benefit society of their own, and pay each 6d. weekly to the sick fund, to which also all fines, &c., levied by the masters are paid in. The men also job their doctoring and surgery, a hospital doctor visiting them for so much a year, and being partly paid by the masters.

More will appear concerning these little works in a future number.

THE NYMPH AND THE DAPHNE.—These vessels have been tried at the measured mile with the following results:

	Nymph.	Daphne.
Maker of engines...	Maudslay	Ravenhill
Nominal horse power...	300	300
Number of cylinders...	3	2
Diameter of cylinders...	55 in.	62 in.
Stroke...	30 in.	27 in.
Diameter of screw...	15 ft.	15 ft.
Pitch of "	15 ft.	13 ft. 9 in.
Steam pressure...	28½ lb.	30 lb.
Revolutions full power...	102	101
" half "	78	
Speed full power...	13.066	12.551
" half "	10.447	10.499

These ships give much the best co-efficients on their half-power trials.

FIRE-ENGINES.—At the last meeting of the Metropolitan Board of Works the report of the Fire Brigade Committee was brought up. It recommended that the tender of Messrs. Shand and Co. for the supply of twenty-four new manual fire-engines for the sum of 1560*l.* be accepted. There were two other competitors, being Messrs. Merryweather and Messrs. Roberts, both of whose tenders exceeded 1700*l.* Mr. Newton moved that Messrs. Shand and Mason's tender be accepted, which was seconded. Mr. Lammen moved, as an amendment, that the report be referred back to the Fire Brigade Committee, in order that they might be enabled to ascertain and report on the relative cost of repairs of the engines manufactured by Messrs. Shand and Mason and Messrs. Merryweather. He said that without such information they might, by fixing on the lowest-priced engines, really buy the most expensive ones. Messrs. Shand and Mason had certainly many more of their engines employed in the Fire Brigade than Messrs. Merryweather, yet it appeared to him that, taking that fact into consideration, there was still a very much larger sum placed to the repairs of the engines manufactured by Messrs. Shand and Mason over that of Messrs. Merryweather than the extra number warranted. On a division the amendment was agreed to.

MR. WHITWORTH'S TRUE PLANES.—Mr. Whitworth has addressed to the Science and Art Department the following letter, which was laid before the Select Committee on Paris Purchases: "Feeling the national importance of maintaining the position which England has reached in the manufacture of machinery in general, I desire to do as much as may be in my power towards effecting this object. I should therefore feel obliged if you would inform the Lord President of the Council that I am willing to deposit in the South Kensington Museum, to be there perpetually preserved, three original true planes and a measuring machine, or instrument, demonstrating the millionth part of an inch, and I propose, subject to some conditions, to make a sufficient endowment to provide for the delivery of lectures to explain such instruments. Their importance will be manifest when it is considered that the value of every machine when made of the best materials depends on the truth of its surfaces and the accurate measurement of its parts."

THE THAMES CONSERVANCY.—The conservators of the river Thames state in their report on the year 1866, just issued, that in that year proceedings were instituted against persons for throwing mud into the river, and against the owners of gas and chemical works for permitting gas refuse and offensive matter to pass into the river, and 77 convictions were obtained.

THE HOLBORN VALLEY VIADUCT.—At the last meeting of the Court of Common Council, the recommendation of a committee to employ Mr. Haywood, the engineer to the commissioners of sewers, as the engineer to the Holborn Valley Viaduct was rejected. It is to be placed in the hands of the City Architect.

OUR EXPORTS.—The Board of Trade returns show a gain of 6 per cent. in the declared value of our exports for June (15,490,091*l.*) as compared with June 1866, and 17 per cent. increase over June 1865. Iron manufactures have held their own, and the increase in the exports of machinery is 21 per cent. over June 1866. There is a decrease in the cotton, silk, and haberdashery trades.

INDUSTRIAL DWELLINGS.—The Improved Industrial Dwellings Company (limited) is paying 5 per cent., and can now profitably employ 150,000*l.* additional capital, the existing capital being 81,225*l.* Several new blocks of houses, capable of accommodating 200 families, are in course of erection. The finished houses are let as soon as they are ready for occupation; indeed, the company cannot supply house accommodation fast enough.

THE SOCIETY OF ENGINEERS.—The members and associates of the Society of Engineers will to-day visit the Millwall Docks. These docks are amongst the most important engineering works now being carried out in the neighbourhood of the metropolis.

COAL TO LONDON.—The metropolis is now taking its 6,000,000 tons of coal yearly, and rather more than half now comes by rail; the rest, as before, by sea. The great and promising coal-field of Derbyshire is now being worked with remarkable vigour, and the railways, especially the Midland, with its extension to London, will have a large share of this traffic. By the way, Powell's Duffryn coal can now be had in the river, by the cargo, at 17*s.* 9*d.*, and the best Durham coals at 27*s.*

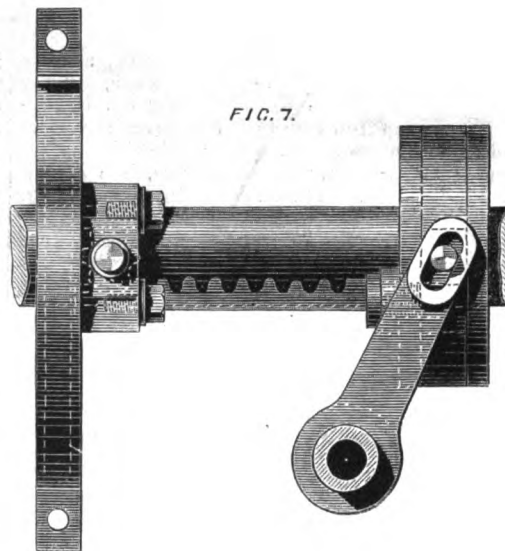
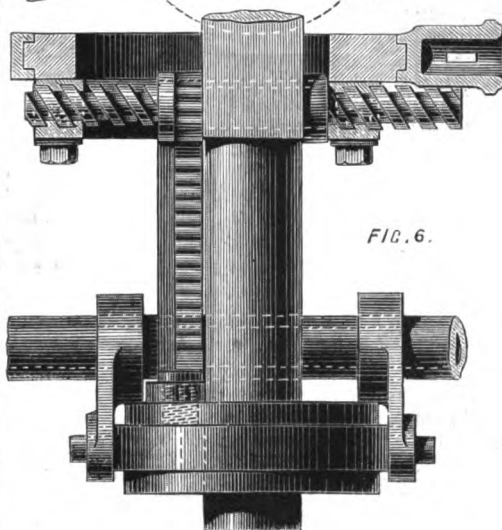
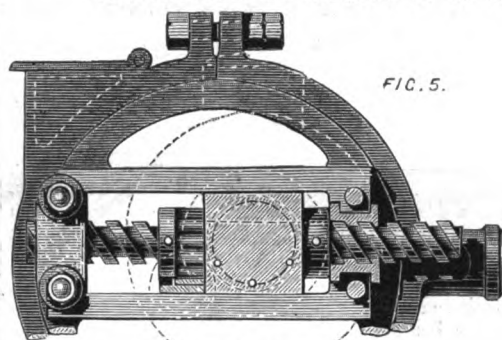
RAILWAY TRAFFICS.—The railway traffic receipts for the week ending July 20th, were nearly the largest ever reported, being 797,689*l.*

SLIPPED INTO THE SEA.—Belmullet, in the county Mayo, may be considered as the north-west extremity of Ireland. Forty acres of mountain bog there last week slipped into the Atlantic. The peat had been dried by the drought, and the water from the late heavy rains had accumulated under it, and so the bog at length broke away. Ten acres of standing crops and the huts of three or four families were destroyed.

THE RAIN.—3.67 inches of rain fell on Friday last at Greenwich, the greatest depth ever registered there in twenty-four hours. 3.70 inches fell at Edinburgh, a fine "Scotch mist" even for that hydraulic capital.

SHIFTING ECCENTRIC FOR TRACTION ENGINES.

CONSTRUCTED BY MESSRS. E. R. AND F. TURNER, ENGINEERS, IPSWICH.



SNIDER RIFLES.—The conversion of the Enfields is now going on at the rate of 1100 daily. Over 270,000 have been converted, and 130,000 more remain to be dealt with.

THE AMERICAN LIFE RAFT.—The raft Nonpareil, Captain Mikes, which left New York early in June, has arrived at Southampton after a voyage of 43 days. Captain Mikes was accompanied by two men. The Nonpareil is formed of three cylinders, charged with air and connected by canvas webs stiffened by planking. She is 24 ft. long and 12½ ft. broad, and carries two masts. Mr. Macgregor, we may add, has been crossing the Channel, alone, and in a gale, in his three-ten yawl, the Rob Roy. Truly old ocean is kind, or these gentlemen would never have reached English soil, there to recount their adventures.

THE BRENNER PASS.—The first trial trip on the Brenner Railroad between Innsbruck and Botzen was to have been made on the 25th ult., and the line will be opened to the public in the middle of August. A direct connexion between Italy and Central Germany will be established by the opening of this railroad.

BLAST FURNACES.—We lately heard it given out as a new discovery the taking off the gas from some of the Staffordshire blast furnaces. A furnace proprietor at Bloxwich has had lately to sue a firm of engineers, who, in putting a dome to his furnace, made it, as he alleged, too small. The matter went to arbitration.

THE SOMERSETSHIRE.—Messrs. Money Wigram and Son's new steam-packet, the Somersetshire, built to take the place of the ill-fated London, was tried last week. She is 271 ft. long over all, 41 ft. beam, and 28 ft. depth. Her engines by Humphrys, who also built the engines of the London, are of 300 horse power, capable of working up to a maximum of 1800. No attempt at speed was made, but at 70 revolutions, and at ten knots, the ship was remarkably steady.

THE NEW ENGLAND AND BELGIAN CABLE.—The contract for the new telegraph cable between England and Belgium, now about to be laid by the Submarine Telegraph Company, has been taken by Mr. W. T. Henley, of North Woolwich.

ENGLISH ENGINE-DRIVERS IN EGYPT.—There are but comparatively few English drivers on the Egyptian railways. They receive from 20*l.* to 26*l.* per month, besides overtime. They lately struck upon a question of hours and lodging accommodations at termini, but their pay was not withheld, as was lately reported in the papers.

IN GALICIA.—The Lemberg-Czernowitz Railway, constructed by English engineers, has withstood the late heavy floods in Galicia, while the lines made by the Austrian engineers have suffered greatly. The Carl Ludwig line from Cracow to Lemberg cannot be reopened for goods traffic before the middle of September.

STEAM CULTIVATION AND UNDER-DRAINAGE.—Mr. Bailey Denton, in a letter wanting in important detail, writes to the *Times* concerning Earl St. Germans, North Park Farm, Blackheath. He alleges that upon soil of the same general character, that ploughed with Fowler's steam-plough and under-drained, is bearing a crop of 45 bushels of wheat per acre; that steam-ploughed but not under-drained 30 bushels, while neighbouring land of the same quality, but neither steam-ploughed nor under-drained, shows a crop of but about 20 bushels per acre. The wheat, valued at 8*s.* per bushel, would represent a value respectively of 18*l.*, 12*l.*, and 8*l.* per acre. It is likely, however, that other causes than those assigned have contributed to these striking differences.

TURNER'S TRACTION-ENGINE.

AMONGST the numerous traction-engines exhibited at the recent show of the Royal Agricultural Society, at Bury, was that made by Messrs. E. R. and F. Turner, of Ipswich, of which we give engravings, on the present and opposite pages. This engine, which is nominally of 5 horse power, has a single cylinder 7 in. in diameter, with a stroke of 10 in., this cylinder being fixed at the front end of the boiler. As will be seen from the engravings the regulator, which is a gridiron-valve, is placed on the top of the steam-chest, the steam being conducted from the boiler to the chamber containing the regulator through a passage formed in the front part of the cylinder casting, as shown in the longitudinal section. The cylinder is not steam-jacketed, but it is surrounded by a space into which the exhaust steam is admitted—a far from good arrangement.

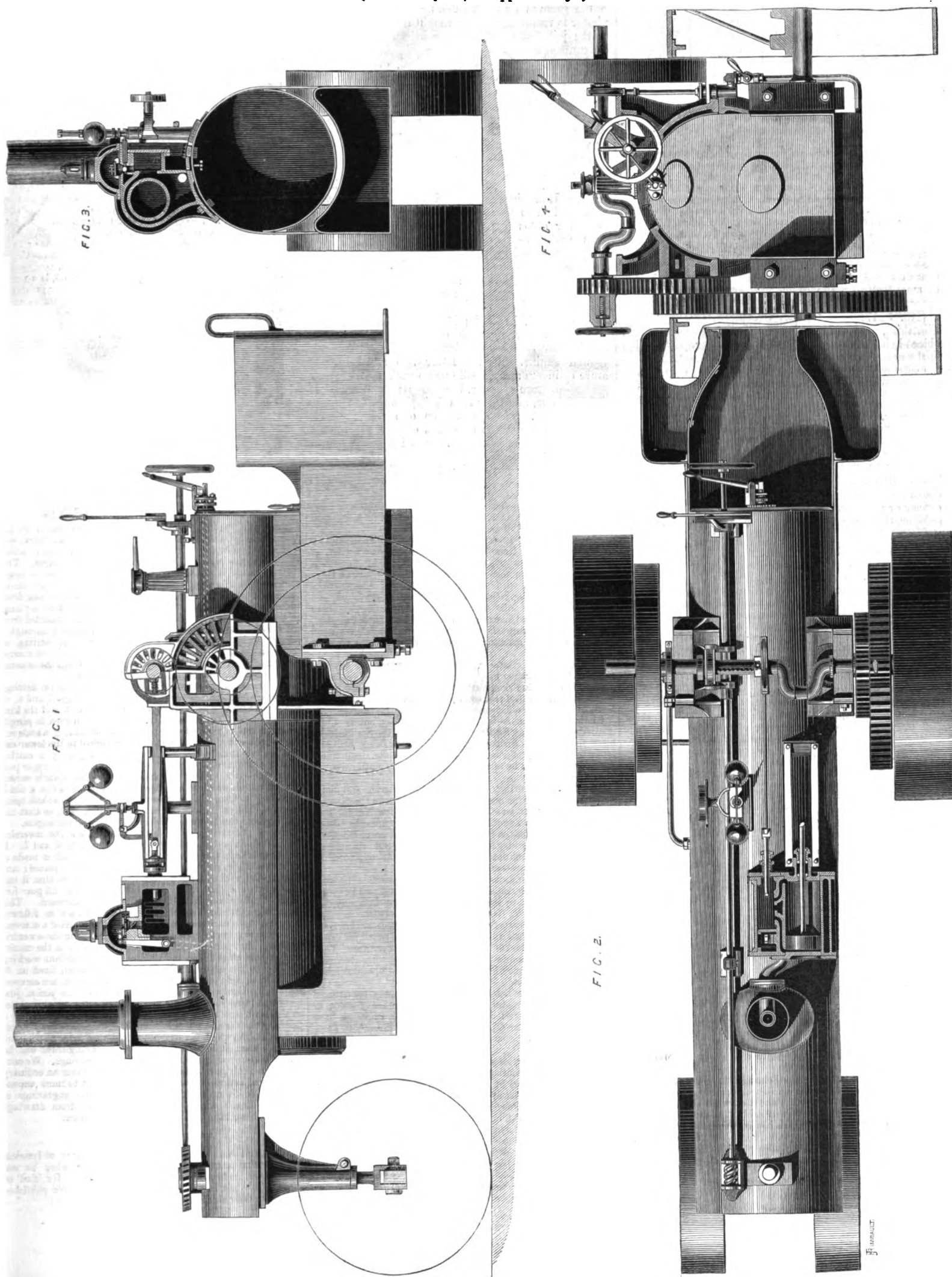
The motion is transmitted from the crank-shaft to the driving-wheels through gearing arranged as shown in Figs. 1 and 4, no pitch-chain being used. The steering-gear, which is of the kind used by Messrs. Turner on all their traction-engines, is simply arranged, and is very effective. The pair of leading wheels run one on each end of a short axle which is jointed to the lower end of a vertical spindle, this spindle passing up through a casting fixed to the underside of a kind of prolongation of the upper part of the smokebox. The upper end of the vertical spindle carries a worm-wheel, which is geared into by a worm fixed on a shaft extending backwards along the top of the boiler, this shaft being provided with a hand-wheel at the footplate end, so that the steering-gear can be worked by the man driving the engine.

One of the chief peculiarities of the engine is the reversing gear, of which we give enlarged views on Figs. 5, 6, and 7. It will be seen from these figures that the crank-shaft is made of square section at the point at which the eccentric is placed: and that the eccentric is fitted to this square portion, so that it can slide across the shaft from the proper position for full gear forward to that corresponding to full gear backward. This traversing movement of the eccentric is effected as follows: Through the square part of the crank-shaft is carried a screwed spindle, which works in a pair of brass nuts fixed to the eccentric sheave. That portion of the spindle which works in the crank-shaft is not screwed, and the spindle is prevented from working endways in the crank-shaft by a collar and pinion fixed on it, one on each side of the shaft. Motion is given to the screwed spindle by means of a rack which gears into the pinion just mentioned, this rack being connected to a collar which is loose on the shaft, and which is capable of being shifted along it by a pair of arms fixed on a hollow shaft, which encloses the steering gear shaft, and which is furnished with a hand lever at the hind end, as shown in Figs. 1, 2, and 4. The arrangement will be readily understood by an inspection of the engravings. We cannot see that this gear possesses any advantages over an ordinary link motion, and we should think that it must be more expensive both to fit up and keep in repair. Our engravings of Messrs. Turner's engine have been prepared from drawings with which we have been furnished by the makers.

THE LATE MR. W. P. WILKINS.—Mr. Wilkins, of Ipswich, was beginning to make a name among engineers when he was struck down, suddenly, and in the prime of life. He died on Wednesday week, in London, at the age of 48. We published a brief letter from him in our very last number.

TRACTION ENGINE WITH SHIFTING ECCENTRIC.

CONSTRUCTED BY MESSRS. E. R. AND F. TURNER, ENGINEERS, IPSWICH.

(For Description, see opposite Page.)

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1866; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 3111, 4d.) Thomas Jabez Barron, of New York, patents a method of converting iron into steel by heating it in a furnace or muffle, and then forcing into the muffle a mixture of carburetted hydrogen and nitrogen or cyanogen gas, or of carburetted hydrogen and nitrogen and carbonic oxide gas. A proportion of from one-sixth to one-fourth of nitrogen to five-sixths or three-quarters of carburetted hydrogen will be found sufficient in ordinary cases. The time during which the iron is to be subjected to the action of the gases depends upon the size of the pieces and the depth to which it is desired the steeling shall penetrate; and the patentee states that he has converted iron $\frac{1}{4}$ in. thick into good steel in three minutes, and pieces 2 in. wide by $\frac{1}{2}$ in. thick in one and a half hours. When the iron to be converted is impure, Mr. Barron first subjects it, whilst in the muffle, to the action of chlorine gas, this gas being allowed to remain in contact with the iron for a few minutes previous to the admission of the other gases. The patent includes methods of manufacturing the gases to be used in the above process.

(No. 3117, 8d.) Charles Crockford, of Holywell, Flintshire, patents a process of reducing zinc ores, the object being the utilisation of the sulphur contained in the sulphuret of zinc. According to this process, the sulphuret of zinc, crushed to a sufficient degree of fineness, is charged into a close furnace or series of retorts or chambers, which are heated externally, the ore, whilst being thus heated, being kept stirred by rakes moved by machinery, so that fresh surfaces are presented to the atmospheric air which is permitted to enter the mouths of the chambers through the openings through which the handles of the rakes pass. The diluted sulphurous acid generated during the above process is led off by a flue into kilns containing copper or iron pyrites, or into a chamber containing sulphur, the pyrites or sulphur being thus ignited, and the diluted sulphurous acid receiving an additional charge of sulphur, after which it is conducted into leaden chambers, and converted into sulphuric acid in the usual way. The patent also includes the construction of furnaces for carrying out the processes above described.

(No. 3122, 1s. 6d.) Thomas Dickens, Harvey Heywood, and John Holland, of Middleton, patent a form of steam boiler. This is an upright boiler with an internal firebox, and the fuel is charged into the latter through a tube leading from the crown of the firebox to a hopper on the top of the boiler. The upper part of the boiler-shell is of a smaller diameter than the lower part, and the products of combustion pass off through tubes leading from the firebox to the shoulder formed by the ring uniting the upper and lower portions of the boiler-shell. We fail to see that this form of boiler possesses any advantages.

(No. 3123, 10d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of John Blake Sarr, of Chicago, U.S., an arrangement of machinery for casting steel railway wheels, and subjecting the metal to pressure whilst in the liquid state. In this apparatus the mould is composed of three principal parts, viz., a fixed bottom, a ring, and a movable top, which can be forced down upon the liquid metal by hydraulic pressure. Arrangements are provided for withdrawing, by hydraulic power, the core forming the hole in the wheel boss, and also for quickly removing the movable parts of the mould from the casting as soon as the metal has set.

(No. 3128, 1s. 10d.) Richard Norfolk, of Beverley, patents a form of delivering chains for reaping machines, &c. The patentee states that the delivering belts generally used for reaping machines and other agricultural implements take up portions of loose corn in a wet state, and also dirt, which they deposit on the sheaves over which they pass until the diameter of these sheaves become so enlarged that the belts are broken. To obviate this, Mr. Norfolk proposes to substitute for the belts chains consisting of double links held apart by pins, and furnished with iron fingers or prongs, these chains being fixed to run upon iron rolls, and driven by toothed wheels in such a manner that they will be self-cleaning. Machinery for making these chains is also included in the patent.

(No. 3136, 10d.) Louis Alexandre Fargon, of Brussels, patents a method of forming the joints of pipes. According to this plan, the ends of the pipes to be joined have grooves formed round them. The

ends of the pipes being placed together, a strip of lead—flat on one side, and of such a form on the other side as to fit the grooves in the pipes—is placed round them, and secured by a wrought-iron hinged collar, the inside of which is formed conical with relation to the outline of the joint. The lead having been forced into the grooves by the tightening up of this collar, the latter is removed, and a wrought-iron hoop driven over the joint, the protruding portions of the lead being caulked up in the usual way.

(No. 3143, 1s. 4d.) Joshua Field, of Lambeth, patents some improvements in the arrangement of double-cylinder and three-cylinder marine engines, and also an apparatus for giving warning if the steam in a superheater is becoming too highly heated. We shall illustrate some of Mr. Field's improvements in an early number, and shall, therefore, not enter into any description of them at present.

(No. 3145, 1s. 2d.) William Brookes, of 62, Chancery-lane, patents, as the agent of Jean Baptiste Helson, of Hautmont, France, a method of making iron or steel disc railway wheels, and also machinery for carrying out the process. According to these plans the wheels—the discs of which have annular corrugations formed in them—are first forged between dies under a steam-hammer, and are then completed by a rolling process, both the dies and rolls being furnished with hollows and projections for forming the corrugations in the discs.

(No. 3158, 2s. 2d.) John Ramsbottom, of Blackburn, patents an arrangement of movable grate-bars and fuel-feeder for steam boilers, and also a form of compound engine. In the latter two small high-pressure cylinders are placed, one on each side of the larger low-pressure cylinder, the three pistons having the same stroke, and their rods being coupled to the same crosshead. The distribution of steam to the three cylinders is effected by a kind of triplicate valve which has a rocking motion imparted to it by an eccentric or other means.

(No. 3163, 1s. 6d.) John Pratt, of Greenville, Alabama, U.S., patents the type-writing machine of which we gave an illustrated description a few weeks ago (*vide* page 539 of the last volume of *ENGINEERING*).

(No. 3164, 8d.) Walter Butler, of Old Kent-road, and Alexander Dalgety, of Shard's-terrace, patent forms of couplings for railway carriages, the object of the arrangements proposed—which could scarcely be described without reference to drawings—being to effect the detachment of the engine from the train in the event of the former leaving the rails.

(No. 3174, 8d.) Benjamin Joseph Barnard Mills, of 35, Southampton-buildings, patents, as the agent of the New England Vice Company, of Massachusetts, U.S., a form of bench vice, in which the main or holding part of the vice is secured to a bedplate fixed on the bench, by three screws passing through slots, so that the upper part of the vice can be partially rotated on a pivot. The jaws of the vice are made so that they overhang one side of the shank of the movable jaw considerably, and they are thus adapted for holding long articles conveniently.

THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.

(Continued from page 78.)

Mr. F. W. BREAREY read the following communication from Mr. John Frederick Bourne, Member of the Inst. of Civil Engineers:

I have read with much interest the first annual report of your society for 1866. It has occurred to me that it may be interesting to you to have an account of some experiments made many years ago in South America.

I happened, in 1843, to be at the house of my friend, James Frazer, Esq., M.D., Eden Hoff van Aurich House, Essequibo, British Guiana, when he received his English papers, one of which gave a description and representation of Henson's flying-machine. Doctor Frazer, who is now residing in Scotland, is a man devoted to science, and an exceedingly skilful mechanic.

When we had read the description, he said to me: "That will never do, Bourne; this is the way to fly." And taking up and opening an umbrella, he held it vertically, and screwed it round. "We must screw ourselves up. There's an idea for you. Now you can carry it out and make a model."

I asked him for a watch-spring, which he found in his workshop, and gave to me.

I made the first model with only one set of four wings stuck into a piece of cork, like the sails of a windmill, each wing being a large fowl's feather.

The cork was stuck on to the top of a stick of white pine, small enough to pass freely through a quill, and about 12 in. long. At about a couple of inches from the bottom of the stick, a pin was pushed through, till only the head projected sufficiently to allow the hole in the inner end of a watch-spring to be hooked over it. The point end of the pin was then cut off flush with the stick. A second piece of cork, rather larger than the first, had a short portion of the tube of a quill pushed through its centre, and to the circumference of it a piece of stick was lashed securely, to which the outer end of the watch-spring was tied, when the stick or vertical shaft had been put into its place in the quill as its bearing.

Into the under part of this lower cork two large feathers or tails were stuck, projecting downwards, to act as fulcrums for the watch-spring.

To wind it up, I held the vertical shaft in the left hand, and with the right hand gave the bottom cork and the two tails a half-turn; then letting one tail rest upon my shoulder or chest till I had got my fingers ready for another half-turn, and so on till the spring was wound up.

On letting it go, it shot up with force to the ceiling; and on trying it out of doors it went considerably higher.

On showing it to Dr. Frazer, he clapped his hands, and said "That's it; the principle is proved." I then made a second model with the same spring, but with the following points of difference:

Instead of feathers for the wings, I used strips of bamboo with cartridge paper clothing pasted on like the little windmills used by children to run against the wind, but with long narrow wings instead of the half-round pieces of paper used by children, and instead of the two tails stuck into the bottom cork, I put four more sails or wings of the same size and description as the upper ones, but "set" in the opposite direction, so that if the upper stratum of four wings formed a right-handed screw, the lower stratum of four other wings formed a left-handed screw. This model, though perhaps twice as large as the other, and with only the same spring power, went up to about twice the height of the first. It shot up to the height of the eaves of the house—about 20 ft. I weighed the model, but forgot the weight now. It was between one and two ounces.

I believe I still have somewhere in my possession one or two of the wings, and perhaps the spring, as I saw them at the Cape of Good Hope when packing up lately to come home.

It seems to me that what is required, first of all, is a very light motive power bearing the same (or even a rather greater) proportion to weight to that of the rest of the apparatus and fuel or other supply that my watch spring did to the model. It would be sufficient for the machine to rise but slowly from the ground, and not to shoot up as mine did.

The common black vulture of South America rises with great difficulty, but once arrived at the required height, seems merely to float on the air without the least exertion. I have timed one which alighted near a spot about six miles from where I stood, and which did the distance in about six minutes, without any apparent motion of the wings.

I have sometimes thought that a boiler of small and thin tubes, using spirits both as the expansive fluid and after it has done its work also as fuel, might possibly answer; and a friend of mine at the Cape, the Hon. Mr. Griffith, Attorney-General, has suggested to me that attention should be paid to some of the new metals, to secure at the same time lightness and tenacity, or as near an approach to the substance of the quill as possible.

My heavier model ascended higher than the lighter one with the same power, and I agree with Dr. Frazer in thinking that when we obtain the right motive power, the rest of the machine may be made of light metal tubes, wire and very thin metallic sheets, without wood, silk, or other bulky material.

The steering will easily be effected, by an easy displacement of the centre of gravity of the whole machine through an universal joint placed between the working apparatus and the car.

In rising perpendicularly, the centre of gravity will be in the same vertical line with the working shaft.

To advance in any direction, it will only be necessary to throw the weight of the car by suitable steering gear towards that direction. This will throw the wing planes towards the same direction, and the diagonal force thus obtained will be resolved into a perpendicular, to prevent descent, and a horizontal to advance to the required spot.

And the speed of the advance will, of course, be plus or minus that of the wind, as it may be favourable or otherwise.

You will be pleased to observe that my experiments tend to show the theory of Mr. Wenham to be correct with reference to a series of superposed planes of wings acting on different planes of air, but I cannot agree with him in his theory of the slip of screws in air as laid down in pp. 24 and 25 of your published Transactions.

It reminds one of the old theories of the slip of driving-wheels of locomotives on the rails, and the patents that were taken out for legs, cogged rails, or wheels, to prevent this slip, or obviate it. I cannot see why a wing travelling in a curved line in a constantly new stratum of air should have more "slip" than if it moved in a straight line. I would only say *try it*, not in the way specified in pp. 22 and 23, but in a machine free to move into new strata.

The experiment with the steam-boat, p. 20, is analogous; very little would hold it; but "let her go," and the difficulty vanishes. And all mechanical locomotion is best effected by propellers moving with a circular and not a reciprocating motion.

Mr. A. Stewart Harrison read an extract from a tale he had published in *Once a Week* some time since. He had put the words into the mouth of a madman who was supposed to have been speaking some fifty or sixty years since, and it was singular that the ideas thus expressed were precisely those which appeared in the paper just read. Now he thought, speaking seriously, and not as a madman, that it would be just as reasonable to study the elaborate anatomy of a duck's foot for the purpose of obtaining the best mode of propulsion on the surface of the water, as it would be the motion of a bird's flight for modelling a flying-machine upon the plan of its wings. He apprehended that if any gentleman could place in that room a steam-engine or other engine of 1 horse power which would only weigh 20 lb., means could easily be devised by which heavy bodies could be moved through the air. He thought it was entirely wrong to found their proceedings upon an imitation of the flight of birds, and that but little success could flow from it. The backward stroke of the bird's wing was undoubtedly a waste of power, and nature had provided the bird with a most delicate apparatus of sensation which enables it to diminish that waste as much as possible. He was convinced it was the upward and forward stroke which effected the work, and that therefore the continuous motion of a rotary wheel was the best means of effecting flight.

The Chairman thought that the preceding speaker had to some extent mistaken the object which the society set before itself in studying the flight of birds. It might be quite possible that ultimately they would not imitate the structure of the bird's