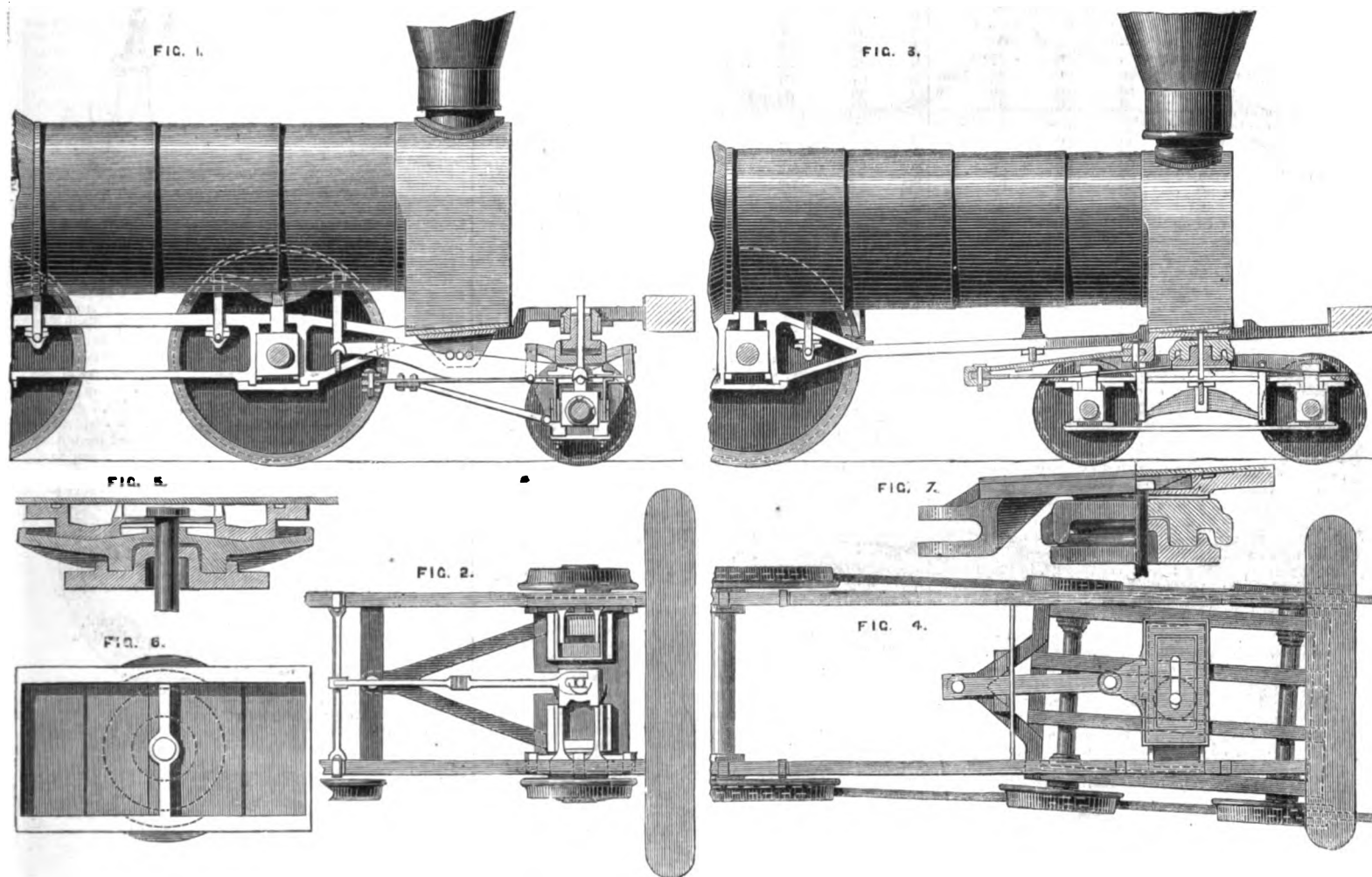


THE HUDSON-BISSELL BOGIE.

DESIGNED BY MR. WILLIAM S. HUDSON, ENGINEER, ROGERS LOCOMOTIVE WORKS, PATERSON, NEW JERSEY, U.S.



THE Bissell bogie, as now adopted in England, was first brought out, in 1857, by Mr. Levi Bissell, of New York, who applied his well-known radius bar to four-wheel trucks. In an early stage of the invention, Mr. Zerah Colburn suggested to Mr. Bissell the importance of adapting his principle to the English style of locomotive construction with a single pair of leading wheels, and the result was the two-wheeled Bissell bogie now in use on many American, and on some English, lines.

Mr. William S. Hudson, a Derbyshire man, and, long ago, a workman under George Stephenson, has been long resident in the States, and has occupied various responsible posts connected with the locomotive department of railways, and is now the engineer to the leading locomotive factory in America—that of the Rogers Locomotive and Machine Company, at Paterson, near New York. Mr. Hudson adopted the Bissell truck shortly after its first introduction, and he has more recently made certain improvements upon it, which he has adopted in his own practice. These are already in extensive use in America, and are, in part, illustrated above. Fig. 1 shows an elevation, and Fig. 2 a plan of the front end of a six-coupled engine, having also a two-wheeled Bissell truck. The improvement consists merely in the introduction of a compensating lever, with an adjustable fulcrum, as shown, between the front coupled wheels and the bogie. The front ends of the springs of the front pair of coupled wheels are connected together by a transverse bar, seen best in the plan, Fig. 2, and this bar is connected by the compensating lever to the centre of the truck, so as to obtain the now well understood advantage of the compensating lever in distributing the effects of sudden jolts over an extended wheel base, with little strain upon the frame.

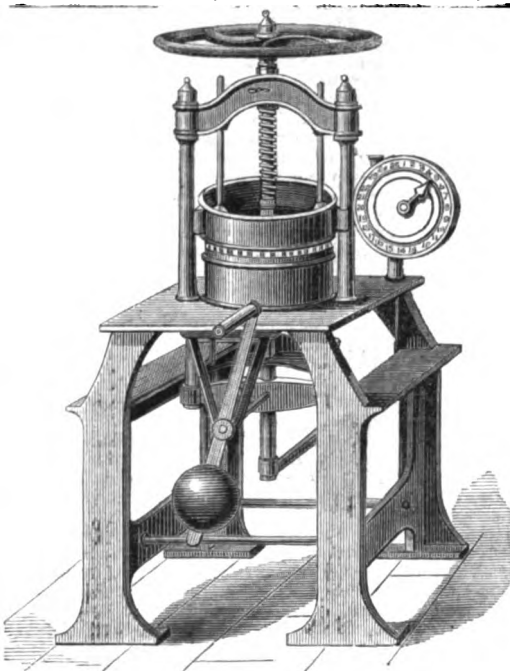
In Figs. 3 and 4 Mr. Hudson has introduced certain radius links which practically leave the truck in exactly the condition of Mr. William Adams's truck, as employed by him on the North London Railway. Mr. Adams provides the gentlest possible government—hardly even paternal—for the truck, by allowing it to swivel about, exactly as the curves of the line may take it, without any positive control from the engine framing. If Mr. Hudson's truck, Fig. 4, be examined, it will be seen that the radius link serves no other purpose than that of carrying the truck along with the engine, and this could obviously be equally done by the pivot or central pin of the truck itself. We may state that the indisputable success of Mr. Adams's truck, on the North London Railway, is even yet doubted and disputed by American locomotive engineers, who regard Bissell's radius link as essential to the whole arrangement.

Fig. 5 shows a section of the pivoting portions of the Bissell truck as ordinarily made. The lowest piece, shown in section, is that upon which the truck swivels; the intermediate piece always remains at right angles to the axis of the engine, and the upper piece, with its double inclined surfaces bearing upon that below it, slides to the right or left, according as the engine is passing through a curve in either direction. The whole

principle of this invention, the Bissell truck, is that of relieving the engine from the constraint to which it was once subjected, and it is almost surprising that engineers have not yet found that, as in Mr. William Adams's arrangement, the truck can go without leading-strings and take care of itself.

AUSTRIAN DOUGH-DIVIDING MACHINE.

THE Austrian bakery in the French Exhibition attracts much attention from the perfection of its arrangements, and the superior quality of the bread it turns out. We have already briefly described its principal features. We at the same time



stated that the dough intended for the manufacture of rolls, after having first been weighed in large pieces, was subdivided by a machine, which machine is shown in the annexed cut. Each lump of dough is placed in a cylinder, upon which a lid is

screwed down by a screw turned down by means of a hand-wheel above, so as to compress the dough into a cake of uniform thickness, and an arrangement of a network of knives is then forced up through the bottom of the cylinder by turning a winch handle, which knives divide the cake of dough into a number of equal parts, each of which is of the proper weight to form a roll. The number of times this operation is performed is registered, through the medium of suitable mechanism, by a hand pointing to the graduations of a dial, so that it is easy to see at any moment what number of rolls have been cut.

CENTRIFUGAL FORCE.—A northern correspondent writes: "About the bursting of fly-wheels and railway wheels, if you turn to Bourne's treatise, last edition, at page 151, you will find the bursting strains calculated as the total centrifugal force of the half of the rim. Now, the centrifugal force acts on each portion radially the same as the bursting strain on a cylindrical boiler shell, and as the resultant is equal to the pressure on the diameter and not on half the shell, so in the fly-wheel, or railway-carriage wheel, we should take the centrifugal force on a length of the rim as equal to the diameter instead of half the entire rim, so that Mr. Bourne's rule is in error in excess for strain as 1.5708 : 1; and the limit he assigns to the velocity of the rims of fly-wheels is, on his own data, too low, in the proportion of 1 : $\sqrt{1.5708} = 1.25$, that is, it should be increased 25 per cent.

THE AMERICAN TARIFF.—We received a visit, last week, from Mr. David S. Wells, United States Commissioner of Revenue, who is visiting England and the Continent, with a view to the collection of information bearing upon the question of American "protective" tariffs. Mr. Commissioner Wells's views and policy are to the effect that too great "protection" is already granted for the true interests of American manufacturers, and that lower duties should prevail.

GERMAN LOCOMOTIVES.—A trial is stated to have taken place at St. Petersburg, on the 30th of June, of two locomotives, one constructed by Borsig, of Berlin, and the other by Sigl, of Vienna. Each had to draw a weight of 600 tons up an incline of 1 to 125. The Austrian engine made 18 westeris in an hour on the occasion, and the Prussian only 12.

TELEGRAPH TO THE EAST.—A prospectus of a company to be called the India, China, and Colonial Telegraph Company, is to be issued in a few days. The proposed capital will be 700,000L, and the route will be by cable from Falmouth to Gibraltar, and from Gibraltar to Malta.

PASSENGERS' AND GUARDS' COMMUNICATION.—This bill, which has passed the Commons, has gone into committee in the Lords.

FACING POINTS.—Were not facing points long ago condemned? And here they are, again, causing a most alarming, if not disastrous, accident on the London, Chatham, and Dover Railway. Why are not these abominations given up altogether?

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Railway Matters.—The contest before the Lords' committee on the Bill for the amalgamation of the Midland and Glasgow and South-Western Railway Companies, is attracting much more attention here than was given to the matter when it was before the committee of the Lower House. The intervention of the Forfarshire and Fifeshire people, and the strong opposition they are offering to the Bill, would seem to indicate that the companies desiring to amalgamate have overlooked the linen manufacturers of Dundee and the Fifeshire towns, or thought their interests too remote to interfere with the Bill. Fifeshire is peculiarly situated in regard to railway communication with the south, and hence the natives are keenly alive to aught affecting their traffic. Direct communication is cut off by the Forth, and since the postponement, *sine die*, of the erection of the great Queenferry bridge—noticed more than once in the columns of **ENGINEERING**—goods and passengers for the south seemed doomed to the long and expensive route *via* Larbert, or the short and uncomfortable ferry passage, the accommodation on which last has for some time back been so miserable that attention was drawn to it in the House of Commons by Mr. Waldegrave Leslie. Oddly enough, next morning, one of the North British Company's saloon steamers, built for the Clyde traffic, and illustrated in your columns, arrived round from Glasgow, *via* the Pentland Firth, to take up the station of one of the old steamers. *Post hoc, ergo propter hoc.* We commend the above facts to the compiler of the *Notes and Memoranda* of your contemporary. Want of money has been the sole cause of the inadequacy of the steamer accommodation, as it is likewise the sole cause of the company's want of carrying plant, bitterly complained of by the coal and iron traders of the Monkland district. The company, some time ago, resolved that all the heavy repairs required by their engines should be done at Glasgow, and for some weeks the students of the history of locomotive engineering may have found in the sheds and sidings at Cowlands abundant materials for reflection, in the large number of small and worn-out engines withdrawn from out-of-the-way branch lines to be sold or broken up. Mr. Wheatley, the new loco-superintendent, has hard work before him.

The half-yearly balances of the various companies, and the consequential dividends are being looked forward to with both interest and anxiety. The traffic returns of the South-Western are 75000 below the corresponding 22 weeks of last year. This is known to be attributable entirely to the almost complete cessation of the pig-iron traffic in the beginning of the year, and the same reason, together with strikes in the Wishaw district, will account for the Caledonian's stationary return. Moreover the latter company have had to lay out great sums in the renewal of both line and rolling stock on their northern section—formerly the Scottish North-Eastern; the directors of which for many years back, knowing that the absorption of their line by one or other of two great companies was only a question of time, spent no more on their line than would simply keep them free of accidents. The Caledonian Company to supply deficiencies have just ordered the construction of 20 locomotives and 50 carriages. The engines are all to be of the outside cylinder class, 8 of them for passenger traffic, with 17 in. cylinders of 2 ft. stroke, and 7 ft. diameter coupled driving wheels, and 12 for goods traffic, with 18 in. cylinders of 2 ft. stroke, and 6 ft. coupled driving wheels. The major part of the order for the engines has gone to Messrs. Neilson and Co.

Shipbuilding.—During the last week there have been launched in the Clyde, the *Hannah Simons*, S.S., of 1000 tons, by Messrs. Stephen and Sons, for the Portugal and Mediterranean fruit trade; the *James Aitken*, sailing ship, 960 tons register, by Messrs. John Reid and Co., of Port-Glasgow, for the Calcutta and Liverpool trade; the *South of Ireland*, paddle steamer, of 600 tons and 200 horse power, by Messrs. W. Simons and Co., of Renfrew, for the Channel service between Milford and Waterford; and the *Siberia*, S.S., of 2500 tons, by Messrs. J. and G. Thomson, for the "Cunard Company." The *Siberia* is 315 ft. in length, 39 ft. in breadth, and 27 ft. 6 in. in depth of hold, with direct-acting engine of 300 horse power (nominal). She is bristled, and may be used either for the mail line or the emigrant line. The *Indiana*, S.S., built at Waterford for the Messrs. Malcolmson, has been brought round to be engaged by the London and Glasgow Engineering Company.

The want of large graving-dock accommodation is much felt at the various Scotch seaport towns at present. The magnificent graving-dock at Leith, capable of containing the largest craft afloat, has been fully occupied for some time back. Last week a large vessel was towed round from Hull to Leith to be overhauled there, but for the above reason was taken to Dundee, where it was found that the dock-gates were *three inches* too narrow to admit her, and the vessel was then towed to the Hartlepool to have the repairs executed there. The Greenock authorities some time ago resolved on the construction of a large graving-dock there, but the project has not made much advance hitherto, neither has a similar project of the Clyde Trustees for the construction of a graving-dock at Glasgow.

Water Supply.—Contracts have been entered into by the Helensburgh authorities for the re-introduction of water to the town. Three or four years ago the side of the large reservoir in the hills gave way, and great damage was done, though no lives were lost, and since then the inhabitants have been dependent on the old wells in the town. The new supply is to be drawn from the hills above Row, from springs there. The authorities of Dunfermline on Monday last concluded a contract with Messrs. Edington and Co., of Glasgow, for the introduction of water to that ancient and historical burgh.

Paris Exhibition.—Besides the medals formerly announced as having been awarded to Scotch exhibitors, we find that the Messrs. Inglis have been awarded a medal for their collection of ship models; a silver medal to Messrs. Bowser for their "heating apparatus for ships;" and Messrs. McIntyre, Hogg, and Co., of Glasgow, have been awarded a gold medal for their collection in the shirt and underclothing department. This last and several other Glasgow firms have large establishments in the north of Ireland, chiefly at Londonderry, where the shirt manufacture, carried on with sewing machines wrought by steam, has assumed dimensions which call for a more extended notice, and of which we expect to give some statistics next week.

Mining Districts.—Trade and the relations of the mine-owners

with their miners continue *in statu quo*. Last week has been unfortunately distinguished by the number of petty accidents occurring in the pits, and besides these, we have noted one fire-damp explosion, and five falls of stone from the roofs of workings; in most of these last the injuries are all anticipated to turn out fatally. The pig iron market has been without quotable change. The shipments from Glasgow and Greenock for the week ending July 6 amount only to 2987 tons. Several small shipments have been made at Leith, chiefly of the Lugar and Eglinton iron, but of these no proper statistics are obtainable.

New Railways, &c.—The Blane Valley Railway, a single line extension of the Lennoxton branch of the North British Company, was opened for passenger traffic on July 1. The length of new line is 8½ miles. It ought to have been opened in November last, but the Government inspector would not certify it for passenger traffic until the rails were all fish-jointed.

The extension of the Caledonian's branch from Busby to East Kilbride is being vigorously pushed on. A month more will see the line ready for mineral traffic half through, and the new year it is expected will see the line open for passengers for its whole length. The "Esplanade" as it is called, at Greenock, was formerly declared open by the magistrates a few days ago. The Esplanade has been partly taken in from the sea, and forms a promenade of over half a mile in length, extending north-westerly from the new harbour works. It has taken about three years in erection.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF **ENGINEERING**.

SIR,—In answer to your correspondent "O. O.," I beg to state that I congratulate him on the improvement which is manifest in his mode of expressing himself; at least, now it is possible to find out what he means. But, on the other hand, he seems to be endowed with a faculty for raising difficulties where none exist, for he finds as many objections as the Parliamentary committees once did to the use of steam on railways. Nor does he seem to improve in manners, for he still "hides" under an incognito.

The sewerage system I advocate is surely as simple an arrangement as well can be. As in Menzies's plan, I use small tubes for the removal of the sewage, but add pneumatic force to gravitation, to prevent stoppages, to diminish cost of construction, to save the expense of the water, for flushing, and to keep the sewage from dilution.

To accomplish this, the faecal matter is allowed to fall free through a pipe, so wide that the sides remain untouched. It falls in a bend, which is thus gradually filled with a sort of thin slush mixed with paper, the whole losing more or less the appearance of separate solids and liquid, and becoming of a more uniform, so to say, "seven-eighths" fluid nature. After the bend, the pipe is again curved slightly upwards, so that the liquid collects and remains in the pocket so formed, until the moment of removal. This occurs every night, by means of placing one end of said "bend" for a moment in communication with a reservoir, in which a partial vacuum is constantly being maintained by a small steam-engine working an air-pump. If any faecal matter has been collected, it will of course be forced out the pocket or bend, and together with a certain volume of air, rush into the "street main" towards the reservoir. If nothing is collected, of course the volume of air rushes in alone. In either case the vacuum is partially destroyed, and would be entirely destroyed if the house-valve was held open too long. This is, of course, however, not done, and the valves are so constructed as to allow a rapid opening and shutting.

Experience has shown that a very short interval of time suffices to remove whatever is collected in the bend below, until it is past the house-valve and in the street "main." The branch and main pipes, which are all equally of but 5 in. bore, are laid with a fall of 1 in 100 towards the reservoir. There is no doubt that after the fluid mass has passed the valve a great deal scatters along the bottom of the pipe, instead of moving on in a compact body; but by each opening of a valve the entering air will move it onwards, and if the pipes get completely filled this movement is of course the most effective. The scattering of matter along the sides of the pipes has, on trial, proved to be much less than often anticipated; and considering that the propelling force equals the concentration of some thirty hurricane winds, this is not surprising. The matter left between the bend or receiving-pocket and the house-valve is practically not measurable; it amounts to little more than a sort of fatty moisture. In either case there is no accumulation of matter, and thus no fermentation and consequent poisonous gases. The slight watery vapour, due to fresh excreta, is of course also carried downwards with the general "suck." Whatever vapour rises from the outer end of the "bend" is carried off by the ventilating pipe (which admits the propelling air) well over the roof of the building.

As regards the pan or receiving funnel in the closet (mentioned in my patent of September, 1866), "O. O." is right enough, that there is some danger of matter adhering to the sides. The truth is, I adopted this simple form in consequence of having seen it work well in various German towns, the rear face retreating so far as to make soiling impossible, and the front slope being washed clear by the urine. I found though, upon closer investigation and inquiry, that this front slope is often soiled by children through their inability to reach far enough on the seat, and consequently abandoned this plan, adopting, instead, a short, nearly vertical earthenware tube, standing centrally over the vertical fall-pipe. To soil this is, in ordinary usage, impossible.

What the nature of the objections is "O. O." has against my mode of putting the fresh manure upon the land, I do not understand. I am sure no farmer would, and fear "O. O." shows there a symptom of his former weakness. I fixed the size of the barrels at five cubic feet, because farmers told me such was the handiest. The weight averages between 340 and 350 pounds. They are laid upon a small cart or wagon, and the fluid manure is allowed to flow with a small stream upon freshly ploughed land in the furrows. Any farmer's lad can drive such a cart, and any arable land can support its weight. If the soil is light, the furrows can be made by a little ploughshare fastened to the cart itself; if not, another plough must go ahead.

Farmers have found upon trial that this mode of manuring requires less labour than first making up a compost manure heap of dung and earth in one corner of the farm, to cart from there

the mixture upon the field, to spread it over the surface as well as they can by casting, and to plough it in afterwards. By using alternate fallow-strips, all this roundabout way of fertilizing can be shortened up to simply pouring it on, as I do.

When I say "as I do," I mean, as many have done, for what I here advocate is by no means a novelty. In fact, I may as well state, that my whole system is but a grouping or combination of well-known contrivances or manoeuvres. I have been careful in not getting on any "terra incognita" in such a dainty business as disposing of faecal matter, and have endeavoured to select measures which had proved to be the simplest, most effective, and answering best the many purposes required.

I am, Sir, respectfully yours,

CHARLES T. LIERNUR.

2, Royal Exchange-Buildings, E.C., July 8, 1867.

TO THE EDITOR OF **ENGINEERING**.

SIR,—I read with much interest the discussions in your journal upon the sewage question. Many of the methods that have been described for abstracting excremental matter from town habitations and utilising it for manure, appear exceedingly ingenious; and I am quite willing to believe may be made to pay a good percentage on the outlay. Granting that all this may be done in an efficient and innocuous manner, saving the country thousands, as well as promoting the public health, there still remains one point that none of your correspondents ever touch upon, and that is, *what is to be done with the waste water?* Take a town of 50,000 inhabitants, with a water supply of, say, one million gallons per day; now what is to become of this million gallons? Though not nearly so objectionable, I grant, as the sewerage from a town where the watercloset system is in use, still it is very far from pure; it has been used for washing yards and pavements, for cooking and domestic purposes, to say nothing of what is discharged from paper mills, dye works, chemical and other factories. Such water is not fit to flow along our street gutters, or into our streams and rivers; for a town sewers are indispensable, whether excremental matter be collected separately for manure, or discharged with the sewerage; in either case the waste water should not be allowed to pollute our rivers, and how to prevent this less expensively, or with a better chance of profit, than by using it for the irrigation of grass land, I am at a loss to know.

Your obedient servant,

CHARLES F. GOWER.

Nova Scotia House, Ipswich, July 6, 1867.

THE CORLISS ENGINE.

TO THE EDITOR OF **ENGINEERING**.

SIR,—In some of your late numbers, your correspondent "Observer" has given his opinion on the Corliss engine, and his letters have called forth several others from different quarters on the same subject: perhaps you will allow me to make a few remarks also. The engine has been so fully described in your journal, that it is hardly necessary for me to go into many details. I know that engineers, accustomed to the ordinary slide-valve and its comparatively ponderous connexions, are apt to condemn at first sight the light gear required for the Corliss valves, and to doubt the possibility of springs being reliable for closing them, yet they are generally satisfied of their mistake from a little practical experience with the engine.

I quite understand the importance of simplicity in any arrangement of valve-gear; and I venture to say that this is a distinguishing feature in the Corliss valves. There are four separate valves to each cylinder; but these valves are just as simple in construction, durable, and as easily got at, as it is possible for any valves to be. Motion is imparted to the exhaust-valves in a direct and simple way; and the only additional complication in the method of working the steam-valves, over that used for any ordinary slide-valve, is the arrangement for liberating and closing them, when working expansively. That the means for effecting this object are simple, certain in action, and durable, has been fully proved in practice, and this is a test worth more than all the opinions that can be brought forward, no matter how high the authorities.

In the operation of the Corliss engine there is no mysterious principle concerned. I do not say that it is the *only* good engine, but I do say that any engine to be equal to it must be constructed on much the same principle, with separate and independent exhaust-valves, while the steam-valves are variable, and the cut-off regulated by the governor. To carry out this principle, it is also necessary that the valves work with little friction, as the Corliss valves do. In the Corliss engine the governor has to exert the smallest amount of force to vary the point of cut-off, and for this reason the action is both quick and perfect.

I have, as has also Mr. Spencer, designed a great many of these engines, at work now all over this country, and driving almost every variety of machinery. They have been tested at every day work, counting over a period of several weeks for a trial, and found to consume under 2½ lb. ordinary coal per indicated horse power per hour, the fuel used and wasted for raising steam and cleaning fires being included.

Your correspondent, Mr. Pinchbeck, as well as "Observer," condemns the valve gear for the cause that it renders high speeds unattainable; both of them being, no doubt, unaware of the fact that, except perhaps in some exceptional cases, the Corliss engine is working every day, at speeds as high or higher than any other kind of engine in this country. It may be, however, that these gentlemen have some peculiar ideas of their own as to what high speed is, for, after all, it is rather an indefinite term. I expect in a few days to have a pair of engines at work, at 640 ft. piston speed, for driving cotton machinery. As far as my experience goes, there is no occasion whatever, on account of the valve gear, to stop at this speed, although it may be doubtful if it is desirable to go beyond it, on account of the increased care and attention it involves for the engine generally.

It has been frequently tested, as in the case referred to by Mr. Pinchbeck, in your number of 5th inst., that a Corliss valve engine, of the same size of cylinder, and with the same pressure and speed, can do the work which an ordinary slide valve engine will fail to accomplish; but the reason, of course, is not as he states he is led to believe, because of the greater degree of expansion.

I may as well correct an error of "Observer's." There are not three Corliss engines at the Paris Exhibition. The engine to which he refers in the Swiss annex is somewhat the same in

appearance as the Corliss valve-engine, but it has a different arrangement of gear, and instead of having Corliss valves, it is fitted with poppet valves.

"Observer" has taken a rather narrow, one-sided view of the question, and I think his letters bear evidence that he has recorded his opinions, or perhaps I should say his repugnance, of the Corliss engine, without first having a sufficient knowledge of it, either from experience or observation.

It seems to me that his remarks are altogether unworthy of the great authority to whom I am inclined—perhaps erroneously—to ascribe them.

Manchester, July 9, 1867.

I am, yours truly,
WILLIAM INGLIS.

TO THE EDITOR OF ENGINEERING.

SIR.—The careful readers of your excellent paper must have been aware for some time that a discussion on the merits or otherwise, of the "Corliss engine" has been slowly but surely descending to the verge of acrimonious personality. Why this class of discussion on purely material and utterly passionless subjects should so often culminate in this way must certainly have occasioned deep thought and wonder to the less intensely engineering minds brought in contact with this class of literature. Can it be that the obstinate, obdurate, in fact, "iron-and-steel" character of the material which the operative engineer daily and hourly does battle with, in manipulating it into the various machines so closely approaching human intelligence, renders it indispensable (as a rule) that he shall have better than the average artisan education to save him from becoming the most pugnacious of the artisan class? Can it be that this unnamable though somewhat natural spirit has inoculated the gentlemen of the drawing-office? If so, no doubt many acting and reacting causes may be named to account for it.

However that may be, desirous of aiding his small share to the common stock of knowledge possessed by us in this country on the subject of this "Corliss engine," the writer would simply premise that, as an Englishman, whatever he may be as an engineer, he is not likely to say more on this subject (an American application of steam) than fair play and justice will amply corroborate.

In 1862, Messrs. Russell and Sturgis, of Manila, having perhaps the largest interest in the great rope-factory there, finding it necessary to provide a more powerful steam-engine for their increased and growing rope-making business, wrote their wishes (of course explaining the high price of fuel in that quarter) to the celebrated Mr. John Ericsson, of New York. He chose for them and sent out a "Corliss engine," and I can well remember the unmistakable look of despair of the excellent engineer of the rope-factory when, shortly after its arrival, he favoured me with a view of the engine as it lay, after the process of unpacking, strewn about the premises; but his particular agony was the "rattletraps" (valve-gear); and indeed your correspondent, although having seen a few steam-engines in nearly all stages and states of their existence, is not ashamed to confess that to him that Corliss engine was (to say the least of it) a "queer lot" of "notions."

In three months after the melancholy survey above recorded, my excellent friend, the engineer (whose name—Michael Klink, of New York—deserves honourable mention), had erected and housed the new engine, boiler, and main lines of shafting, and his unfeigned and natural delight at the complete success and beautiful action of the new engine was something "easier imagined than described"—at least by the present writer, who has himself sat for an hour at a time watching the generally graceful movements of this engine, especially the valve-motion, with a pleasure scarcely less intense than that which must have been felt by Arago, to have inspired the language of his immortal description of Watt's parallel motion, on first beholding its action.

The points in which this American-made Corliss engine appeared to excel, were its marvellous regularity, under every condition or amount of resistance, at once singling it out as the engine for cotton, silk, or flour mills, its massive framing giving it great general stability, and its greater length of stroke than is usually given to horizontal engines in this country throwing less labour on the valve-gear per foot of piston travelled; but, in fact, the valves of the Corliss engine being so well balanced—being, so to say, "afloat" in steam—require, perhaps, less power to work them than any other description of valve for steam distribution. The "wear and tear" during the knowledge of the writer (the engine's first two years' working existence) was practically nil, and the attention it required must have been but very little, as the engineer had his time too fully occupied repairing and renewing the various quick-running machines required in the preparation of coir hemp, and twisting it into rope. It formed a pleasing labour of love, occupying him two or three hours about every fourth Sunday morning, to examine his idol, and for the interval intervening month it worked on an average fifteen hours per day.

The economy of fuel of this engine was more pleasantly conspicuous to the engineer referred to than any of its other good qualities, as about the time he had set it to work, he was offered and accepted a fifth or sixth share of the profits of the factory. There was incontestably much more work done by the new engine than by the old one, as new additional machines were set to work, and the saving of expense in fuel was sufficient to pay the wages of attendants on both boiler and engine, as also to find all ordinary engine stores.

This economy is said to be the result of the valves for admission of steam being nearer their work in the Corliss engine than any other arrangement admits of; the admission, by the sensitive action of the governor applied direct, of only just the necessary quantity of steam required at the instant, and the almost entire absence of back pressure, the separate exhaust valves being unvarying in their action, and adjustable to close at any point desired, before the termination of the stroke. The "literally" primary question of first cost is not known to the present writer; it would very likely be more expensive in this respect than the ordinary horizontal engine, although almost all the parts of the Corliss engine could be prepared by machine tools, there being especially a great deal of lathe work in it.

In conclusion, in the words of one of your correspondents on this subject, "I may state that, whether the Corliss engine is 'good or bad' is a matter of indifference to me, for, unlike Mr. Douglas, I have no personal interest in the question."

London, July 4, 1867.

I am, Sir, yours obediently,

ANONYMOUS.

TO THE EDITOR OF ENGINEERING.

SIR,—I have lately started a Corliss engine at our new mill here, and, as you are already aware, our four large beam engines are in course of alteration to the Corliss system of valve gear. The engine lately started has a 22 in. cylinder, 3 ft. stroke, and is working at 100 revolutions per minute, with 100 lb. steam, cut off at from one-tenth to one-twelfth stroke. I find no difficulty with the speed, and, were it required, I should have no hesitation in driving the engine at 150 revolutions per minute, equal to 900 ft. of piston. The "rattletrap" valve gear will, I have every reason to believe, wear well, and give no trouble.

Saltaire, Bradford, July 6, 1867.

Yours truly,
GEORGE SALT.

THE CORLISS VALVE GEAR.

TO THE EDITOR OF ENGINEERING.

SIR,—It is to be hoped that the discussion in your pages as to the merits of the Corliss engine will enable your readers to judge for themselves whether it is the important improvement which some persons maintain, or the "sterile expedient of economy" and "futile machine" which one of your correspondents asserts it to be.

Mr. Douglas, whether his views upon this subject be correct or otherwise, can hardly with any show of propriety find fault with the objection that provincialism or obscurity constitutes no title to authority, since, in fact, this was the very objection which he himself raised against the dictum of your correspondent, "Observer," he having written over that title instead of over his own name. Now the rules in questions of anonymous authorships are well understood and generally accepted. When a man who is either little known or wholly unknown makes assertion of a fact as coming within the sphere of his knowledge, none can be expected to accept such statement as of any authority. If, therefore, your correspondent, "Observer," had, like Mr. Douglas, vouched for the perfections or imperfections of a machine, as being demonstrated by his own knowledge and experience, it would be quite warrantable to set such testimony aside as not of the smallest value. But whilst anonymous assertions of fact would not only be futile, but presumptuous, anonymous argument based upon facts generally known and admitted is just as good as any other argument, which cannot properly derive any additional force or currency from the authority of any name, however great.

I do not see that Mr. Robert Douglas has been able to controvert any of the arguments which "Observer" brings forward in opposition to the Corliss valve gear, while no attempt has been made in any quarter to impugn the accuracy of the first principles he lays down. Nor does it lie with "Observer" or any other advocate of existing methods of construction, to prove that the Corliss system is much worse than the usual one, as the onus manifestly lies with the Corliss advocates to prove that it is much better. Neither reliable facts nor valid arguments have yet been advanced to prove that it is better at all.

I should like Mr. Douglas to explain the meaning of working "night and day," as the expression is usually understood, the assertion that three and a half years of such work is equal to seven years' "running of an ordinary factory engine," is certainly loose and unsatisfactory. Mr. Gill's evidence in favour of the Corliss system is also evidently of no value whatever; to compare a new and carefully got up engine with such a one as at Manila, is absurd.

Mr. Douglas states that Mr. Pinchbeck "founds his objection to the engine on its unfortunate valve gear." Upon what else should he found it, since of that appears to consist the whole Corliss engine? I quite think, with Mr. Pinchbeck, that the only chance of getting such contrivances to stand is to run the engine at a slow speed. You yourself, in extenuation of the fact that the Corliss valve gear is a "rattletrap," say that other machines, which are nevertheless in extensive use, are unquestionably "rattletraps" too; and manufacturers who use such machines are not likely, on account of this stupid, if not vulgar, nickname of the old school of millwright engineers, to reject an improvement merely because they are so characterised. You also state that Mr. Corliss has sought to bring the full pressure upon the piston with the least loss in the ports, and to cut off at an early point for regular work, and to vary the cut-off according to the resistance for irregular work—points which other engineers have also sought to do long before Mr. Corliss, and which are habitually and efficiently done in engines which are without his complications.

Of course no one can deny that power-looms and steam-hammers are very noisy, and are nevertheless used extensively; but nobody would be disposed to maintain that they are good in consequence of this peculiarity. But, on the contrary, if such machines as these could be made to work noiselessly, this would be an improvement which every one, mechanic or otherwise, would be disposed to recognise. We all know that when steam hammers first came out it was very difficult to prevent the pistons, piston-rods, and other parts being broken by the shock to which they were continually exposed; and although by increasing the strength and other expedients they have at length been got to stand, yet no one will be disposed to look upon this necessity as a valuable feature of construction, or advocate the introduction of such concussions into steam engines as an improvement.

You state that his gear is durable, and adduce in evidence of the soundness of the conclusion that some engines with the gear have made voyages to South America without missing the right supply of steam on a single stroke. Do, then, common engines necessarily break down on such a voyage or miss this supply of steam? Have we not in evidence that engines of the ordinary description have been at work for thirty, forty, and even fifty years without once going wrong, and have even worn the same brasses for most of the time?

The Corliss engine, whatever its qualities, can adduce no such proof of durability as this. No mechanic would expect from it such durability; and as it is noisy, less likely to be durable, and secures no superior economy beyond that attained in engines of ordinary construction, it is quite idle to maintain that any case in favour of this innovation has yet been made out.

London, July 9, 1867.

[It will save space in this discussion if correspondents will frankly say whether they do or do not know anything, practi-

I am, &c.,

W. H. N.

cally, or by extended acquaintance, of the Corliss engine. It has gained a prominent position abroad, after seventeen years of just such arguments as "Observer's" and "W. H. N.'s." Are they in a position to show, by any reference to practice, that their arguments have been anywhere borne out by experience? —ED. E.]

HOW TO DESCRIBE THE PARIS EXHIBITION.

TO THE EDITOR OF ENGINEERING.

SIR,—At a time when nearly everything connected with our profession in the Paris Exhibition has been seen and studied by many hundreds of English engineers, I am surprised that no one has pointed out certain remarkable mis-statements or blunders in Mr. Mallet's series of articles in *The Engineer*, although, possibly, their very number makes the task too great, while their real influence is, after all, no doubt, insignificant. Imagine the writer, in his paper of June 28th, speaking of the six-coupled goods engine, made by the Compagnie Belge, as "a large passenger locomotive of the Luxembourg Railway, very similar in design and finish to the admirable passenger engines" made by Kitson, of Leeds! When this or any other maker turns out a six-coupled passenger engine (unless for work like that of the new St. John's-wood Railway), "may I be there to see." In the same account M. Walschaert, of the Southern Section of the Belgian State Railways, is described as "M. Valerae, locomotive superintendent of the Southern Railway of Belgium." The Cockerell engine, it is stated, has one pair of coupled wheels behind its "prodigiously long firebox," whereas the axle is under the firebox, at the middle of its length. Carels's tank locomotive is described as "a well-turned-out specimen of locomotive work." Had it been ordered by the Imperial Commission to be removed from the Champ de Mars, it would have been "well turned out" indeed, for it is conspicuously the worst in workmanship and finish in the whole Exhibition. It is Mr. Mallet (the inventor, I believe, of the *Hauptoberbergamtschule zu Berlin*, of which he lately wrote, whereas no school of that name exists there) who is so assiduously seeking to discredit English manufactures and machinery abroad, by proclaiming how much foreign nations are surpassing us, and he lately gave one instance in the shape of the wretchedly turned out rolled beams from Châtillon and Commeny, beams which any Scotch or English mill master would have sawn up into scrap, and I presume this villainous piece of Ghent locomotive work (Carels's) is another example of foreign excellence.

In the same number of *The Engineer*, p. 589, we are informed that "flints are melted by steam under pressure," and thus converted into silicate of soda. No doubt the flints would not melt but for the steam, under pressure, but how about the caustic solution? The idea of melting flints by steam only under pressure is worthy a place among those wonderful "Notes and Memoranda," or the lively intelligence (page 585 of the same number) that "the scavengers of New York turn up their noses at two dollars a day." On page 594 (same number) is a drawing of Mr. Ramsbottom's duplex hammer, with a single vertical cylinder, and with neither scale nor dimensions given. We are told that Mr. Ramsbottom's description of his hammer, as read at the Paris meeting of the Mechanical Engineers (that hammer having two horizontal steam cylinders) "applies in almost every particular" to the one shown, "the only difference being in dimensions!"

These are fair specimens, collected from a single number, too, of the accuracy and knowledge with which *The Engineer* still seeks to maintain a place in the profession.

I am, Sir, yours, &c.,

BEN LOMOND.

Glasgow, July 9th, 1867.

NEGATIVE SLIP.

TO THE EDITOR OF ENGINEERING.

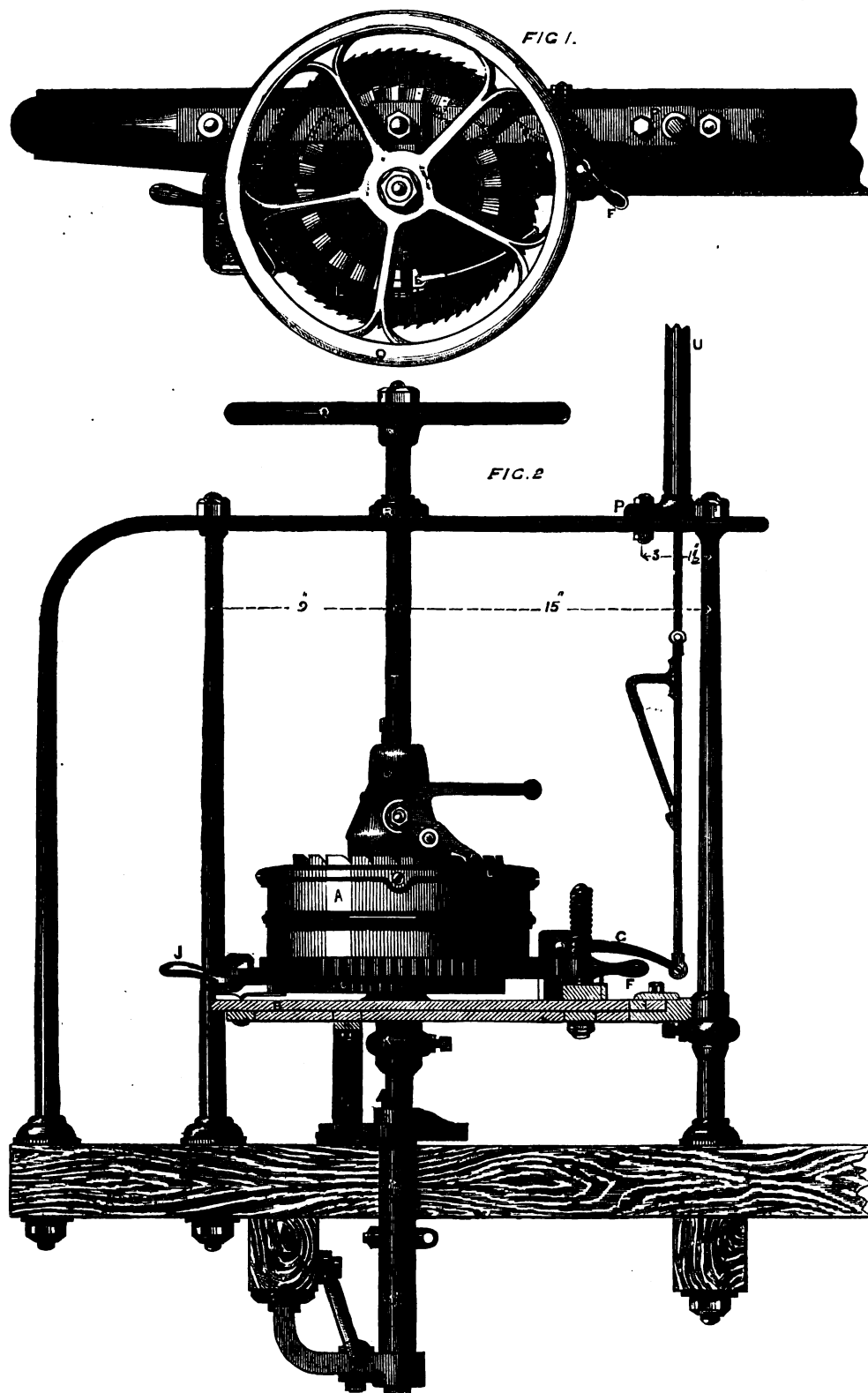
SIR.—Seeing the subject of negative slip again revived, may I offer a few remarks on a disturbing cause likely to impair the true working of the propeller, and to produce the above evil, namely, the disturbing action of the working face of the blade on the water in contact. I believe that I am correct in stating that negative slip generally occurs with propellers moving through the water at a high velocity, whether owing to a fine pitch, large diameter, or both. When we consider that a screw moves at a rate due both to its own revolution and the advance of the ship, it is not unreasonable to suppose that a certain amount of skin friction, if we may use the term, is likely to exist on the working face; the effect of which would probably be that a certain quantity of water would be retained and carried round by the blade, entering at the leading edge and gradually diminishing in its velocity towards the after portion, where it would escape. This, together with the centrifugal action, would produce a stratum of water constantly tending towards the periphery and after portion of the blade in a spiral direction, and by its continual presence would be to all intents and purposes a part of it, and consequently have the effect of increasing the pitch of the propeller for the time being. The fact of the rapid destruction of the leading corner in a common Smith's screw goes far to support this view of the case, for on the foregoing assumptions this would be the part least protected by the film. I think the recent trials of our ironclads go far to prove—1st, that if positive slip is required, propellers with an expanding pitch will not accomplish it; and, 2nd, that (as in the case of the Belle-rophon) negative slip may be a result of the propeller alone, for when fitted with a Griffith's propeller, the same ship gave a far better result and positive slip. All our recent ironclads have been originally fitted with the four-bladed Mangin screw, and all have to a greater or less extent produced negative slip. In some cases the engines have not been able to attain their calculated number of revolutions, this would tend to show that an immense amount of friction was developed somewhere in the region of the propeller, which could be well accounted for on the foregoing assumptions. Again, the existence of a following current, though it, no doubt, is a very material predisposing cause to negative slip, may be overrated, for supposing the propeller to be advancing at a rate greater than that due to the pitch of its blades, a large amount of water would necessarily be kept up under the stern of the ship. Apologising for trespassing on your space,

I am, Sir, yours respectfully,

HALL.

Greenwich, July 8th.

CREAMER'S SAFETY RAILWAY BRAKE.



On nearly all American railways every passenger train has a brake on every wheel, these brakes being worked by hand by brakemen always stationed on the end platforms of the passenger carriages and luggage vans, the latter called "baggage cars." By the sudden and simultaneous application of all these brakes, trains moving at from 25 to 40 miles an hour are pulled up, in cases of emergency, within a much shorter distance than is possible under our own system of break vans, with one or two guards only, to act as brakemen for a long train. But the American system has not been found sufficiently effective. A train moving at 40 miles an hour, or 58½ ft. per second, would be stopped, on a level railway, supposing the brakes to be instantaneously applied, and the friction of the wheels upon the rails to be one-seventh of the weight, within a distance of about 376 ft.; and it is a fact that trains have been, not once, but often, brought up within this distance at the speed named, merely by the simultaneous application of all the brakes to all the wheels. A train, moving at 58½ ft. per second (40 miles an hour), has an energy, or amount of stored-up work which, were it directed upward in vacuo, would lift the train 58½ ft. high. If the adhesion of the wheels, suddenly arrested by the brakes, be as much as one-fifth of the weight, the train should be stopped within a distance of $58\frac{1}{2} \times 5 = 268\frac{1}{2}$ ft., and we have very good authority for stating that a train, at the speed named, has actually been stopped within this short distance by the instantaneous application of a brake to every wheel.

To effect the instantaneous application of all the brakes in cases of emergency, many of the leading American railway com-

panies have adopted Mr. William G. Cremer's system, as shown above, and which was also put in use under Mr. Cremer's directions, in 1863, on a train on the South Eastern Railway.

The illustration shows the buffer beam and stanchions of one of the ordinary end platforms of an American railway passenger carriage, together with the ordinary American brake-spindle with its large horizontal hand-wheel. This spindle winds on a chain secured to its lower end, below the buffer beam, the spindle being locked when the brake is on by a ratchet and pawl, the latter put on by the foot of the brakeman while turning the brake-spindle and winding on the brake-chain.

In Mr. Cremer's arrangement, the brake-spindle is furnished with a powerful coiled spring formed of rolled brass, and coiled within the box A, and this spring may be wound up to a tension of about 12 cwt. without putting on the brake, by engaging the catch marked F, and working through the pawl, E. This does not in any way interfere with the ordinary application of the brakes by hand; but if the trigger, G, be tripped, as it may be by the bell cord running throughout the train, every brake so acted upon is put on in an instant. If a train accidentally breaks apart the action is the same, and the severed portions of the train, even if on a steep descending gradient, are at once stopped.

It is not too much to say that this appliance has already saved some hundreds of lives from otherwise inevitable death, in the case of impending danger upon the American lines. Mr. Cremer, who pursues the application of his system more as a matter of philanthropy than of business, is now in London, and may be addressed at No. 9, Woburn-place, W.C.

EAST INDIA IRRIGATION COMPANY.

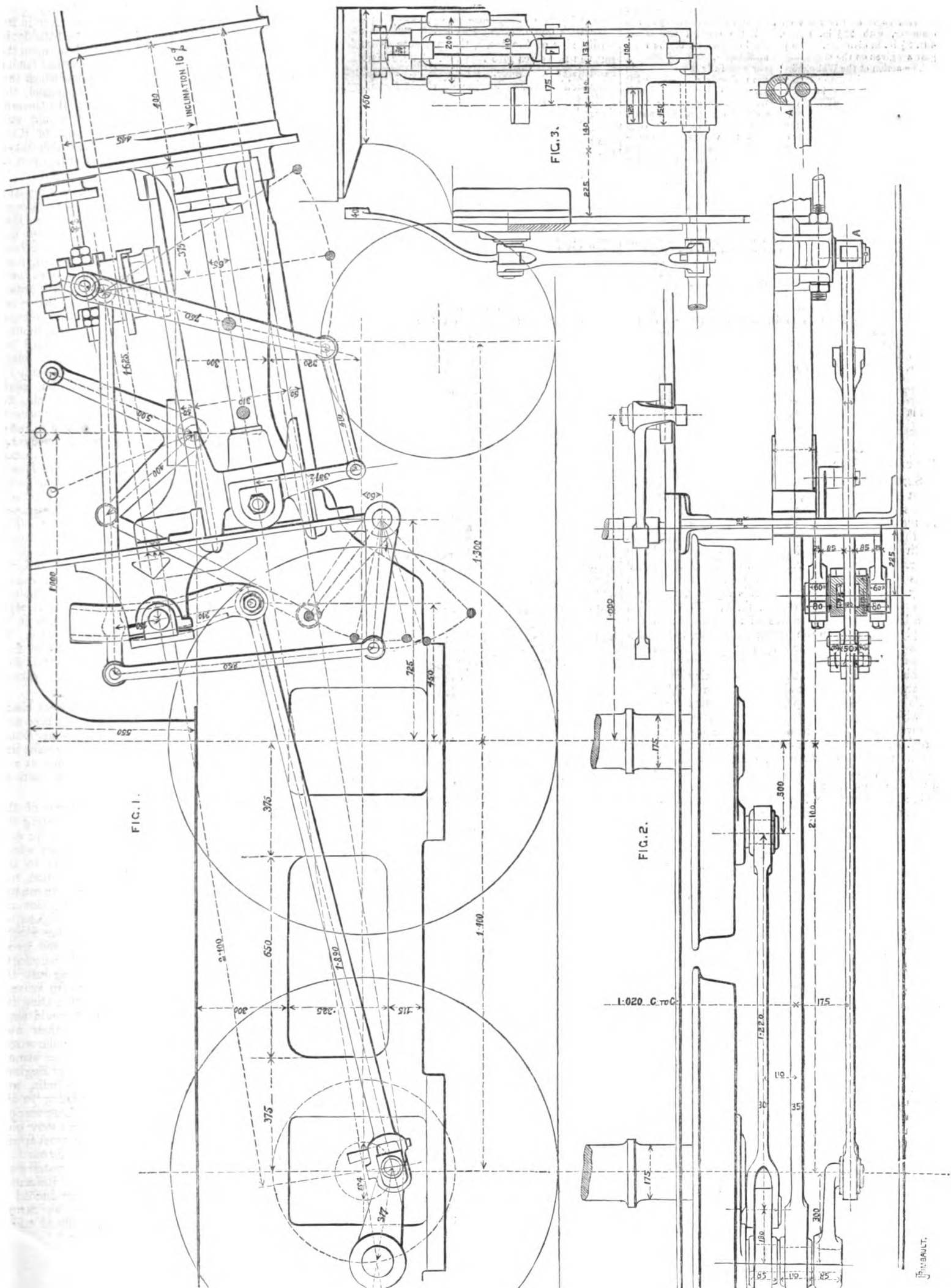
AFTER a long and tedious course of negotiations between the East India Irrigation Company and the Indian Government, it has been finally arranged that that company shall be entrusted with the carrying out of a system of irrigation from the Soane river in the lower provinces of Bengal. There can be little doubt that but for the pressure brought to bear upon the Government in consequence of the calamitous famine which still prevails in most of the districts which this new system of irrigation works will command, the old policy of delay, which is as familiar to the Government of India "as household words," would still further have retarded the commencement of these works, which should long ago have been undertaken as one of the most urgent requirements of that part of India.

Unfortunately, the East India Irrigation Company have not hitherto been able to show any very successful results from their operations in Cuttack, and this cause, we fear, may tend to impede their raising the additional capital required for these new works, not that their scheme appears to possess the slightest elements of uncertainty as to its ultimate success, but, on the contrary, it is considered by the best authorities on such matters to contain within itself all that is required to ensure ultimate success and remunerativeness. The works to which the company are at present limited are such as are contained within the area fixed by Colonel Dickens, and on the plans of their chief engineer, Colonel Rundall. We will not now stop to give minute particulars of this scheme, but shall do so on a future occasion, when we hope also to be able to state that the works have been commenced in good earnest. Should the company be able to raise the necessary capital, a beginning will be made by placing across the Soane river a great weir or anicut near Dehree, where it is crossed by the Grand Trunk Road. From this point, canals for irrigation and navigation will branch off eastward to the river Moorhur and to Patna, and westward to Chunar, Benares, Buxar, and Arrah, commanding an area of 1,800,000 acres for irrigation. The total length of the canals will be 1065 miles, of which 545 miles will be first-class navigation lines, which will afford excellent means of transporting the produce of the soil raised through irrigation. The amount required to complete the works is estimated by Colonel Rundall at 210 lakhs of rupees, or about 2,100,000£, on which it is anticipated that the returns will enable them to pay ten per cent., raised at the Orissa rate of five rupees an acre for half a million of irrigated acres. For the present, however, only a million sterling is asked, by the issue of 100,000 shares of 10£ each.

The company's contract with the Government binds them to repay the cost of the land used for offices and for preparing materials after dividing 5 per cent. amongst their shareholders, and half the profits are to be made over to the Government that may at any time be in excess of 20 per cent. on the paid-up capital.

Although we are fully aware of the nature of the arguments raised against the policy of entrusting the construction of irrigation works in India to private companies, we are unable to hold with a policy which has hitherto neither constructed such works to the extent demanded by the wants of the population, nor permitted others to do so; and now that we are apparently entering upon a new era, when the Government is raising special loans for the purpose of more completely developing the practicable irrigation schemes for India, we have only too great reason to fear that that very fact will henceforth be advanced as an additional argument against the concession of any further such schemes to private enterprise. If we are correct in thus interpreting the intentions of the Indian Government, we would warn them that such excuses for retaining in their own hands a monopoly in the construction of public works in India cannot long prevail; we are doing our utmost to raise some interest amongst the people of England for the welfare of their fellow-subjects in India, and the time must arrive when anything relating to our eastern empire shall be listened to with some respect in the Imperial Legislature. If the subject were only better understood, and the importance of the trust appreciated, we might not unreasonably look forward to the time when "India" should become the watchword of political parties, instead of the bugbear "Reform;" and now that the latter may fairly be considered as settled, for some years to come at least, we cannot commend to the notice of professional political agitators a more important subject than "India."

THE WALSCHAËRT VALVE GEAR.
AS APPLIED TO M. VAESSEN'S LOCOMOTIVE "ST. LEONARD," PARIS EXHIBITION.
(For Description, see next Page.)



WALSCHAERT'S VALVE GEAR.

In the second volume of this journal we gave (*vide* page 461) an account of the valve gear patented in France by M. Walschaert, and we now give on page 33 engravings showing this gear as applied by M. Vaessen, of St. Leonard, to the engine now exhibited by him at Paris. The engine in question is a ten-wheeled tank engine, there being six-coupled wheels and a four-wheeled bogie at the front end. The cylinders are 18½ in. in diameter, with 28½ in. stroke, and the coupled wheels are 4 ft. 3¼ in. in diameter. The principal dimensions of the valve gear are given on the engraving in millimetres.

The action of the Walschaert's gear was fully investigated in our former article, to which we have already referred, and it will, therefore, only be necessary that we should describe it here in general terms. In the Walschaert's gear the valve derives its motion partly from the piston crosshead and partly from a small overhung crank, placed as shown in the engraving. As will be seen from the side elevation, the valve spindle crosshead is coupled by a side pin to the shorter arm of lever, the longer arm of which is connected by a link to an arm on the piston crosshead. The fulcrum of the lever just mentioned is not a fixed one, but consists of a pin carried by the end of a radius rod, which derives its motion from a quadrant link, which has an oscillating motion imparted to it by a rod extending from the small overhung crank already alluded to. The extent and direction of the motion of the radius rod depends upon the position which the blocks carried by it occupy in the vibrating quadrant link, and this position is adjustable by a weigh-bar and lifting arms in the usual way. It is the motion imparted to the fulcrum of the lever by the action of the crank and vibrating link, which gives the lead to the valve, and enables the motion to be reversed. It will be seen from the engraving that, in order to make the short arm of the lever as short as possible, and thus to reduce the total length of the lever, the boss for the upper pin has been cut away, as shown in the separate figure. The distribution of steam effected by the Walschaert's gear is very fair; but except in instances where, as on the Continent, outside valve gears are tolerated, it is somewhat difficult to apply conveniently, and this will probably prevent it from ever being used to any extent in this country. In Belgium it has been somewhat largely applied, and in France a few engines have been fitted with it.

THE PARIS EXHIBITION.

CONCLUDING EXPLORATION IN THE MAIN BUILDING.

SUNDAY is always a *dies non* in the English department of the Exhibition, and the Monday on which the prizes were distributed was much the same from most of the exhibitors being absent from their usual places on that occasion. Following the carriages and locomotives of the English department, to which we lately referred, we come to a very good display of engineers' tools by Sharp, Stewart, and Co., of Manchester. They also show a form of Giffard's Injector, which we illustrated in October last, vol. ii., p. 284, and which is self-adjusting, irrespective of any changes in the supply of water or in the pressure of steam, the instrument being once started by merely letting on the steam.

John Fowler and Co. show one of their clip pulleys of large diameter, with weight hung from the V groove in its edge by a wire rope, so as to show the manner in which the small hinged segments composing the groove are tightened against the rope by the strain itself. The same makers also show a small portable engine of usual construction, carrying a clip pulley at one end, which is rotated by a pinion working into a wheel set on the same axis as the pulley, and which is in about the same line as the axis of the boiler. This arrangement is said to represent the system of M. le Baron Oscar de Mesnil, and it may be used either for drawing ploughs overland or for other purposes requiring steady traction.

Clayton, Shuttleworth, and Co. show a small fixed horizontal engine, well designed and admirably finished. A similar engine by the same makers is also shown in the agricultural annexe. The governor is wrought by a strap and two bevels, and there is an expansion valve behind the main valve worked by a separate eccentric. The standard which supports the governor has eyes pierced through it to serve as guides for the valve and expansion-valve rods, and also for the throttle-valve spindle. This engine has the top of the piston-rod steadied by guides in the usual manner, and the crank is one formed in the shaft by bending. There is one fly-wheel pulley. The workmanship is of a kind very seldom seen in this class of engine, and is not excelled by anything to be found in the Exhibition.

B. and S. Massey, of Openshaw, Manchester, show a small steam hammer, and also a very well designed steam oliver, in which the handle of the hammer is worked up and down by the piston-rod of a small vertical oscillating engine set beneath it. The slide valve of this cylinder is moved by a weight which hangs stationary while the cylinder moves, and so works the valves. This is a very well designed and well finished instrument, and ought to be able to get through a great deal of work.

There are two rotatory engines shown in this depart-

ment of the Exhibition, one shown by J. C. Hill and Co., of Newport, and the other by R. W. Thomson, of Edinburgh. Hill's engine consists of two great discs toothed on the edges, and gearing into one another. They are surrounded by a case on the larger part of the internal circuit, of which the teeth rub steam tight. But the steam being admitted opposite to where they gear with one another, and being emitted at the opposite side of the teeth, the pressure is sufficient to put the two discs into rotation. There is nothing new in this contrivance, which is a reproduction of Murdoch's rotatory engine of the last century, and it in its turn is a copy of the *Machina Pupperheimana*, figured as a pump in Leupold's *Theatrum Machinarum*, published in 1727. The objections to the system are the magnitude of the steam-chambers relatively with the power produced, and also the number of surfaces to be made tight. For the points and sides of each tooth has to work steam-tight in its enveloping casing; or if only some of them are made tight, as it has been suggested will be sufficient, the steam will leak backwards into the empty spaces of the machine, and will be wasted. The machine, moreover, is noisy, and the teeth are liable to wear. In some cases the last evil has been sought to be counteracted by applying wheels outside of the machine of the same size as those inside. But this, at least, is a palliative only, and the machine must still be noisy if it is run at any high speed. Thomson's engine is somewhat on the principle of Hornblower's, also contrived in the last century. There are two radial pistons, which rotate continuously in one direction, and there are also two other pistons, working intermediately between the first two in the same case, but continually working up nearly to the first two, and then again lagging behind, so that these last two pistons have relatively with the first two a reciprocating motion, by which steam is expended and power generated. Hornblower's engine had two rotating leaves, revolving upon a vertical axis in the centre of a cylinder, like a door turning on its hinges. But one of these doors remained fixed, while the other moved until it came up to the fixed one, when the moving door stood still, and that which had before been fixed moved away, and performed the circuit of the cylinder until it approached the fixed door on the other side. In Thomson's engine the same principle operates, only that neither leaf stands absolutely still, and the power is measurable by the relative spaces which the rotating pistons pass through. The advance and retirement of Thomson's pistons from one another is effected by the application of elliptical geared wheels on the outside of the casing; but these wheels make a great deal of noise. An alternative arrangement of cranks and links, however, is shown in a rough model exposed on the top of the engine; and as this plan would work without noise, it would be in every way preferable.

G. Bower, of St. Neots, Herts, shows the design of apparatus for purifying gas. B. Donkin and Co., of London, show a wave rider-roll for a paper-machine, and also a roller-press; also a small machine for chopping rags. H. Pontifex and Co., of London, exhibit a brewing copper to boil by steam, a small three-throw pump, a coil of steam pipes, a wooden vat, and a self-acting apparatus for cleansing beer. They also show a model of a machine for cleaning casks, and a mash-tun, fitted with Maitland's self-acting washing apparatus for washing malt; also a model of a pair of malt-crushing rolls and some vertical cast-iron pipes, about four inches diameter, connected at the ends with bends, constituting H. Ashley's refrigerator for worts, and which somewhat resembles the pipe-condensers used in gas-works. They also show a contrivance called an "attemperator," for the fermenting tun, and which is substantially a small barrow of pipes, with two india-rubber tubes joined at the opposite ends.

Luke Collier, confectioners' machine-maker, of Rochdale, shows two rotating globular vessels of copper for making comfits; one, the larger of the two, revolving on an oblique axis; and the other having its axis inserted at the bottom as a crank-pin in a rotating disc, while the bottom of the pan rests with each point in a ring fixed on the bottom, resting in succession upon a small circular tramway, so that the pan is tilted successively in every direction. The same maker also shows brass rollers for making bonbons; also a mill, somewhat like a vertical coffee-mill, for grinding up loaf sugar.

Neilson, of Glasgow, shows a remarkably well-designed and well-finished radial drill for boring iron. It is to be regretted that this is the only tool of this maker exhibited, and it, too, is of small size, and is set in an obscure place, where it might readily be passed over by the visitor; but the quality of the instrument will attract the attention of all discrimi-

nating observers who may chance to see it. Several photographs of other tools by the same maker are shown, which will give some idea of the mode of their construction in the absence of the tools themselves.

Messrs. Fleet, of Walworth, London, exhibit two very complete soda-water machines, with engine, pumps, receiver, and bottling apparatus, all combined into a compact and elegant machine. The design of these machines reveals the hand of an accomplished mechanic, and the workmanship is excellent. The prices, moreover, we observe from the price-list, are very moderate. There is no soda-water machine that we have remarked in the whole Exhibition that is comparable in neatness and goodness to these.

Samsou Barnett, of London, exhibits a diving-dress, and a three-throw pump of excellent workmanship for sending down air to the diver.

In this part of the Exhibition there are two winding machines for thread—one for winding it upon bobbins, such as are sold in the shops for containing sewing cotton, and the other for winding it upon pieces of flat card with projecting ends like those of a bobbin for preventing the thread from slipping off. These machines, by Ermen and Smith, of Manchester, do their work exceedingly well. A row of bobbins is filled at once, the thread wound on each, passing from a large bobbin on which it had been wound during the process of being spun or twisted. The wind of the thread upon each bobbin is regulated by a screw which moves an eye through which the thread passes; and when the end of the bobbin is reached the motion of this eye is reversed, whereby a second layer of thread is deposited upon the first. The mechanism for winding the thread upon the cards is similar, except that in the case of the cards the thread passes through an eye of a fly like that of a spinning-machine, by the rotation of which it is deposited upon the card. The makers of these and similar machines are not very fond of explaining the details of their construction to the general public, as they complain that their plans are pirated by Continental makers, some of whom have a bad reputation in this respect.

Brasier's flax-breaking and scutching machines, manufactured by J. E. Hodgkin, West Derby, Liverpool, are probably the most efficient machines of this class in the Exhibition, as they do their work well and quickly, and are strong, compact, and symmetrical in all their parts. The breaker, for breaking up the brittle woody parts of the hemp, consists substantially of a fluted drum, on which four fluted rollers of small diameter press, and the fibre being bent suddenly by being passed between these grooved surfaces, the woody part is in a great measure broken out. The rollers have a long forward motion alternating with a short reverse motion, so that the preponderating motion is a forward one. But by the alternating retrograde motion the shive is better broken away, and the flax is longer exposed to the action of rotating beaters, which are introduced at one part of the machine. One machine will break about 12 cwt. of flax straw in the day, and one breaker will keep two double or four single scutchers going. The scutcher consists of a drum of wood, carrying alternate straight and vandyked blades, which strike the flax as it passes between the drum and a sort of venetian-work casing, carried about one-sixth round the circle, and through the interstices of which the remaining particles of shive and dirt fall. The tow is swept off the revolving blades by another revolving wheel with suitable projections, and is collected on the floor at the back of the machine.

Fox, Walker, and Co., of Bristol, exhibit a horizontal engine in operation, about which there is little remarkable, except the simplicity of the design and the excellence of the workmanship. There is a separate eccentric for working the expansion valves, which consists of two plates advanced or retired by a right and left hand screw, and by means of a hand-wheel the rate of expansion can be changed. The governor is driven without bevels, by means of a twisted belt working to a pulley on the governor-ball.

Thwaites and Carbutt show their large steam hammer with wrought-iron side-frames; also model of their 2-ton hammer with cast-iron side-frames, and models of Ramsbottom's duplex hammer, each hammer weighing 10 tons, and model of same hammer with each hammer weighing 30 tons. Tannett, Walker, and Co., of Leeds, show a small steam hammer containing several ingenious modifications of the valve-gear; and Austin and Dodson, of Sheffield, exhibit examples of hammers, files, and other objects of their manufacture of good quality. Joseph Robinson and Co. show a calendar for glazing calicoes with four rollers driven by a pair of diagonal engines at one end, two of the rollers being of bright cast iron and two covered with

pasteboard. The crank-shaft of the engine carries a pinion, which works into a wheel of about three times its own diameter, which is attached to the second highest roller, which is also the smallest in diameter, and is of bright cast iron. The four rollers of the machine stand vertically over one another, the lowest and second highest being bright and the others covered with pasteboard, and the whole are of about the same diameter, except the second highest, which is of about half the diameter of the others. The second highest roller is the prime mover, and it has a steam pipe leading into it at one end to enable it to be heated by steam. The lowest roller is worked from the highest by an intermediate wheel, which also enables the rollers to be set up or down by a hand-wheel on the top of each frame, and also by levers overhanging the top frames, and the ends of which are pulled down by screws. This is a well-designed and well-constructed machine. But the rollers are not in the best order as now shown, one of them having got somewhat damaged in being brought over, and having stamped its irregularities upon the others. This, however, is no disparagement of the machine, but rather the reverse, as it shows the power of one surface to mould the rest.

Monsieur Delabarre, of Huddersfield, shows a specimen of his steam plate press, in which, instead of the common hot plates, chambers heated by steam are employed, the steam being led into each hollow plate or chamber through two or three turns of small piping, to enable the plates to be set down somewhat while the pipes are still passing steam. The same exhibitor also shows drawings of his cylindrical boiler with spiral seams, and of his rotating fulling-mill. M. Delabarre, besides himself exhibiting, notifies that he undertakes translations for other exhibitors, and the printing of circulars, pamphlets, lithographs, and other things of that nature. M. Delabarre also says that he supplies machines of any kind whatever, and also castings. Perhaps more might be done, if less were aimed at.

Of the various looms and spinning-machines in the English department we do not pretend in this notice to take any account. Galloway's engines, with two cylinders laid on their sides, and the two slide valves in a casing between them, as is an usual arrangement in locomotives, we have already referred to in terms of praise, merely on account of its simplicity and directness, and the fewness of its moving parts. Bradford and Company show a very good washing-machine, consisting of a polygonal box, into which the clothes, the water, and the soap are put, and the box is then turned on a horizontal axis, when the wet clothes, by falling from side to side of the polygon, have the dirt washed out as in a dash-wheel. Wringing is performed by passing the wet clothes through a pair of wooden rollers, of which the top one is kept down by levers, on which weights are hung, which weights rise if a thick part of the article to be wrung is carelessly passed through. This appears to be a simple and efficient mechanism likely to come into use, as it has no tendency to wear or injure the clothes.

Worsam's wood-working machines, and other machines by Charles Powis and Co., standing next to them in making the circuit of the building, have already been described in separate articles. But we shall here briefly notice the wood-working machines of Powis, James, and Co., of Lambeth, London, and T. Robinson and Son, of Rochdale, both of which stand in the second row behind the others, and both of which firms exhibit machines of the first quality. The most prominent of the machines exhibited by Messrs. Powis, James, and Co., is their moulding and planing machine, which planes four sides of the wood at once, by means of two horizontal spindles carrying cutters, and two vertical; and the vertical can be set at any desired angle, so as to bevel the edges of planks, or to groove and tongue the staves or lagging placed round a cylinder or boiler, so that they may all fit one another accurately at the proper angle. Another feature of this machine is that the feed of the wood may be varied gradually from any desired quickness to any desired slowness, by means of a pulley rotating on the face of a disc, and capable of being pressed near the centre or near the circumference, whereby the speed with which the feeding-rollers rotate is correspondingly affected. The power of thus altering the rate of feed is useful when wood with knots or stakes is being planed, as when the knot is approached the feed may be made so slow as to create no risk of injuring the tool. The same makers show hand-saws, in which the band is tightened by a spring like a locomotive spring, one end of which is attached to a slide, in which the upper wheel is carried, while the centre of the spring rests on

the top of the framing, and its outer end is pulled down by a screw turned by a hand-wheel. There is a circular swivelling-table for carrying the wood presented to the saw-band, so that the wood may be cut at any desired angle, and where the saw passes through the table, it is steadied sideways by passing through a slit in the wood, which wood is circled to the radius of the swivel, so that the bottom of its table moves on this wood without shifting or swivelling it in any degree, whereby the support given sideways to the saw remains unimpaired during all the operations. The same makers exhibit mortising machines, circular saws, and a tenoning machine, in which the wood is advanced between two rotating cutter-blocks fixed on horizontal shafts, the advance being accomplished by moving forward a slide-frame of cast iron, to which the wood is clamped; and the upper part of this frame is capable of being swivelled round a pin at the end next the cutters, whereby the tenons may be cut at any angle. The cutters consist of two plane irons set as tangents in each rotating-block. The body of the block is made square, and its face circular, and in each face there are two chisels indented, projecting a little way beyond the circumference, the better to clear out the shoulders, and to take the strain off the corners of the plane irons. The framing of these machines is generally made tubular for the sake of greater stiffness, and the workmanship and design are both good.

T. Robinson and Son, of Rochdale, exhibit a number of wood-working machines of a very high order of merit. Among these is a circular saw, with flat iron table and adjustable piece standing up at the side of the saw, which piece may be set at any desired angle; and as the plank is pressed flat against it as it moves along, the plank may be cut diagonally at any desired angle. Then there is a very elegant machine, consisting of a circular saw, which is vibrated to and fro in a slit in a cast-iron table, whereby staves or other pieces of wood may readily be cut by a gauge to any desired length. The saw is placed at the end of a vertical vibrating arm, the centre of which is at about the level of the floor, and the belt is conducted from a pulley at the vibrating centre to a pulley fixed on the axis of the saw, whereby the necessary speed of rotation is given. The vibration is accomplished by a pin set in a disc, which moves in a vertical slot connected with the vibrating arm. When the arm is being so moved as to bring the saw against the timber, the pin of the crank or disc is moving in that part of the slot furthest removed from the vibrating centre, and the consequence is that the saw moves forward slowly. But when the arm is being retired, the crank-pin is moving in the part of the slot nearest the centre, and motion is much more rapid. By this ingenious arrangement—applicable to many machines, such as planing-machines and slotting-machines—the cutting edge is withdrawn much more rapidly than it is advanced, whereby time is saved.

The same makers exhibit a self-acting tenoning machine, in which the wood is advanced and retired by the action of the machine itself, and of which the cutter blocks are capable of being moved up or down and in or out, whereby the tenon may be cut more near to the one side of the piece than to the other, or with one shoulder higher than the other. There is also what is called a scribing block, with vertical spindle for carrying cutters to finish off at one operation the sash bars for windows. The cutter blocks are in all, or most cases, square blocks of cast iron, to which the plane-irons are fixed by screws or otherwise, and sometimes these square blocks have round faces with indented chisels, and in fact in all tenoning-machines they are usually so formed. This machine has also a pulley, which can be set down or left loose, so as to tighten or loosen the driving belt.

The mortising machine of these makers is marked by the same qualities of skill and ingenuity which have presided over the construction of their other machines. A boring augur and mortice-chisel are worked by the same machine, and when a mortice has to be cut, the first operation is to drill a hole with a screw augur. The augur is driven by bevel gearing, and the depth to which it shall penetrate is regulated by an adjustable ring-stop or sliding collar, with pinching screw on the augur spindle. The mortising chisel is moved up or down by a pin in a disc, like that in a common slotting machine, and there is a pulley arrangement like that of a fast and loose pulley, whereby either may be put into operation that is desired. But the act of shifting the belt from one pulley to the other, also makes fast by a friction brake the instrument not in action, so that there is no risk of the wood being damaged by the partial action of the machine. The

mortising chisel can be turned round at any time by a small handle attached to its side, which handle then slips into a notch. The bed to which the wood is fixed has an in-and-out, as well as an up-and-down and longitudinal motion.

The same makers also show a small saw-bench, with boring augur at its side, and the saw can be replaced by rabbetting irons, which rabbet the edges of planks very rapidly. But perhaps their most important machine is their moulding and planing machine, with adjustable feed and cutters. In this machine, the cutters can be raised or lowered while in motion, and side cutters can also be moved in or out. The cutter-block, moreover, which is cutting a moulding can also be angled to the general face of the work, whereby the necessity is obviated of having more overhang of the cutter irons at one part than at another, the result of which is that the irons seldom break, whereas in machines without this provision much breakage of the iron occurs. Moreover, in this machine the irons do not spring or twist, and a smoother quality of the work is the result. The mouldings run by this machine, while we were examining its action, were of the finest quality, and were as smooth as if they had been carefully finished with sand paper. In the details of the machine great skill and care are exhibited in making its action perfect, and the conical bearings of the cutter-blocks work with little wear and little friction, whereby the machine acquires both more truth and durability, and at the same time consumes less power. Where bearings move with such a great velocity as these, the circumstance of working with more or less friction has a very sensible influence on the amount of power to drive the machine. The velocity measured by the resistance is the measure of the power consumed in overcoming the friction, and a resistance, therefore, which is of little account in a slow-moving machine, may become formidable from its amount when the velocity is great. The whole of the machines shown by these makers are of the very first quality, both as regards design and execution, and they are skilfully manipulated by the very intelligent workman who has charge of them, who is able clearly to explain their special features of advantage, and who manifestly takes a pride in his work.

Let us now pass on to examine the screw and other jacks shown by Messrs. Tangye, of Birmingham, and which exhibit special skill in that particular class of apparatus. Messrs. Ransomes and Sims exhibit one of their double cylinder and one of their single cylinder portable engines, of good construction, the former with an adjustable expansion slide-valve, the adjustment being effected by altering the length of its stroke, which is done by forming the eccentric of two eccentrics, one inside the other, so that the eccentricities may either be concurrent or antagonistic. The same makers also show a fan for blowing air with curved vanes set between sides, wide at the middle, and converging towards the edges. Messrs. T. Rhodes and Sons, Wakefield, show some rough tools for punching iron, mortising wood, &c., which would have been better left at home; and Messrs. Stothert and Pitt, of Bath, show a model of their wheel, with hides hung radially within it for accelerating the operation of tanning by keeping this wheel of hides in continual rotation in the proper tanning infusion. They also show a model of an apparatus for smoothing leather by causing a weight to run backward and forward over it, which weight is moved by the piston-rod of a horizontal engine, formed without a crank, and of which the valve is moved by tappets. Messrs. Robinson, of Bridgewater, show one of their cask-cleaning machines, in which a number of casks, set in an annular frame, are made to rotate in every direction, partly by rotating the casks and partly by rotating the annulars. Davies shows his swivelling steam-hammer, already described in our pages, close to which there are two of Allen's engines, constructed by the Whitworth Company, one of which has been running very smoothly at a very high rate of speed, and giving excellent indicator diagrams for some months past. Then the Whitworth Company show an assortment of their world-renowned tools; and one new tool, a machine for planing the different sides of Whitworth's hexagonal shot at the same operation, so that the shot may be manufactured with great rapidity. In its general features this machine resembles a turning-lathe, between the centres of which the shot is set, and it is drawn by appropriate mechanism between cutters, set the right distances apart on all the sides, and is at the same time twisted to the proper extent by the action of a spindle moving longitudinally, in which a spiral recess of the proper pitch is cut. In this recess

a part of the machine works, which suitably rotates the ball. De Bergue's punching-press has already been represented in our pages; and Clayton and Co.'s brick-making machines will be described in a separate article. Matthew Paul and Co., of Dumbarton, show a steam winch, which also drives ships' pumps, in operation, of a rather rough construction, but probably adequate for nautical purposes. Gwynne and Co. show one of their centrifugal pumps raising large volumes of water by means of a small and simple engine, working at a very high speed, but springing a little, from the lower web and flanges which hold it being rather weak. Williamson Brothers, of Kendal, show one of Thomson's vortex water wheels, also a centrifugal pump and a fan for air, all of good construction. They also show a machine for turning bobbins for cotton-spinning, and in which nine chisels are arranged round the central axis. Bastier shows a chain pump with circular pistons, for raising water; but there is nothing new or peculiar in its construction. The North Moor Foundry Company, Oldham, show models of turbines and other hydraulic apparatus; and Carrett, Marshall, and Co. show one of their double-cylinder horizontal engines, with high and low pressure pistons moving in opposite, or nearly opposite directions; also one of their coal-mining machines, and a small engine, which would have been better away, in which two discs are rotated by a small cylinder and piston, with friction ratchet gear, one of which acts in the ascent, and the other in the descent of the piston.

Messrs. Bryan Donkin and Co., of Bermondsey, London, show a double-cylinder horizontal engine of rather straggling design, working a pump for compressing air into an air-boiler, which air is subsequently expended in working Beaumont's machine for tunneling rocks, and which consists of a horizontal shaft of iron, with a great fan wheel on the end of it, from which project great steel chisels or jumpers. These jumpers are projected violently against the rock by a piston fixed on the shaft, and when withdrawn again, are moved round a little on the common axis before making a new blow. An annulus is thus scooped in the rock; but it does not very clearly appear how the machine could advance through the bore thus made, supposing it to be made, as it more than fills the whole passage up. The machine does not appear calculated to do useful work in its present form. In the engine, the high-pressure cylinder is placed at the end of the low, and the piston rod from it engages a crosshead, from which a connecting rod proceeds to the crank, and from which also side rods proceed backwards to another crosshead at the other end of the engine, which is connected to the piston rod of the low-pressure engine, and a continuation of this piston rod moves the compressing pump, which is set in a rectangular vessel with inlet and outlet valves, and on the top of which water may be suffered to run. There are three valves to the engine, two of which are driven by one eccentric, and the other by another eccentric. The workmanship is, no doubt, adequate for the purpose, but is somewhat rough. The air pump, which is vertical, stands in a pit beneath the crank by which it is worked, and it is guided by a parallel motion.

The gilded pyramid at the end of the English annexe, representing the bulk of gold procured from Australia in the fifteen years ending October 1866, is a very South Kensingtonian conception. Near it are four steam cranes—one with two square wooden jibs converging at the top, by Russell, of Glasgow; one with plate iron double T jib about four times broader at the bottom than the top, by Appleby Brothers, of London; one by Shanks and Sons to lift 6 tons with two converging jibs of timber; and one by James Taylor and Co., of Birkenhead, with iron jib like that of Appleby's, but four or five times broader at the bottom than at the top. A model of one of the Tyne dredgers, of 55 horses power, designed by J. F. Üre, engineer, of the Tyne, is shown. It has a chain of buckets upon each side, and is capable of raising 1000 tons of dredging per hour from a depth of 35 ft. This is the most powerful and efficient species of dredger ever constructed. A model is also shown of the whole of the apparatus necessary for the prosecution of the Bessemer process for making wrought iron and steel direct from cast by blowing in air, and subsequently adding sufficient carbon in the form of spiegeleisen to produce steel when steel is the product desired. It would have attracted great interest if this process could have been shown in actual operation. Near the end of the English department there is a small railway with carriages and a post-office van, to show the manner in which letter-bags are received and dropped in England without stopping the train.

The spinning-machinery shown in the English de-

partment has been already partially described. But along the outer wall of the building there are several objects of interest placed, of which no notice has yet been taken by us, and to which we may here devote a few words of description. Among these is a machine for washing bottles, by W. E. Hickling, of Leicester. In this machine about a dozen bottles are fixed horizontally in two circular rows round a main axis, and by rotating this axis shot placed in the bottles rubs the interior clean. The horizontal axis, however, not only rotates, but one end of it is moved up and down; and it is also moved to and fro on end by means of a crank, whereby the shot, or other cleansing substances, placed inside, rubs over every part, and the washing is made more effectual. M. V. Stones, of Barbican, London, exhibits woven wire dandy-rolls for paper makers. Turton, of Sheffield, displays locomotive plate-springs, and various forms of spiral springs. John Spencer and Sons, of Newcastle, exhibit springs, toughened cast steel for hooping ordnance, &c. Saxby and Farmer show railway signals. W. H. Preece, of Southampton, and other English inventors, show electrical signals for communicating between the passengers and guard of a railway, and various other kinds of electrical signals, by Preece, are also shown. Models and drawings of Fairlie's locomotive are also exhibited. There are a few tubes shown of Howard's boiler, and a large variety of electrical instruments by Siemens, of London. In the English department there is a great deal of sterling capacity manifested, such as can be but imperfectly reflected in this cursory review, with which we now conclude these explorations.

LIGHTHOUSE ON THE GREAT BASSES, CEYLON.

THE necessity for a light at the Great Bass Rocks, off the Island of Ceylon, have never once, so far as we are aware, been for one moment disputed, and the establishment of a light-ship in the vicinity of that dangerous spot clearly proves the recognised necessity for such a guide to the passing ships. The amount of steam-ship tonnage which annually passes in sight of the Great Basses, *en route* to Calcutta, China, and Australia, has been estimated at not less than 500,000 tons, which, by the addition of sailing vessels passing in similar directions, is raised to a total of about 750,000 tons per annum. It cannot, therefore, be denied that the utmost importance attaches to the establishment of the best possible class of and most permanent light on, a danger past which such a vast amount of commerce annually passes. To trust to a light-ship at a danger so extensively shared, appears to be little short of repudiating a probability known to have occurred more than once in other situations, namely, the breaking loose of the light-ship from her moorings in very stormy weather, as has happened on more than one occasion with the light-ships at the mouth of the Hooghly river.

The obvious remedy for the present state of things would be, of course, the construction of a permanent lighthouse at that point, the cost of which would be covered by a tax on all ships passing within its range. As far back as the year 1856, it was, indeed, proposed to erect a permanent lighthouse on the Great Basses, and steps towards that end were actually taken to the extent of collecting a quantity of granite on the spot, as well as all the other necessary materials for an iron superstructure raised upon a granite base, including also the necessary light apparatus, &c. For some reason or another, which we believe to have been a fear lest the building should cost more in erecting than the amount of the estimate, in consequence of the difficulties in the way of getting in the foundations, the works were never proceeded with; but, after an expenditure having been incurred amounting to over 50,000*l.*, it would appear that that sum is to be sacrificed, rather than that a necessary work should be completed by the expenditure of a further similar amount, for the whole of which, there is every reason to suppose, ample returns would be obtained by the levy of light dues on the passing trade.

The necessity for proceeding with the erection of the proposed lighthouse on the Great Basses has, on more than one occasion, been fully recognised by the Government of India, and a correspondence on the subject has taken place between the Secretary of State for India and the Board of Trade; but the chief difficulty is the decision of the question as to who is to pay for it. In a memorandum by the Government of India, dated in April, 1865, it is stated that, "judging from the case of the Alguada Reef, there appears to be no reason to doubt that a permanent lighthouse

"on the Great Basses could be constructed at a cost of about 100,000*l.*, and that this would, no doubt, afford much greater security to trade than a floating light. The Secretary of State has objected," the memorandum further states, "to the construction of such a lighthouse at the cost of the revenues of India; and, indeed, under present circumstances, it would have been impossible to spare any money for such an object. But yet it seems that it may be worthy of consideration whether steps should not be taken, with the permission of her Majesty's Secretary of State, to ascertain, through the India Office, whether the present arrangement is considered satisfactory to merchants and shipowners, or whether they would prefer, even at some enhancement of the rate of light-due to be levied, to have a secure and permanent lighthouse."

Now, although the Indian Government refuses to find the necessary funds, and the Board of Trade declines to incur the expense of completing what has been already begun, there appear yet two methods by which the work might be accomplished. The one being that the Ceylon Government should be authorised to raise on loan the amount necessary for completing the lighthouse, or that a loan should be raised on the security of a tax on all shipping deriving benefit from the light, in which case this very important work might be accomplished without expense either to the British or Indian Government.

INDIAN ENGINEER EXAMINATION.

THIS examination is now going on in a room temporarily fitted up for the purpose in the new Indian offices. It commenced on Monday morning last, and will, we believe, terminate to-morrow evening. The number of appointments to be competed for is twenty-five, and forty-five candidates presented themselves before the Indian Medical Board on Saturday last, of whom, however, one was rejected as not being constitutionally fit for service in India, and two others retired from the examination during the first and second days, thus leaving forty-two only to compete for the twenty-five appointments advertised as vacant.

It must be satisfactory to the Indian Government to find so many candidates forthcoming to this examination, in spite of the very adverse letters regarding service in the Public Works Department which have occasionally appeared. But this success, so far, must not be mistaken as a sign of the popularity of the service, as it is rather a consequence of the great depression at present overhanging all engineering enterprise in this country. In order to secure a continual supply of candidates for future examinations, which will occur occasionally in times of great engineering prosperity in this and other countries, greater inducements will most unquestionably be required than are at present held out; and, in our opinion, some increase to the salaries on which civil engineers are first appointed to the Public Works Department in India, would be the most likely means that could be adopted for rendering the service popular and attractive.

THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following premiums for papers read at the meetings during the past session:

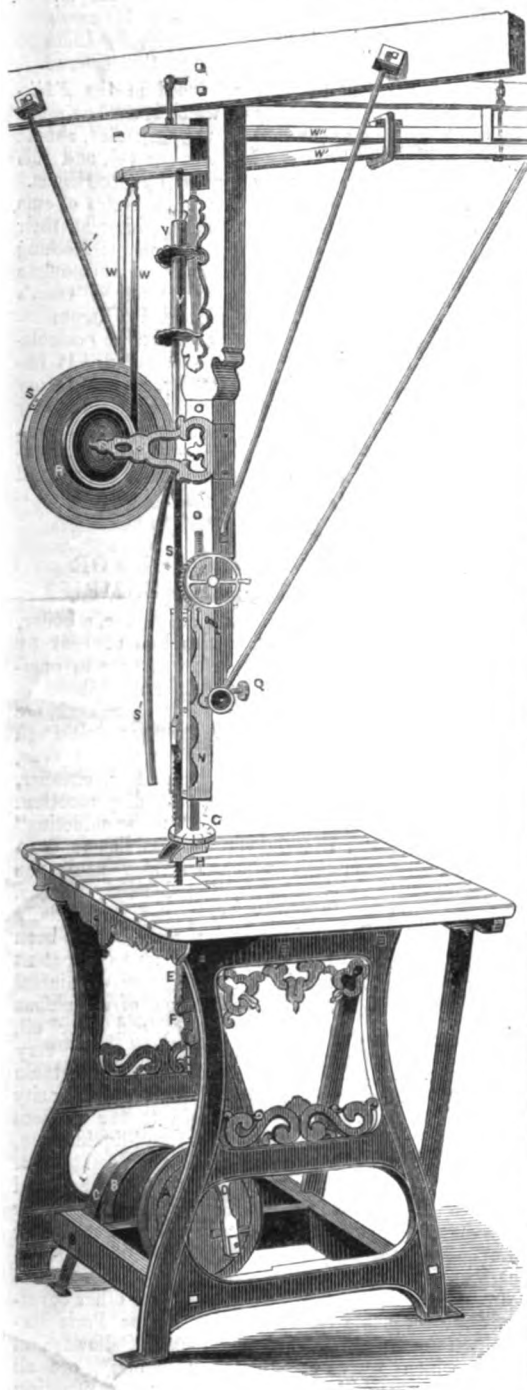
1. A Telford Medal, and a Telford Premium, in Books, to James T. Chance, M.A., Assoc. Inst. C.E., for his Paper "On Optical Apparatus used in Lighthouses."
2. A Telford Medal, and a Telford Premium, in Books, to Edward Byrne, M. Inst. C.E., for his Paper, "Experiments on the Removal of Organic and Inorganic Substances in Water."
3. A Telford Medal to George Biddell Airy, Astronomer Royal, Hon. M. Inst. C.E., for his Paper "On the Use of the Suspension Bridge with Stiffened Roadway for Railway and other Bridges of Great Span."
4. A Watt Medal to Colonel Sir William Thomas Denison, K.C.B., R.E., Assoc. Inst. C.E., for his Paper on "The Suez Canal."
5. A Watt Medal, and a Telford Premium, in Books, to John Bourne, for his paper on "Ships of War."
6. A Telford Premium, in Books, to Captain Henry Whitley Tyler, Assoc. Inst. C.E., for his Paper "On the Working of Steep Gradients and Sharp Curves on Railways."
7. A Telford Premium, in Books, to William Henry Preece, Assoc. Inst. C.E., for his Paper on the Best Means of Communicating between the Passengers, Guards and Drivers of Trains in Motion."
8. A Telford Premium, in Books, to William Alexander Brooks, M. Inst. C.E., for his Paper on "The River Tyne."
9. The Manby Premium, in Books, to Charles Douglas Fox, M. Inst. C.E., for his Paper "On Light Railways in Norway, India, and Queensland."

THE SWEDISH NAVY.—The administration of the Swedish navy will shortly launch a third monitor. This vessel will make an experimental trip of three months.

* Have previously received Telford Medals.

WRIGHT'S PATENT SCROLL-SAW.

We give below a perspective view of Mr. Wright's scroll-saw for cutting ornamental work exhibited at Paris. The purpose of this arrangement is to have a clear space all round the table for taking in work of any length and turning it round to any required position, according to the sweep of the curves cut out. The saw has a reciprocating action, being worked by a crank and connecting-rod, *p*, at the bottom of the table, and the counter action is given by a spring, *w w*, fixed overhead. This spring is made of wood, and it is connected by a strap, *w*, to a

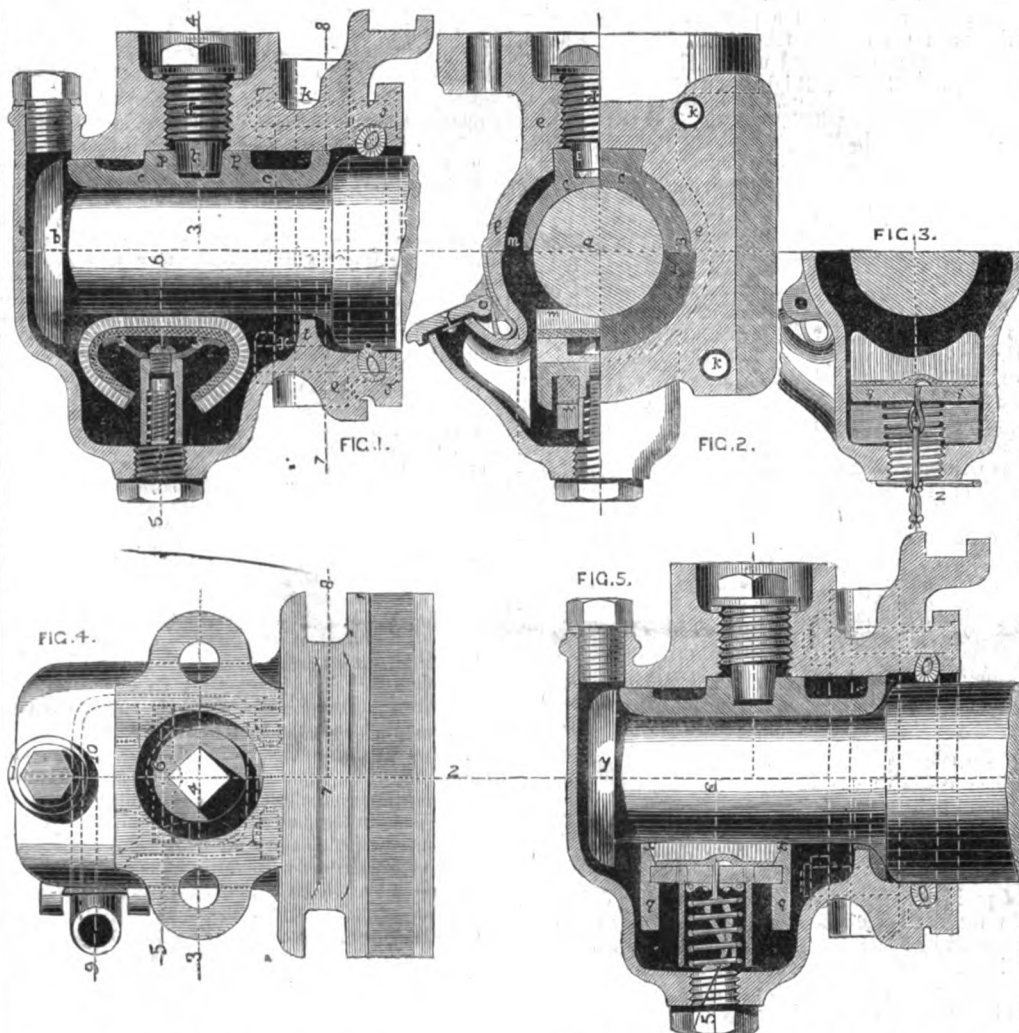


pair of pulleys, which transmit the tension of the spring to the upper end of the saw-blade, multiplying the strain in proportion to the relative diameters of the two pulleys. The saw is moved up and down in an adjustable guide, *N*, which can be set in an inclined position, and maintained, after adjustment, by means of the screw, *g*. By these means a variable feed is given to the saw, since it is advanced against the wood in the down-stroke by a quantity corresponding to the more or less inclined position of the guide, *N*. The spring, *w*, is also connected with a small air-pump piston enclosed in a cylindrical blower, *V*, which, at each down-stroke of the saw produces a blast of air, carried down upon the work through the pipe, *s'*, so as to clear the work from sawdust. In the Exhibition, no provisions having been made for fastening parts of machinery to the roof or ceiling it became necessary for Messrs. Wright and Smith to construct a temporary framework, so as to connect the top spring with the table itself, and make the machine self-contained. This has been cleverly done, although it gives to the machine a somewhat inelegant appearance. We have, therefore, preferred to represent this machine unaltered, as it is used in practice and constructed for sale by the makers.

THE FRENCH SOCIETE DES INGENIEURS CIVILS.—This body now numbers 858 members, under the presidency of the veteran engineer, M. Flachet, who now occupies the presidential chair for the seventh time.

AXLE-BOX PATENTED BY M. DELANNOY,

ENGINEER TO THE SCEAUX AND ORSAY RAILWAY.



We give above engravings of an axlebox for railway carriages which has been designed and used by M. Delannoy, the engineer of the Sceaux and Orsay Railway. This box, which is lubricated with oil, is cast in one piece, and its construction will be readily understood from the illustrations, which represent two forms of it, these differing only in the arrangement of the pads by which the oil is supplied to the underside of the journal. Figs. 1 and 2 refer to one, and Figs. 3 and 5 to the other of these arrangements; whilst Fig. 4 represents a plan, and is common to both.

In putting the box shown in Figs. 1 and 2 together, the screws, *d* and *y*, in the top and bottom are removed, and the lubricating pad, *m*, and its support, *s*, introduced. The screw, *g*, being out, the tube to which the support, *s*, is attached falls through the hole, and the pad is thus kept out of the way of the journal, whilst the box is being placed on the latter. In putting the box on the axle, the former is inclined downwards at its front end, so that the collar, *b*, may be got over the rib, *l*, at the bottom of the box, and it is then raised into a horizontal position, and slid on to the journal, the latter having previously had the brass, *c*, and the crescent-shaped packing, *t*, placed on it. When the box is in place the brass is secured by means of the screw, *d*, the conical point, *t*, of which enters a corresponding hole in a boss, *r*, at the top of the brass. The pad, *m*, is then raised into its place by means of the screw, *y*, tightened up by the gland, *f*, so as to close the back of the box. The screw, *v*, in the front of the top of the box, serves for the introduction of oil or grease in the case of the box heating; under ordinary circumstances the oil is introduced through the small side-door shown in Figs. 3 and 5.

The method of placing the box shown in Figs. 3 and 5 upon the axle is the same as that above described, except that as the spring by which the pad is kept against the journal will not fall through the hole in the bottom of the box when the screwed plug is withdrawn, it has to be held down by means of a string, *z*, attached to it, whilst the box is being got into its place on the journal. The pad is shown held down in Fig. 5. These boxes are stated to answer their purpose well, and are said to run from 2500 to 3000 miles without the oil requiring to be renewed.

NEW GUNBOAT.—The Elswick Ordnance Company (who have remitted the contract to Messrs. C. Mitchell and Co., of Walker) have been directed to build a new gunboat for harbour defences. The boat, which has been invented by Mr. G. Rendall, is small, and is only designed to carry an Armstrong 300-pound gun, of 12½ tons weight, and 9 in. bore. The gun is mounted upon a platform in the fore end of the boat, and under the platform is a kind of well, into which the gun can be lowered when not in use. The introduction of the well is the novelty of the invention.

THE JET, OR RUTHVEN'S HYDRAULIC PROPELLER.

TO THE EDITOR OF ENGINEERING.

SIR,—In the leading article in your last issue, it is there stated that the evidence is against the economic use of the hydraulic propeller; "that the jets must, of necessity, have a considerable slip"—"four or five fold greater than that of the screw;" and that "the centrifugal pump, according to the comparative perfection of its construction, at once wastes from one-fourth to one-half the power expended in driving it; whereas the screw or paddle, if treated as a huge driving pulley for a piece of machinery, would give off the whole engine power, less the engine and shaft friction expended in driving it." As these statements and scientific opinions are very injurious to the hydraulic as a propeller, I hope you will allow me the opportunity of saying briefly, by way of answer, that they are completely at variance with the facts, as proved by two vessels, one the Nautilus, river steamboat, and the other H. M. S. gunboat Waterwitch.

The Nautilus, as you are aware, was tried against a vessel of greater power and better lines for sailing, the Volunteer, one of the Iron Boat Company's boats, and fairly beat the paddle-wheel in speed. The Waterwitch, again, was tried at the Maplin measured mile by the Admiralty officers, and proved to attain a speed of above ten knots, while her sister ships, of the same power and displacement, very little exceeded nine knots at the best; thus proving that the hydraulic, under similar circumstances, fairly and largely beat the latest improvements in screws—the twin screw. It follows, even if you be correct as to the many sources of loss which you state are inseparable from the hydraulic propeller, that the amount of these losses must be less than the losses which the best paddle and double screw sustain in propelling, otherwise the hydraulic could not have beaten them as it has done.

Again: by taking your statement of the losses of the hydraulic, or jet propeller, it goes to show that that propeller has not one-fourth of the power of the screw; and yet I have shown that—a far as yet tried—the hydraulic in point of speed is greatly superior to the screw or paddle.

W. B.

London, July 10, 1867.

[We admire the confidence of our correspondent, but must remind him that the first authentic statements of the performance of the Waterwitch appeared many months ago in our own journal, and that we were the first to analyse this performance in detail. We attach no importance whatever to the so-called competitive trials, but confine ourselves to the fact that the Waterwitch showed miserably low co-efficients, and that it is clearly demonstrable from the data adduced that there was an enormous waste of power in driving her. In stating these facts, it is of course immaterial to us, as it is to ninety-nine out of every hundred of our readers, whether they are injurious or otherwise to the system of hydro-propulsion. The evidence already collected, and which, with its analysis, we first published, is so far greatly against the system of hydro-propulsion.—ED. E.]

LITERATURE.

A Handbook of Practical Telegraphy. By R. S. CULLEY, Engineer to the Electric and International Telegraph Company. Second Edition. London: Longmans.

We have recently had a plethora of works on electricity and the electric telegraph. Noad, Ferguson, and Foster have favoured us with theoretical subject-matter, while Sabine, Bright, and Culley have issued books on the more practical element. Up to within a very recent period, there was no branch of the applied sciences so indifferently represented, in a literary point of view, as that of the telegraph. There was no work on the subject that we could place in the hands of the student. Mr. Culley first filled the void by his excellent handbook, which was published in 1862, and this was more recently followed by Messrs. Sabine and Bright. Bright's new edition of Lardner is, however, purely popular in its tendencies, while Sabine's is too far advanced for the general telegraphist. Mr. Culley has, however, now thoroughly revised and rewritten his original handbook, and has produced a work which should be in the hands of every telegraphist. Avoiding mathematics on the one hand, and historical or descriptive details on the other, he has written a book which, as its title affirms, is a handbook of practical telegraphy, and nothing more. While he fully develops the laws upon which the system of electric telegraphy depends, he carefully avoids discussing questions which are simply hypothetical in their character, and does not touch those parts of electrical science which have no immediate bearing on telegraphy. "He has attempted," as he remarks in his preface, "to supply, in some measure, that technical knowledge which has hitherto been attainable only 'by means of verbal instruction or actual experience,' and it must be owned that there is no telegraph engineer better fitted for the undertaking. The work is divided into several parts, the first of which treats of the sources of electricity, which is defined to be a peculiar force, which causes the atoms or ultimate particles of matter to alter their position with respect to each other. The dynamic theory of electricity is gaining much ground, and the old notions of positive and negative fluids are rapidly dying out. As the death-knell of caloric as an entity has been sounded by Joule Mayer and others, so are our electricians disposing of electricity as a fluid or two fluids. The same good service that was done to light and heat is being done to electricity by Grove, Brooks, and others, both in England and on the Continent. Electricity, as much as heat, is a mode of motion, and in all its movements and actions it faithfully follows the laws of dynamics. Mr. Culley defines the current to be, not 'the actual passage of any fluid or gas, but a simple transfer of force, an action which is progressive in its nature, like the passage of light through space or of heat through a bar of metal.' The mathematical development which the laws of electricity have received, and the beautiful accuracy with which these laws are verified in practice, impress a truth upon the dynamical theory which renders it unassailable. Mr. Culley deals with the sources of electricity found in friction and chemical action. The definitions about which there is so much ambiguity, difference, and irregularity amongst electricians are well expressed. The following will clear away many a cobweb from the brain of the thoughtful student:

"As chemical action produces electrical tension, if it were possible for both metals (zinc and copper) to be attacked equally, an equal tension would be acquired by each, and there being no difference in tension there would be no tendency towards a transfer of electricity; but if the chemical action be greater upon one than upon the other, the tension of the two will differ by an amount equal to the difference of chemical action, and as this difference increases so will the difference of tension increase. Therefore, when there is no action upon the second plate, the difference of tension is the greatest possible.

"As voltaic electricity is produced whenever the conditions just mentioned are complied with, there are many different methods of making a battery. The specific power which each combination possesses of causing the transfer of electricity from one place to another, is called its *electromotive force*. This term, strictly, means any cause whatever by which a difference of tension is produced between any two points.

"In dilute sulphuric or nitric acid, the substances furthest apart in the following list form the most energetic combination:

Graphite (carbon from gas retorts).	Lead.
Platinum.	Tin.
Silver.	Zinc.
Copper.	
Iron.	

Mr. Culley retains the good old term *quantity* to express magnitude of current. Some would have us use *intensity*, because the French use "*intensité*" to express quantity, but intensity in England has quite a different meaning; it is synonymous with tension; and while 999 out of every 1000 telegraphists in England

conceive intensity to mean tension, it is absurd to use the same word in a totally different sense, simply because a somewhat similar word in sound is used abroad. We might with equal propriety call cabbages shoes (*chous*). We apply intensity (or tension), the latter for choice, to electricity, as we apply the same word to sound, heat, and light. We apply *quantity* (magnitude, or strength of current) in the same sense that we apply it to any other expression of volume, mass, or magnitude. The French word *intensité*, as applied to the current, is not properly translated by intensity. The following extract defines quantity:—

"Owing to the rapidity with which the electric force is propagated in the form of a current, when not influenced by induction; any effect which can be produced at hand can be produced at a distance at the same instant of time, subject to a diminution of force arising from causes which diminish the quantity of electricity or current before its arrival at the distant end, and thus weaken the signal: for the strength of all telegraphic signals, including the deflection of the galvanometer, depends upon the quantity of electricity passing through the receiving apparatus in a given time, not upon the tension of the received current. The causes of diminution of force are the resistance of the circuit and defective insulation.

"If the tension of the battery is increased, it is with the view of enabling the current more readily to overcome the resistance of the circuit, so that more electricity may pass in a given time. Thus, when the deflection of a galvanometer is increased by an increase in the number of cells of the battery, it is because a greater quantity is, as it were, forced through the wire.

"The force of the current depends on two things, the *electromotive force* or tension which sets the current in circulation, and the resistance the electricity has to surmount.

"Resistance is the obstruction offered to the current by the bodies through which it is made to pass, and is the opposite, reciprocal, or converse of their conducting power, or *conductivity*. When resistance is so great as to approach infinity it becomes *insulation*."

The construction, action, and practical manipulation of the Daniell's cell—the battery so extensively employed by the Electric Telegraph Company—is very fully detailed. It is the king of batteries for practical use. Many modifications have been suggested, and many different forms used, but they all fall back upon Daniell's grand principle of depolarising plates by placing them in their own salts. No real improvement has yet been effected upon the original trough form of battery adopted by the Electric Telegraph Company, and devised by Mr. Fuller, of the Silvertown Works.

The following is useful:

"In setting up a Daniell battery the following precautions are necessary: The crystals of sulphate of copper should not be crushed so as to reduce them in part to powder, for they then form a compact mass which dissolves so slowly as to be almost useless, and cannot be removed without danger of breaking the cell.

"The sulphate should be free from iron.

"If the water contains lime it decomposes a part of the sulphate, forming a cloudy or jelly-like deposit. To prevent this a few drops of dilute sulphuric acid should be added. The porous cells should be charged with saturated solution of copper, so that their pores may be filled with a good conductor; for otherwise the action of the battery will be checked.

"A battery when it is first charged rarely assumes its full power until it has been at work for two or three days; but it can immediately be set in full action by the addition of a few drops of acid. This, however, interferes with its permanence, and should be avoided.

"The copper connecting straps, wires, and binding-screws must be perfectly clean. The end of the strap which is cast into the zinc should be tinned to ensure perfect contact.

"The plates should be alike in size, and immersed equally in the liquid. The coppers should be carefully brightened and the zincs brushed clean. Copper plates, if very dirty, may be cleaned by being made red hot and dipped into weak ammonia. A piece of the "card," used in cotton manufactories, is the best brush for battery plates.

"It is false economy to work batteries after the zinc or the porous cells have become coated with copper, or to use cracked porous cells.

"When a battery is cleaned the plates should be removed and the divisions thoroughly rinsed and washed out; the plates well scraped and scrubbed, defective porous cells and zinc plates removed, and the battery again carefully charged.

"In re-charging the battery, the liquid from the zinc cells may be used. It may be withdrawn by a syringe before the battery is cleaned, and placed in a vessel containing a few pieces of zinc to reduce any copper that may remain in solution. When the battery has been cleansed, the plates replaced, and the sulphate of copper deposited in the cells, the solution may be distributed equally throughout the zinc cells, diluted, if necessary.

"It often happens that the copper plate is eaten away near the surface of the solution; this frequently occurs when the supply of sulphate of copper is exhausted.

"Batteries must be kept in a dry place and be well insulated, or part of the current will escape to earth. If too warm, the water will evaporate. Cold stops their action, so that they must never be placed where they are not perfectly secure from frost.

"Porous cells, or troughs fitted with porous plates, if set aside after they have been used, must be kept moist, or the sulphate of zinc contained in the pores will crystallise and destroy them, by an action similar to that of frost."

The second part is devoted to resistance and the laws of the current. The following is useful:

"The unit adopted by the electricians of this country is that

determined by a committee of the British Association, and is called the '*ohm*' (from Ohm, who first ascertained the laws of electrical resistance), and sometimes the '*B.A. unit*.' It must be understood that the unit is a measure of *resistance*, in the same way as the yard, inch, or mile is the measure of *length*.

"The unit formerly used by Mr. Varley, called the '*Varley unit*,' is one mile of that quality of No. 16 copper wire, which was employed several years since. '*Siemens' unit*' is one metre of pure mercury, of one square millimetre section, at a temperature of 32°. The Ohm is $\frac{1}{1000}$ of the Varley unit, and .956 of the Siemens. Thus the Ohm and the Siemens are nearly alike, while twenty-five Ohms equal one Varley.

"The resistance of the iron wire most generally used is:

No. 4	7.8 ohms per mile.
" 8	13.5 "
" 11	23.0 "

Mr. Preece has recently proposed in the *Philosophical Magazine* that the ohm, which is used as much by the electrician as the inch by the carpenter, should be symbolised by the Greek letter *omega* (ω), and this innovation is being gradually adopted by electricians.

Mr. Culley develops Ohm law by a series of cuts and calculations which cannot fail to impress their value and truth upon the most casual student. Nothing is more important than a thorough and complete knowledge of these laws to the telegraphist. Ohm's law is the key-note of all electrical phenomena. Without its aid no problem can be solved, no calculation made, and no test properly conducted. It has been stated that it contains in itself the whole theory of electricity. But without affirming this we may state that Ohm's law is as valuable and essential to electricity as Newton's laws of gravity to the conception of the theory of the universe. We shall return to Mr. Culley's excellent book.

SPENCE'S COMPOSITION FOR LAGGING BOILERS AND STEAMPIPES.

THE question how to protect a steampipe, a boiler, or a steam cylinder from excessive loss of heat by radiation is one of considerable importance to engineers and manufacturers. The ordinary methods of lagging and clothing with felt, wood, or brickwork, are each subject to objections of some kind; and although these things must be resorted to as necessary evils, this is done only in absence of some better, cheaper, or more conveniently applicable mode of protection. There has been for some time past a "non-conducting" composition under trial in various establishments in this country, amongst which we may name the Royal Arsenal at Woolwich, the Elswick Works, the Wigan Coal and Iron Co., and the Saltair Mills, and the results of these practical tests have been very satisfactory. This composition forms a patent of Mr. Spence, and consists of a mixture of mineral substances with a certain percentage of oleaginous matters, principally the residue of cod liver oil, which is obtained from the refinery, at a very low price. To this a quantity of fibrous vegetable matter is added, so as to increase the tenacity of the whole. The mass is applied to the surfaces to be protected by it in a pasty or semi-liquid state, and allowed to dry by the application of moderate heat. After this it remains in a sufficiently hard and solid state to allow of being painted over, and even neatly finished at the surface, without danger of cracking or breaking off through the effects of variations of temperature, vibration of machinery, or other common causes of destruction, which most of the other coverings are incapable to withstand. At the Paris Exhibition the boilers of Messrs. W. and J. Galloway and Sons, which work the British machinery, are all covered over with Mr. Spence's non-conducting material; so are also the steam pipes which lead from these boilers, and of which a certain length is above the floor level. These pipes attract much attention on account of their efficient lagging by means of that composition, which is applied to them in a layer of very moderate thickness. We have been informed that the same or a similar composition is applied by Mr. Spence to steam cylinders, dispensing with all other more expensive covering. The composition is in these cases very neatly finished, and painted at its surface so as to give the steam cylinder a neat appearance, which is said to be preserved very well in the wear of the engine.

COMPOUND ENGINES.—A number of steamers have been built and engined in Liverpool, with a high-pressure and low-pressure piston working simultaneously upon a long crank-pin formed in the crank shaft. One would say that such an engine would be apt to hang on the centre. The valves are worked by a link motion with crossed rods, giving an increasing lead as the block is moved towards the end of the link. So long as such an engine is stopped or reversed with steam on, the compression within the cylinder prevents the engine hanging on the centre, and the engines are found to work exceedingly well.

AGRICULTURAL ENGINEERING.

ONCE in four years the Royal Agricultural Society offers prizes for the best portable and fixed steam engines (of dimensions prescribed within certain limits) entered for trial at their shows. The last trial was at the Worcester show in 1863, and that for this year has just been concluded at Bury St. Edmund's. The various portable-engine factories in the kingdom, perhaps forty or fifty in number, are now able, if fully employed, to complete upwards of fifteen hundred engines yearly; a fact sufficient to show both the extent of the trade and the competition which attends it. The Royal Agricultural Society's prizes are, therefore, keenly contested for, and, although the engines entered for trial are generally of a more expensive, and, possibly, less durable class than those ordinarily sold by the same makers—being, in fact, what are known as "racers," only seldom bought for actual work on the farm—it is indisputable that these competitive trials have done, and are doing, much to raise agricultural engineering to the highest standards of efficiency and economy. There are many of our readers who can even now recal the time when, under the practice of the Liverpool and Manchester engineers—in the days of John Gray and John Dewrance, who were always encouraged by that paragon of railway secretaries, Mr. Henry Booth—locomotive engineering was refined and perfected almost beyond all previous expectation, the consumption of coke being diminished from 40 lb. or 50 lb. to 18 lb. per train-mile. There are many who can recal the time when the Cornish engineers, by emulation and the greater care which it inspired, were raising the duty of their engines from 30 or 40 up to 70 or 80 millions, and sometimes to even more. And we have more lately seen how, by increased attention to the conditions of marine-engine economy, a consumption of from 5 lb. to 7 lb. of coal per indicated horse power per hour has been brought down to from $2\frac{1}{2}$ lb. to $3\frac{1}{2}$ lb.

Something like these reforms has been introduced into portable-engine practice by the agency of the Royal Agricultural Society's quadrennial trials, and we have this year an engine running steadily for nearly three hours with a consumption of but $2\frac{1}{2}$ lb. of Welsh coal per effective or dynamical horse power per hour, equal probably to about $2\frac{1}{2}$ lb. or $2\frac{1}{2}$ lb. of coal per indicated horse power per hour, the measurement to which most engineers are better accustomed. Put into Cornish notation, $2\frac{1}{2}$ lb. of coal per effective horse per hour means a duty of nearly 88 $\frac{1}{2}$ millions of foot-pounds for each hundredweight of coal, a result which, we need not say, has been but rarely surpassed even in Cornwall.

This result is, of course, a maximum result, obtained by the exercise of the greatest care in design, in construction, and in working. That in the working was perhaps the most remarkable of all, and we say, advisedly, that it would have well paid any farmer employing steam power to any considerable extent, as many now do, to have sent his engine driver or drivers to Bury, even from a distance of 200 miles or more, and to have kept him or them in the show-yard during the whole period of the trials, to study the wonderful jockeying (and we do not employ the term reproachfully) of George Wilkinson with Clayton, Shuttleworth and Co.'s engine, of Robert Gelles with Tuxford's engine, of John Bristow with Ransomes and Sims's, and of Whitcombe with the Reading Ironworks engine, the latter, when worked to 50 per cent. above its nominal power, giving the greatest economy of fuel yet recorded, Clayton and Shuttleworth beating on the trials at nominal power. Not perhaps that the care was so much, if at all, greater than that of railway-engine drivers, when working, as they lately did on the Great Eastern Railway, by contract; but railway practice is not often accessible to portable-engine drivers, nor, differing so much as it does from their own, does it so directly carry home its lessons of example. Even if they be not likely to be generally repeated in every-day practice, it should be as interesting to the large farmer—the steam farmer we will call him—as to the engineer to observe the expedients by which a little engine, not working within a warm house, but in the open air, is nevertheless enabled to rival, in its dynamical results for a given weight of coal, the triumphs of Cornish and marine and locomotive practice. Not only is the boiler lagged, but it is sheltered from winds and rain, and there was rain and wind in plenty, and more than enough, last week and this, at Bury. The coal is broken into lumps hardly larger than dice; it is fed to a fire hardly 3 in. thick (plenty were told, and some, perhaps, believed, that some of the fires were not 1 in. thick). The distribution of coal upon the grate is as

even as the utmost care can make it; the fire-door is never allowed to be open a moment longer than absolutely necessary; the ash-pan is carefully cleared of cinders and bits of unburnt coal, to be added to the fire for the final effort when all the clear coal is gone; the ash-pan damper is regulated with the nicest care, and, where not tight in all its joints, all openings except at the bottom are carefully stopped with rags, so as to compel the entering air to pass through the whole volume of heated air contained in the pan; the feed-water is heated by waste steam almost to boiling; the safety-valves are screwed to slightly more than the working pressure, and the latter is maintained to half a pound at one fixed point on the gauge; the slide and expansion valves are, in the best engines, set exactly to the intended work, and the regulator is kept wide open where this is possible, as in many cases it was; the brasses of the engine are left to run as freely as can be tolerated in respect of thumping; the piston-packing is in the most perfect condition, neither tight nor loose, as drivers understand the terms; the oiling is assiduous and just sufficient, and everything is done that the driver, with all his wits about him, can think of to prolong the time of work with the quantity of coal so scrupulously weighed out to him. It is here that engine-driving, or even boiler-stoking, becomes a profession; and there was a curriculum of technical education in at least one of its important branches, in the week's trials concluded on Tuesday last. Could the large competing firms make drivers as well as engines, they would surely increase their trade in the latter, and it might even pay, in the way of business; to educate the former gratuitously, for nothing would more hasten the adoption of steam upon the farm, both at home and abroad, than a general understanding and practice of the best principles of engine-driving, so splendidly exemplified in the trials at Bury.

It is difficult to point to any new feature of design which has contributed to the excellent results attained. It is even difficult to say what the results prove as to many questions of plan and proportions which are often discussed by engineers, and, now and then, by steam-farmers. Clayton's double-cylinder engine beat his own single-cylinder engine; but this could not have been because of this difference in the number of cylinders, since the double-cylinder engines were worked at 80 lb., while the single cylinders were limited to 50 lb. This enabled the double-cylinder engines to work more expansively, and possibly it will be said with more expansion than a single engine would bear, and still work with uniformity. With 80 lb. steam, however, the single engines would have run well, cutting off at one sixth stroke, and but one only of the double-cylinder engines tried cut off as short as one-eighth, and only one other as short as one-sixth. The reason for the difference of pressure is, no doubt, that double-cylinder engines are now oftener made for ploughing, and are better made for this purpose than common portable engines, mostly with single cylinders, which would (not, however, because the cylinder is single) not be safe at 80 lb. As a matter of fact, the best result attained in the trials, the best perhaps on record, was had from a single-cylinder engine working to one-half more than its nominal power—the system of testing the engines not only to their nominal power, but, subsequently, to one-half as much more, having been introduced for the first time at the trials at Bury. So, too, some of the engines, which were not doing particularly well, were observed to have strokes more than 12 in. long, and were hence called long-stroke engines. We heard some good judges assert that the long-stroke engines would be nowhere, yet the best result of all, and that when working to one-half more than the nominal power, was obtained with the longest stroke of all, viz., 18 in.

Without looking forward, at present, to better results than the best that have been booked at Bury, we must hope to see such results become more general, and that consistently with reasonably economical construction and working. At present ordinary portable engines burn, as they burnt at Bury, from 5 lb. to 9 lb. of coal per horse power per hour, or, on the average, twice what they ought. In other words, working a 10 horse engine up to 15 horse, for ten hours a day, they burn 7 cwt. to 12 $\frac{1}{2}$ cwt. per day, so that with coal at 1s. a cwt., the difference in the cost of fuel between the most economical and the most wasteful engine would amount to 9s. per day, and the average difference might be taken at 5s., equal, for even 100 days' working in the year, to the interest on 500l., or to that on 350l., even if 1s. 6d. extra were paid for a first-rate driver. The means of economy lie in sound construction, thorough lagging of the boiler, heating the feed-water, liberal expansion, in short, the most miserly care to prevent loss of heat, heat being the true

representative of power. All this and the most careful firing and fettling of the engine are necessary to economy. And will other engine-makers allow one or two, or even three or four, firms to run off with the greater prizes of these Exhibitions? It takes a great deal of money to carry on business in these days of competition, but it is sound policy to expend money judiciously in building better engines, and with this to keep in sight every means, even to the most refined, to secure economy of working. And what wonderful results would be attained, too, by prizes for engine-driving as well as prizes for engines. If bets were made on engine races, the winning jockeys would come in for handsome gratuities, as happens with the triumphs at Epsom, at Ascot, and at Newmarket; and, seriously, good engine-driving is just now most wanted of all on the steam farms of England.

TELEGRAPHY IN THE UNITED STATES.—An action arising from an extraordinary case of telegraphic forgery is now passing through the courts on the other side of the Atlantic. On the 12th of August, 1865, a person named T. F. McCarthy brought a message to the telegraph office at Titusville, addressed to the plaintiffs at Pithole, which was duly forwarded. This message was as follows: "From Erie, Pa., August 12th, forwarded. 'Titusville, August 12th. Keystone Bank Company will pay 'on cheques of T. F. McCarthy to the amount of \$20,000. 'Keystone Bank.' This message was delivered to the managing partner of the bank of the plaintiffs at Pithole. It being always customary to sign the name of the president and cashier to a dispatch of this character, instead of the corporate name of the bank, the manager very naturally supposed an error had been made in the transmission of the message, and informed Pithole, that he could not advance money on such a telegram, that there was probably a mistake—and suggested to him the propriety of ascertaining that fact. The operator accordingly sent a message of inquiry to Titusville, and McCarthy was informed of the omission. The evidence shows that he was excited, and claimed that he was liable to lose a large amount of money by the mistake, and he insisted upon another despatch being sent at once. He then, in the presence of the operator, wrote a despatch, addressed 'Prather, 'Wadsworth and Co., from Erie, August 12th, received. 'Titusville, 1865. August 12th. Keystone Bank will pay the 'cheques of T. F. McCarthy, amounting to \$20,000. John F. 'Towne, cashier Keystone Bank, Erie, and answer.' On the receipt of this second telegram, and relying upon its authenticity, the plaintiffs cashed McCarthy's cheque for \$10,000. Three days afterwards, they learned by a telegram from Mr. Towne that the previous messages were not sent by him, and that the whole transaction was a swindle. McCarthy, however, had taken his \$10,000 and left for parts unknown, and his whereabouts still remains a mystery. The telegraph company against whom the action was brought to recover the \$10,000 state that the second dispatch was never sent over their wires from Titusville at all, and that there must have been a 'cross' or contact between the Western Union and United States lines on that day. The message was sent by the United States line, and it was received on that of the Western Union. The first message was duly forwarded by the latter company, but they knew nothing of the second. It was proved to have been sent from Titusville by one company and to have been received at Pithole by another. The verdict was given against the telegraph company, but they have appealed. The case, however, gives evidence of the looseness of the transaction of business, not only of the telegraph companies, but of the banking establishment concerned. Such messages are always accompanied in England by private codes, and no banker would accept such an order without the addition of some private signal. Such contacts are also impossible, because each company in England adopts a different and distinct system of working. Many curious cases of contact occurred after the great snow-storm of January, 1866, to the private telegraph wires in the city of London. Firms which were in the constant habit of using their instrument for the transaction of business suddenly found themselves bereft of a very useful friend. Operators for days eagerly watched their apparatus for some glimmer of life and restored health. A large house in the city, after several days' inanition, was gratified by the renewal of the familiar click. The clerk asked, 'Who are you?' 'Swan with two necks,' was the reply. 'Oh, bother,' he sent; 'if you were a swan with six necks you would be of no use to me.' Many similar cases occurred, but we have never heard of the transmission of an actual message in this crossfire fashion. Indeed, it is impossible with the divers systems in work here.

THE MOERDYK BRIDGE.—We understand that Mr. Sedley has tendered to construct and erect the Moerdyk Bridge on his patent system, for the sum of 636,000l. Eleven of the spans of this structure, as designed by Mr. Sedley, are each about 400 ft., a width of opening in excess of that required by the Dutch Government. As the superstructure is, however, much less expensive than in the ordinary system of bridge building, it proved more economical to diminish the number of piers, and the consequent cost of the foundations, at the expense of a certain additional weight in the superstructure.

SHEFFIELD.—The iron trade of Sheffield remains dull. Only a moderate business has been done in railway plant and material. A 'Chamber of Industry' is proposed to be established in Sheffield. The chamber will give advice in cases of dispute between employers and employed, and study the laws relating to capital and labour, and the principles of political economy generally.

MR. G. R. STEPHENSON'S YACHT.—On Saturday the George Crow, steam yacht (named after her owner's principal foreman) was launched by Messrs. C. Mitchell and Co., of Low Walker. She will be principally employed in sailing about the lochs and islands of the Kyles, where Mr. Stephenson has purchased an estate. Messrs. Stephenson have supplied the yacht with two oscillating engines of 12 horse power.

THE ROYAL AGRICULTURAL SHOW.

We have given, on another page, complete particulars of the trials of steam-engines at Bury St. Edmunds. The data were collected by ourselves, the staff of *ENGINEERING* having been in constant attendance, often till between nine and ten o'clock in the evening, during the six days over which the trials extended. Our own notes have been supplemented also, wherever requisite, by information freely supplied by the judges and exhibitors.

We shall here notice other features of interest in the show, confining ourselves, however, to those either of most novelty or of most importance, as nothing is more tedious than a running catalogue of everything, good and bad, in a great competitive display, or the over-description of objects already well known to our readers.

The steam-ploughing, in fields outside the yard, was, as usual, well done, although more or less interfered with by the rain. Messrs. Fowler's for light lands was particularly noticeable, and was evidently just the thing for much of the open friable soil about Bury, all of which rests on the chalk, and is perfectly drained by natural watercourses, the surface being everywhere undulating. Messrs. Howard's tackle, too, and of which, by the way, the Viceroy of Egypt, who visited Messrs. Howard's stand in the show-yard, has now about forty sets, gave much satisfaction. Both tackles are now so well known as to require but little description here, and that only for the benefit of our many readers abroad. Messrs. Fowler pull their plough to and fro between two self-moving engines, one on each of two opposite headlands of the field. The plough, supported upon a pair of wheels, is formed of eight or more single ploughs, rigidly attached to the framing in two sets, one on either side of the wheels, the respective sets pointing towards each other. The framing is so bent at the wheels, and is so tipped in working, that while one set of ploughs is in action the other are lifted well off the ground, the latter being tipped down again for the return furrow. The ploughs are pulled by a steel rope passing round a drum under each engine, each drum having a continuous series of jointed clips around it, and which clip the rope with greater force the greater the strain upon the plough. Messrs. Howard also employ two self-moving engines; but instead of a single plough they work both engines constantly, and pull each plough halfway across the field, reversing twice as often, for a given breadth of field, as Fowler, and doing twice as much work, other things being equal.

The recent report of the Royal Agricultural Society on steam-cultivation has shown that it is more generally practised, and with better results, than many farmers were disposed to believe, and the consequence has been that makers of steam ploughs have received many additional orders, and are now unusually busy. The general introduction of steam ploughs is a matter of great public importance, since they open up land which could not be otherwise ploughed at all; they go deeper into the ground, and bring out latent qualities of nutriment to crops which horse ploughs never reach, and in these and other ways they increase the production and lessen the cost of food. Let us hope that under-drainage may keep pace with steam ploughing, and we shall then be in the position to get the most out of the soil with the least injury to its own energies.

But as for cultivating or working up ground already once ploughed, and on which the sods are rotted, may there not be cheaper and equally, if not more, effective instruments than a double engine-tackle costing 1000*l.*, more or less? We should have been glad to have seen at work the rotary spader (Comstock's), exhibited by Mr. J. T. B. Porter, of Lincoln, and which has been already used on a number of farms, more especially in Scotland. It is not the formidable machine which Mr. Romaine made of his "rotary digger," with his steam-engine travelling over the field; but is more in appearance like a hay-maker, but narrower, far stronger, and made to work into instead of over the ground. One of these implements, costing thirty guineas, will break up the soil into a light porous seed-bed, to a width of 3 ft. or 3 ft. 8 in. at a working, and to a depth of 8 in., this work being done by four horses. If it has all the merits which we have heard ascribed to it, Mr. Porter should make it more widely known.

How common the traction engines have become! And how useful they are, as well in the place of ordinary portable engines as for drawing loads. They are more costly at the start, but they are also nearly twice as powerful as portable engines of the same nominal power. Messrs. Aveling and Porter, who make only traction engines, have already turned out nearly three hundred, and there were two of theirs at Bury, which had steamed down by road, as Aveling's engines always go to shows, at whatever distance. One was spinning about within a small circle in the yard, and as completely under control as the most docile horse. Whatever objections may be raised to the pitch-chain (for few now object to the single cylinder), no other engines do their work better, if as well. This was unquestionably the case at the Paris Exhibition, yet the jury in this class, with the discernment common to so many of the juries, put off Aveling and Porter with a silver medal, reserving their higher prize for a French affair, far inferior in its capacity for real work.

Clayton, Shuttleworth and Co. exhibited at Bury a traction engine, in which each driving-wheel is driven by a six-horse "engine" (or cylinder and moving parts), geared down to the proper speed. Each engine has an overhung crank, and as the shafts of both engines are in line, their crank-pins can be coupled by a drag-link carried for the purpose. We cannot commend this arrangement. If a single cylinder can be depended upon (and it is well known that it can be) to drive a single wheel, it can equally drive both wheels. Or if double cylinders be preferred, it would be simpler to have but a single crank-shaft, with but one bearing outside of each crank, and with no drag-link. The separate engines (the drag-link not being coupled on) enable the locomotive to be turned readily around short corners, but this can be done with quite as little trouble by employing the usual driving-pin in each wheel, and removing the pin on the side towards which the engine is to turn. It might, too, be an over-nice matter for a driver to always work two independent engines in unison, and even with the drag-link coupled on, it might be found that one engine was doing more work than the other.

Savage's traction-engines were not well designed, and are unfit for regular work, and wholly unfit for heavy work. It

could do no good to any one but Mr. Savage to point out their defects here, and now that he has actually made his engines we must leave him to gain wisdom from experience.

Turner's traction-engine, with spur-gearing between the crank-shaft and driving axle, and steered from the foot-plate, was well made, and was remarkable for its reversing-gear with a single eccentric. This we will not now attempt to describe, as Mr. Turner has promised us a drawing of it, which we shall engrave.

Underhill's traction-engine was a wonder for its curious zig-zag wheels, which cut up the ground in fine style. While other makers have sought to get all the bearing possible for their driving wheels, Underhill has vandyked his on both edges by cutting out great gores from the rim, so that what is left is of the famous pattern of the Virginia snake-fence. Mr. Underhill may not have thought of it, but this wheel is a decided evasion of the Locomotives Act, and we wish him well back from Bury to Shropshire with his engine, and that nobody will pull him up before the beaks, as any one clearly may, and have him fined and possibly reprimanded. But the most curious traction-engine was a disguised nondescript affair by Crowe, of Gaywood, King's Lynn. It was a combined traction-engine and thrashing-machine. Heaven and Mr. Crowe can only know what sleepless nights were spent in scheming, and what cash was disbursed in making, this formidable contrivance, which, according to a printed placard, has actually done seven days' thrashing. Mr. Crowe himself says seven days and a half, and, with his permission, a well-known and waggish agricultural engineer has rectified the record by appending the "½" in pencil. Mr. Crowe, with paternal fondness, observes in his placard that the machine is the best for its purpose that he has ever seen in his thirty-five years' experience. If, however, it were really desirable to combine a steam boiler, engine, and thrashing-machine in one, it would have been done long ago. Indeed, Messrs. Tuxford once made much the same class of machines. But it is not desirable to have a boiler built in under the wood framing of the thrashing-machine, the wood becoming in time dried to tinder, if not loosened at all the joints by shrinking; it is not desirable to have a boiler so near the straw and chaff, and it is not desirable, whenever any little repair is required to the engine or thrashing-machine, to lay them both up at the smith's. As well might man and wife be coupled by a natural ligament, from birth till death, like the Siamese twins.

Mr. E. E. Allen's compound engine was not exhibited, as has been usual at so many agricultural shows. What has become of it? And the Reading Ironworks Company have given up Lenoir's gas-engine, and it was not shown, as it usually is. And there were no steam fire-engines, although even in Bury one or more should be provided, and there are Norwich, and Yarmouth, and Ipswich, and Colchester besides, all in the same district.

But the Reading Ironworks Company exhibited a fixed engine on the Corliss principle, with Spencer's and Inglis's improvements, and we are glad that this old establishment has taken up so promising a type. We only regret that it was not tried at the brake, nor do we know why it was not, the diameter of the cylinder, 11½ in., being within the society's limits for trial engines. There are two induction and two exhaust valves, all vibrating on circularly bored seats, the two former, one at each end, on the top of the cylinder, the two latter beneath. The four valves are worked from a single eccentric, the exhaust-valves being always in motion, while the steam-valves are released from their valve-spindles at a point, in the stroke, regulated by the governor, and are then closed by springs. We shall shortly publish drawings of the Corliss valve-gear, as applied to the engines of Messrs. Salt's great mill at Saltaire, Bradford. It has the appearance of complication, but is, in reality, cheap in construction, easy of adjustment, and seventeen years' experience in America, where there are now more than a thousand Corliss engines at work, up to 60 in. cylinders, has proved it to be durable and certain in its action. The valves have the least possible movement, except when actually traversing the width of the ports they are intended to cover, and then, on the contrary, their movement is more rapid than that of ordinary slide-valves. And during this portion of their movement they are always in equilibrium, the pressure of the steam being practically the same above them and beneath them. No other engine has valves working so easily, unless it be with double-beat valves. And, within pretty wide limits, say, from a given power to five or even ten times that amount, according to the variation in the work being done, the engine runs at a perfectly uniform speed, working more expansively the lighter the load. The adjustment of the expansion to the varying work being done takes place independently at every stroke. For the varying work of fixed engines, where employed upon a farm, no engine is better adapted than the Corliss type, and we are glad to see it at last brought directly under the notice of farmers.

Whitmore, of Wickham Market, who got no prize for mills, exhibited a corn-mill and dressing-machinery in work, the former driven by a horizontal trunk engine working an upright shaft, the connecting rod moving in a horizontal plane. This, it is alleged, saves gearing, a strap being taken direct to the pulley on the mill spindle; but there is no necessity for a trunk engine, and a twisted belt works quite as well from a horizontal shaft. The thirty-two pairs of stones in the City Flour Mills (Hadley's), are all driven by twisted belts. The trunk engine and the upright shaft, with its upper bearing supported in a mass of timber framing, are objectionable. The fly-wheel, it will be understood, revolves horizontally beneath the floor.

Wilkins's patent cast-iron grinding-mill, an adaptation of an American invention, is beginning to attract the attention it deserves for its extraordinary efficiency and durability. In ordinary mills a great proportion of the power is expended in useless friction, which is furthermore positively injurious by heating the flour. In Wilkins's mill 20 bushels and upwards of corn are ground per hour, not into the finest baking flour, but into fine food for cattle, and it is now used for grinding chaff, at the rate of 16 sacks, or 64 bushels, an hour, the grinding breaking the knots in the straw which has been cut, and which are indigestible in the stomachs of beasts. The same mill is now used for grinding coal for foundry use, and for calcined moss as used by the dyers, and, indeed, for almost everything that is pulverisable. The mill consists of a horizontal drum of a sugar-loaf

shape, its surface cut into longitudinal or rather slightly spiral grooves, so as to leave intermediate ridges of a blunt saw-tooth section. The drum works nearly in contact with a corresponding concave, with like grooves and ridges of an opposite spiral. The drum and the concave are of hard white cast iron, about 1½ in. thick, and of much the same quality used in making the famous Palliser chilled shot. The edges of the ridges on the drum are skimmed by a turning tool to bring them to a perfect circle, and the mill thus made, enclosed within a case, and fed at the smaller end of the drum, is ready for work and will go on for years.

Richmond and Chandler had a stand with chaff-cutters, but why do they never, as the makers of Carr's disintegrator, exhibit that also? We lately described this machine, which is wonderful both for its efficiency and simplicity, breaking up cloggy earths, clays, superphosphates, &c., into the finest powder. The machine is not known to one-tenth the extent it should be.

Blake's stone-breaker was one of the greatest attractions of the implement-yard. This, too, is a machine not yet known according to its merits, and although it has been made these seven years—five years in this country—we have never seen it exhibited at any show before. It breaks any kind of stone, even in good-sized boulders, into pieces of any desired size, and at a cost of not more than 3*d.* per ton, the machine exhibited getting through 40 tons per day, when driven by a three-horse engine, and any other size, larger or smaller, can of course be made. There is no more work for paupers or poor labourers in breaking stones, for even able-bodied paupers' labour costs 18*d.* per ton. Our great ironmasters in the Cleveland district and in North Lancashire are using the machine to break ore, limestone, calcined cinder, and slag for road-making, and it is in considerable use for breaking copper ore-stone, flints for glass-making, and for ordinary road-metalling, railway ballasting, concrete, &c.

Crosskill's bone-mills, which took all the prizes in their class, have their gearing exposed, and keyed upon the shafts by hook-headed keys or spikes. At the Battersea show, five years ago, an attendant of these mills was caught in the sleeve by one of these spikes, and his arm drawn into the gearing and out of his body! Will it be believed that he is yet (or lately was) alive? One of the provisions of the Factory Act ought to be extended to bone mills, that of fencing the gearing.

Wilkins, of Ipswich, exhibits what appears to be a capital machine—quite a new one—for cutting Esparto grass for paper-making. This grass—a sort of vegetable wire, for it has no pith—well nigh defies the chaff-cutters. So Mr. Wilkins, who makes this machine for Mr. Lloyd of *Lloyd's Weekly News*, and who makes his own paper, at Bow, largely from Esparto grass, has resorted to sharp circular cutters of equal diameter, but revolved, the lower set four times as fast as the upper set. These cutters, 4 in. or thereabouts in diameter, are mounted, about 1 in. apart, upon parallel shafts, and the upper shaft has spikes which rake in the grass in regulated quantities, and with the stalks laid perfectly parallel.

Tangye Brothers, of Birmingham, exhibit one of Cameron's steam pumps, the first they have made. This is the simplest of the class of pumps with steam-moved valves which has come under our notice, and we have seen a good many varieties. At each stroke the steam piston knocks open a small piston-valve which admits steam to a larger piston, one on each end of the slide-valve, and which work the latter by direct pressure of steam. These pistons (to the valve) have no packing, and are the simplest possible. They cushion perfectly. A handle on the outside puts on the slide-valve at starting, in case it is not well over to admit steam. The best test of steam pumps of this class is to see, not how fast, but how slow they will go, and we worked Cameron's so as to make but a single stroke per minute, the stroke being but a few inches in length. At these very slow speeds the stroke is not gradual, but intermittent, the engine stopping to collect steam at the end of the stroke. The action is certain at all speeds, and when working at full speed, and with 100 lb. pressure in the air-vessel, the suction-hose may be suddenly lifted out of the water without the pistons striking the ends of the cylinder covers. The parts are so accessible that, although still hot with steam, and just after it had been working, we had it to pieces in hardly more than a minute.

Messrs. J. and F. Howard's new steam boiler was shown, and no boiler, for fixed engines, offers such advantages to the farmer. It cannot burst destructively, as they say of the guns at Shoeburyness, and it can only burst in one or more comparatively small water-tubes, and under enormous pressure, such as is never likely to be accumulated in any boiler. Besides, it effects a thorough circulation of the water, and even the worst water may be used without choking or scaling, if the boiler be frequently blown out. And it gives good dry steam, and, when fired slow and carefully, gives a high rate of evaporation, being as economical in fuel as any other boiler, although it was not designed with especial reference to this single object. We have had occasion to examine this boiler, professionally, and can speak of it with confidence. Messrs. Howard's own works, well known as combining nearly every modern improvement of attested value, are driven with steam from these boilers only, and they drive a considerable portion of the machinery in the English department of the Paris Exhibition.

Riches and Watt exhibit a neat steam drilling-machine for drilling iron-work. There is a little steam engine, of 2½ in. cylinder and 2½ in. stroke, driving a fly-wheel perhaps 9 in. in diameter, and having a bevel wheel on the crank-shaft. This gears into another bevel wheel of twice or thrice its diameter, and on the vertical shaft of the latter is the drill-spindle. For some reason, this machine was withdrawn from exhibition on Tuesday. It is made, we believe, at a cost of 12*l.*, and for many kinds of work in an iron-ship yard or an iron-bridge yard it would, we think, be found very useful.

Williamson Brothers, of Kendal, exhibited large blowing-fans and centrifugal pumps. The construction of their make of these machines is well known, and we need only add that the workmanship was excellent.

E. and F. Turner exhibited one of Easton, Amos, and Son's centrifugal pumps, raising water to the head of a pipe, at the bottom of which worked a small Jonval turbine, the turbine case glazed with curved glass sides to permit the action of the wheel to be seen. A single illustration of this kind does more

than a world of description to enable the agricultural mind to comprehend the principle and, after this, the value of this beautiful machine, so inexpensive and easy of application where water power is cheap. On Lord Radnor's estate, near Folkestone, one of the late Mr. Richard Roberts's turbines—a very small affair too, not much larger than a good-sized Stilton cheese—drives the barn machinery on a 45 ft. fall of water.

The leading agricultural engineers exhibited circular-saw benches, and one London maker sent quite a collection of wood-working machinery. Farmers, however, do not want much of this kind of machinery, and can hardly afford to pay London prices. Much cheaper and equally serviceable machinery is made in the provinces. The provincial makers, however, who make this machinery a specialty, and we may name Robinson and Son, of Rochdale, never exhibit at the Royal Agricultural Society's shows.

How was it that Holmes and Son's steam thrashing machine took the first prize, and that makers of much higher repute came second and third? The trials, no doubt, showed that this machine took less power than the others; but in its present form, with its small journals, rambling structure, and profusion of belts, it is not one, surely, which the judges would recommend to the farmer in preference to Clayton and Shuttleworth's or Ruston's.

We have already spoken, both in the present and in other articles, of the engines, but we may still add a few words here. Nalder's was remarkable as a high-speed engine, having but a 2 ft. 9 in. fly-wheel and working at from 220 to 240 revolutions per minute. The single cylinder was 8 in. in diameter, and the stroke 12 in., so that the piston speed was from 440 ft. to 480 ft. per minute. The makers, however, were not half clever enough. In seeking to introduce high-speed engines, with all the prejudices of farmers against them, they should have sought to make them especially economical. Instead of this, the steam was cut off only at half stroke, there was no steam jacket, no feed-water heater, and the firing was not the best. So the engine consumed 7 lb. to 7½ lb. of coal per horse power per hour, instead of 2½ lb., as in the Reading engine, and 3 lb., as in Clayton's. High speed is a condition of economy of fuel, but Messrs. Nalder have rather shown the contrary.

Garrett and Sons exhibited some enormous portable engines, more resembling in bulk the locomotives of the Great Western Railway. Still such engines are sometimes required, and those shown were well made. By the way, did we not see one of the engines of this firm numbered 1970 odd? Their highest number at Salisbury, a few weeks ago, was less than 970. Have they actually made over 1000 engines since then? Or have they clapped on a thousand to give a brisk appearance of business, Clayton and Shuttleworth's number being already nearly 7800?

We wish those rural engineers, Kinsey, Amies and Barford, and Woods and Cocksedge, would not make their upright boilers of two plates for the whole height, with two ugly lines of weakness, in the shape of longitudinal seams, inviting explosion, all the way from top to bottom.

Eddington shows an engine to work to 120 lb. pressure, which is well up to railway practice. The boiler is made of Bowling plates, the firebox ½ in. thick, and closely stayed. All this, we may tell the farmers (and what we say will reach more than 5000 of them next week), means a very strong boiler, and high pressures will yet become the rule rather than the exception. Eddington has the ugly manhole on the swell of the firebox casing, but like a sensible man he rivets a thick ring around its edge, according to the teachings of the Manchester Boiler Association. Well done, Eddington! and stand up, two places to the front.

At no former show of the society have there been seen so many nor, possibly, so ingenious varieties of valve gear for steam-engines. There is the Corliss engine; there is Ransome and Sims's balance valve; there is Underhill's reversing motion, by which a single eccentric works the valve in both front and back gear; there is Turner's, still more curious; there is Ruston's, a sensible contrivance for altering the rate of expansion, and which we shall illustrate next week; there is Wallis and Haslam's cam gear, the noisiest in the whole show, but which gives a sharp cut-off, and an exhaust open the whole length of the stroke; and possibly there were other peculiarities which escaped us.

What constitutes excellence in an agricultural labourer's dwelling? A happy blending, we suppose, of opposite qualities. Cheapness with comfort, for we will not speak of elegance, still less luxury. How we must pity the jurors of the Suffolk Agricultural Society who awarded the premiums to the competing designs for labourers' cottages, these designs being exhibited at the show at Bury. The first premium of 25*l.* was awarded to a London firm of architects whose name we do not find in the Directory, and who do not conduct their business, we believe, at 1, Park-lane West, as inscribed on their award sheet. Their pair of cottages are to cost 170*l.* The second prize design is that of Mr. Thomas Shaw, of Birkenhead, and is for a pair of cottages to cost 190*l.* Whatever the real cost would be, the second design is altogether for a better class of dwelling than the first. Still this may be a reason for not giving it the first prize, for we really do not know but that to be too good is on objection to designs for labourers' cottages.

Is it not time that the Royal Agricultural Society was inoculated with a little new blood, and that the repeated prizes for engines, and for thrashing and reaping machines, and for chaff-cutters, and bone-mills, and horse-rakes, and seed-drills, now so regularly appropriated by old firms, and used merely as advertisements, were revised, and new subjects for prizes introduced? The tardy steam cultivation report was in itself a grand premium for steam farming, but we want prizes for reports upon practical farming, with authenticated instances of success, prizes for good engine-driving, prizes for agricultural discoveries, the prizes not to be shovelled over into quadrennial groups, but to be awarded yearly by special juries well informed upon the respective subjects. The machinery of the Agricultural Society is hardly up to the demands upon it, and needs reform. There should be more live thought in its proceedings, and less hum-drum, jog-trot, routine work. It requires a strong "one-man power" and fewer committee-men to work this improvement. Except as a vehicle for publicity, a sort of grand advertising machine, the society is now doing but little good to agriculture.

ENGINEERS' TOOLS AT THE PARIS EXHIBITION.

We gave, in our first volume, a description of the large engineering works of Mr. Richard Hartmann, of Chemnitz, in Saxony, and mentioned it as being one of the most important establishments of its kind throughout Germany, and as a sample of a very well laid-out and properly managed engineering workshop. Mr. Hartmann's works are principally employed in the manufacture of engineers' tools and locomotives, and a special branch of this establishment is devoted to the manufacture of textile machinery, for which this firm has a great reputation and a wide-spread market. At the Paris Exhibition all three branches of Mr. Hartmann's trade are represented by very creditable specimens, which have deservedly obtained a gold medal from the International Jury. The group of engineers' tools exhibited by Mr. Hartmann consists of several large and very powerful machines which amply illustrate the great facilities and powers of production of his establishment. The designs are professedly of the English school, and they are selected from some of the best models of their kind, and with regard to material and workmanship they leave nothing to be desired. The castings are sound and of a fine surface, and being principally made of the best marks of Scotch pig iron, with the best English coke employed in the cupola, we consider it unnecessary to ask for further proofs of the strength and good quality of the metal itself. In the wearing parts, steel enters largely into the construction of Mr. Hartmann's most modern tools. This material, of course, is almost exclusively of German manufacture. Its present price allows it to be used with comparatively economical advantage, and it improves the quality and appearance of the tools in many respects. With regard to the workmanship shown in Mr. Hartmann's tools, it is one of the few which we would like to call an honest exhibit. The surfaces, with the exception of those which require scraping for the sake of accuracy, are all left with the tool-marks upon them, just as turned out by the machines employed in their manufacture. The tool-marks are broad and uniform all over the surfaces, giving an unmistakable evidence of the great power and reliability of the tool-machines with which the exhibited articles were made; and in this manner Mr. Hartmann has not only succeeded in showing the good quality of the tools made by him, but he also proves that it is a very fine set of tools which he employs in his own shop. Amongst the tools exhibited by Mr. Hartmann, we notice a large double-wheel lathe for turning and boring railway wheels when fastened to the face plates, which can be driven each independent of the other, and also for turning pairs of wheels keyed on to their axles by gearing both face plates, so as to move simultaneously, and to produce no torsion upon the railway axle placed between the centres. This lathe has 1.1 metres height of centres, and can take a length of 2.3 metres between the two centres. The total weight is 23 tons. Mr. Hartmann has for a long time past adopted Mr. Whitworth's duplex tool for his sliding and screw-cutting lathes; but for the latter machines he has added a rack and pinion motion for sliding the carriage, instead of using the guide-screw for this purpose. A large slotting machine and a shaping machine, with two independent arms, complete Mr. Hartmann's exhibition of tools. It contains no special novelty, although Mr. Hartmann's works occasionally produce very neat and useful original designs, as an example of which we may name the nut-shaping machine, exhibited in London in 1862, and since then adopted in this country by several tool makers. Mr. Hartmann has also been one of the first to introduce the Whitworth standard screw thread in Germany, and he makes a great quantity of screwing tackle for the engineering establishments of Germany and of Russia, thereby very materially assisting in that very desirable object of creating an uniform system of screw threads in all machine shops all over the world.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

The Sewage Question.—The Aberdeen Town Council, at their last meeting, approved of a report by one of their committees on a scheme for the irrigation of certain sandy meadows with the sewage of the city. To carry out the scheme a low-level sewer will require to be constructed, from which the sewage of the low-lying parts will be pumped up to a reservoir, the quantity requiring to be lifted being estimated at 100,000 gallons per day; and the committee was instructed to call for tenders for the construction of 600 yards of intercepting sewer as a beginning. The pumping-lift will be 7 ft., and the engineer calculates that 10,000 gallons of water, per day, taken from the city reservoir in Union-place, with a fall of 120 ft., will supply the necessary

power to the turbines and pumps. 8500*l.* is stated as the probable cost of the limited scheme, and the council, with the oft-quoted Craigeintinny Meadows, at Edinburgh—which rent at 27*l.* 8*s.* per acre—before them, anticipate it will be a remunerative one.

Clyde Trustees' Works.—The extensive workshops of the Clyde Trustees at Dalmuir, about eight miles from Glasgow, which have been two and a half years in progress, are now almost completed. The site is very nearly six acres in extent, besides which there are two acres upon which the trust intend erecting houses for their workmen. The whole of the repairs of the dredgers, hopper-barges, tugs, punts, diving-bells, &c. which have hitherto been distributed among the various ship-building yards on the river, will now be concentrated within these works. Opening from the river there is a basin 230 ft. long by 200 ft. broad, and from the basin there extend two slips, one 502 ft. in length, and as it is intended chiefly for the repairing of dredgers, whose machinery projects below, there is no centre rail, as that would have interfered with freedom of access. The slip carriage is 134 ft. in length, and will catch the vessel by the bilge and leave the space beneath quite clear. The other slip is 240 ft. in length, is intended for the repairing of punts, &c., and is to be wrought by hand-winch. The large slip is to be wrought by hydraulic apparatus, for which there is provided a horizontal high-pressure engine of 30 horse power, which is calculated to raise a dead weight of 300 tons. The carpenters' and joiners' shops, smithies, stores, pattern and machine shops, &c., are very complete and fully equipped. The engine for the machine shop, and which in fact supplies power generally over the works, is by Simons and Co., of Renfrew, double-cylindrical, working both high and low pressure steam, and is of 60 horse power, nominal.

Improvements on the Forth.—The Burntisland Railway Pier works, for which an act was obtained in 1865 by the North British Railway Company, are now all but completed. Beginning at 330 yards eastward of the old pier, a new sea-wall 1000 ft. in length, with pier and loading slip inside, and with a small lighthouse at the extremity, has been constructed. The new erections form the hypothenuse of the triangle, of which the railway and the old pier are the base and perpendicular. There will be abundant depth at the lowest states of the tides, there being a mean depth of 42 ft. at the entrance. Wagons can now be run on to the steamers without the use of turntables, and saving of time to the extent of two-thirds is expected in loading and unloading. The works presented no great engineering difficulty, although 115,000 cubic yards of rock had to be blasted in forming the pier and approaches. The steamers will have the advantage at night of an east and west line of lights, in addition to the present north and south guiding line. The engine, winding-gear, and slip have been constructed by Messrs. M'Lellan, of Glasgow. The estimated cost of the works was 25,000*l.*, though their actual value to the company must be at least twice that sum.

Highland and Agricultural Society's Show.—Extensive preparations are being made on Glasgow Green for the forthcoming show. A space of 20 acres has been enclosed, and a very large implement and machine shed erected. The display of machines is expected to be a very full one, several leading makers, we are informed, being busy preparing articles for exhibition.

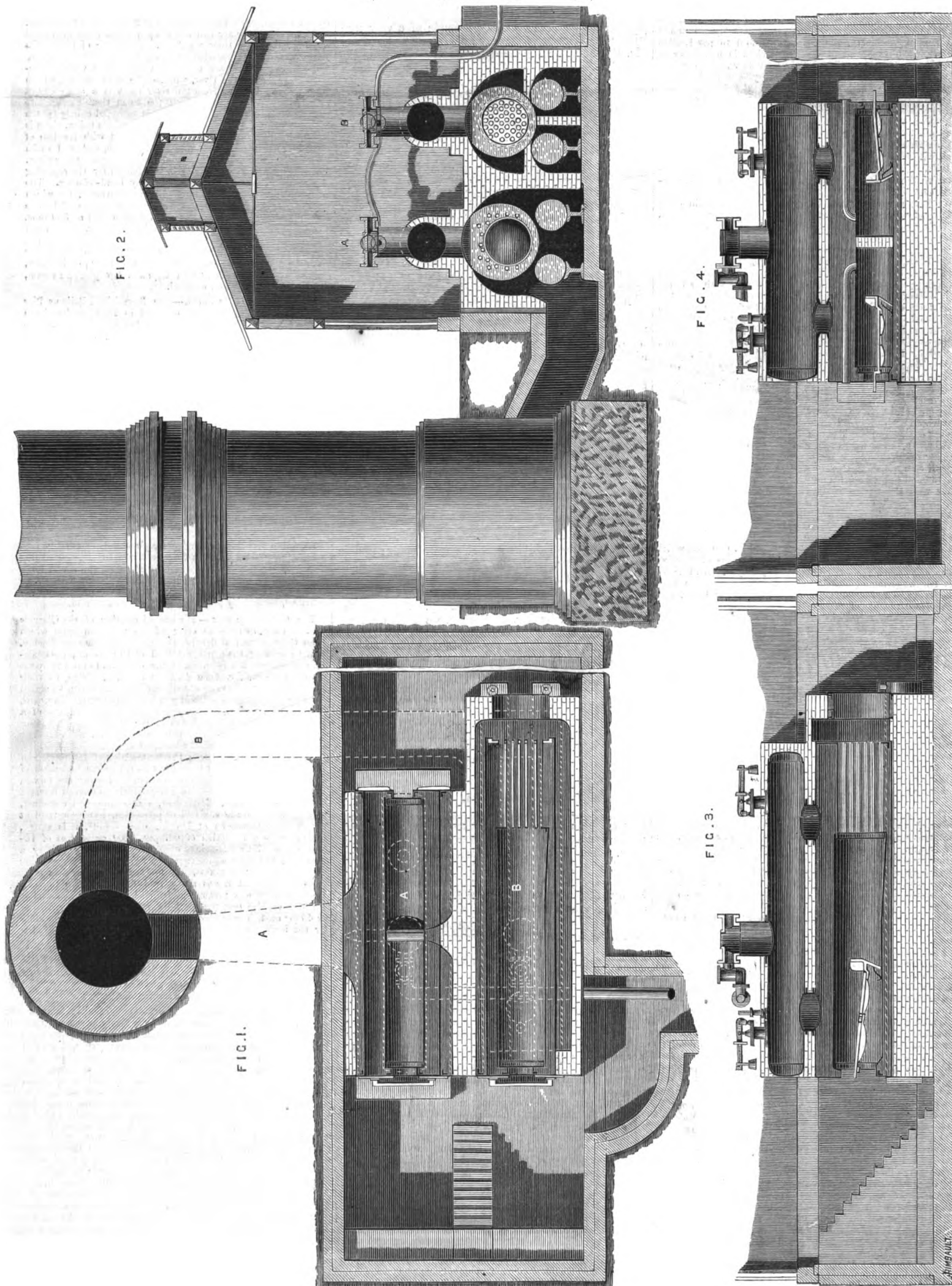
The Gas Companies.—The annual meeting of the Glasgow Gas-light Company—the elder of the two companies which enjoy the monopoly of lighting Glasgow—took place on Monday. While proposing the usual dividend of 10 per cent., the chairman announced the intention of the directors to raise the price 5*d.* per 1000 ft., i.e. from 4*s.* 2*d.* to 4*s.* 7*d.*, giving, as their reason, the increased price of coal over last year, which he stated to be 40 per cent., and a rise in wages of 30 per cent. He urged, in palliation, that the Glasgow companies supplied gas of a higher quality than any others in the United Kingdom, and were the only ones which made no charge for meters. The City and Suburban Company will, of course, follow suit. A long-standing feud between the authorities of Hamilton and the gas company of that town has resulted in the formation of a new company, the articles of association of which are now in process of subscription. The gas-producing material brought out by Mr. McKenzie, of Glasgow, viz., compressed coal-dust, saturated with crude shale oil or petroleum, has been tried at the Alliance Gasworks at Dublin, with results, it is stated, equivalent to a reduction of 6*d.* per 1000 cubic feet of 16-candle gas. New gas-works were erected in Londonderry a year ago; but the consumers were astonished, on the rendering of their winter accounts, to find their consumpt in most cases double what it was the year before. To save lawsuits a leading case was taken and referred to arbitration, and it has been decided that the company must reduce their accounts by 40 per cent. The arbitrator—a civil engineer of Dublin—accounts for the increased consumpt by gross mismanagement of the pressures at the works.

Sewing-machine Trade.—Last week we alluded incidentally to the sewing-machine trade in Glasgow and the north of Ireland. The shirt trade, in which these implements are used, has absorbed the greater part of the female labour which was thrown idle on the downfall of the sewed muslin houses nine years ago. Glasgow has become a leading depot for the manufacture and importation of sewing-machines. In Londonderry alone there are about 1400 sewing-machines at work; the three shirt-making firms of M'Intyre, Hogg and Co., R. Sinclair and Co., and Tillie and Henderson having among them 1200, all wrought by steam. In these factories the cutting out of the work is also done by machinery. In Glasgow, on the 13th, a large shoe-making establishment, in which machinery was extensively used, and in which 223 sewing-machines were at work, was completely destroyed by fire.

Leith.—We referred a fortnight ago to the income of the Clyde trust and to the Leith docks. The Leith commissioners have just issued their returns for the month of May, and these show the port duties to be, for that month, 538*l.*, being an increase of 1294*l.* over the corresponding month last year. We note that the exports of coal from that port for the month were 6153 tons, increase 2714 tons; pig iron, 10,034 tons, increase 3767 tons; malleable iron, 56 tons, decrease 104 tons.

STEAM BOILERS, AT THE PARIS EXHIBITION.

CONSTRUCTED BY M. L. CHEVALIER, ENGINEER, LYONS.

(For Description, see opposite Page.)

DESIGN FOR A CAST-IRON ARCHED BRIDGE.

M. GEORGES MARTIN, ENGINEER, PARIS.

FIG. 1.

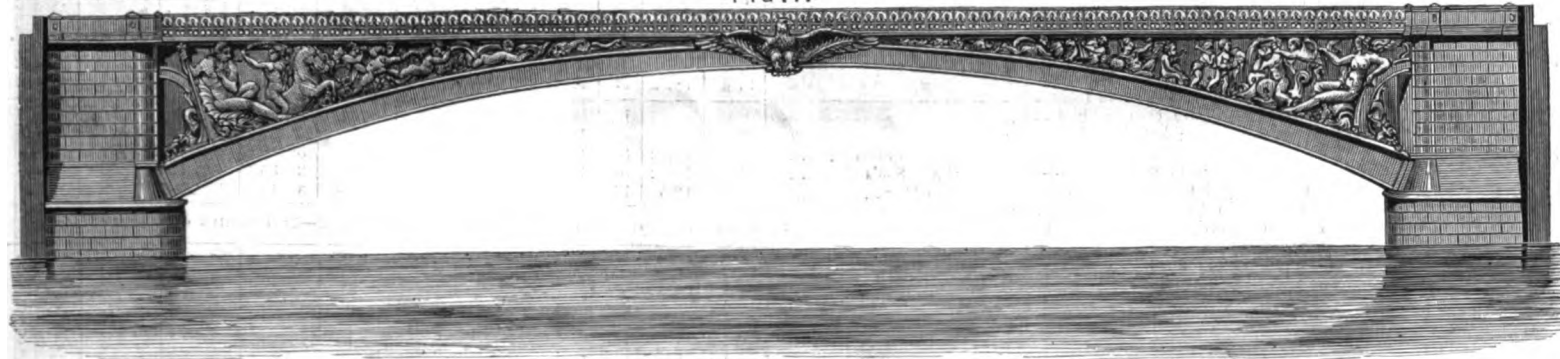
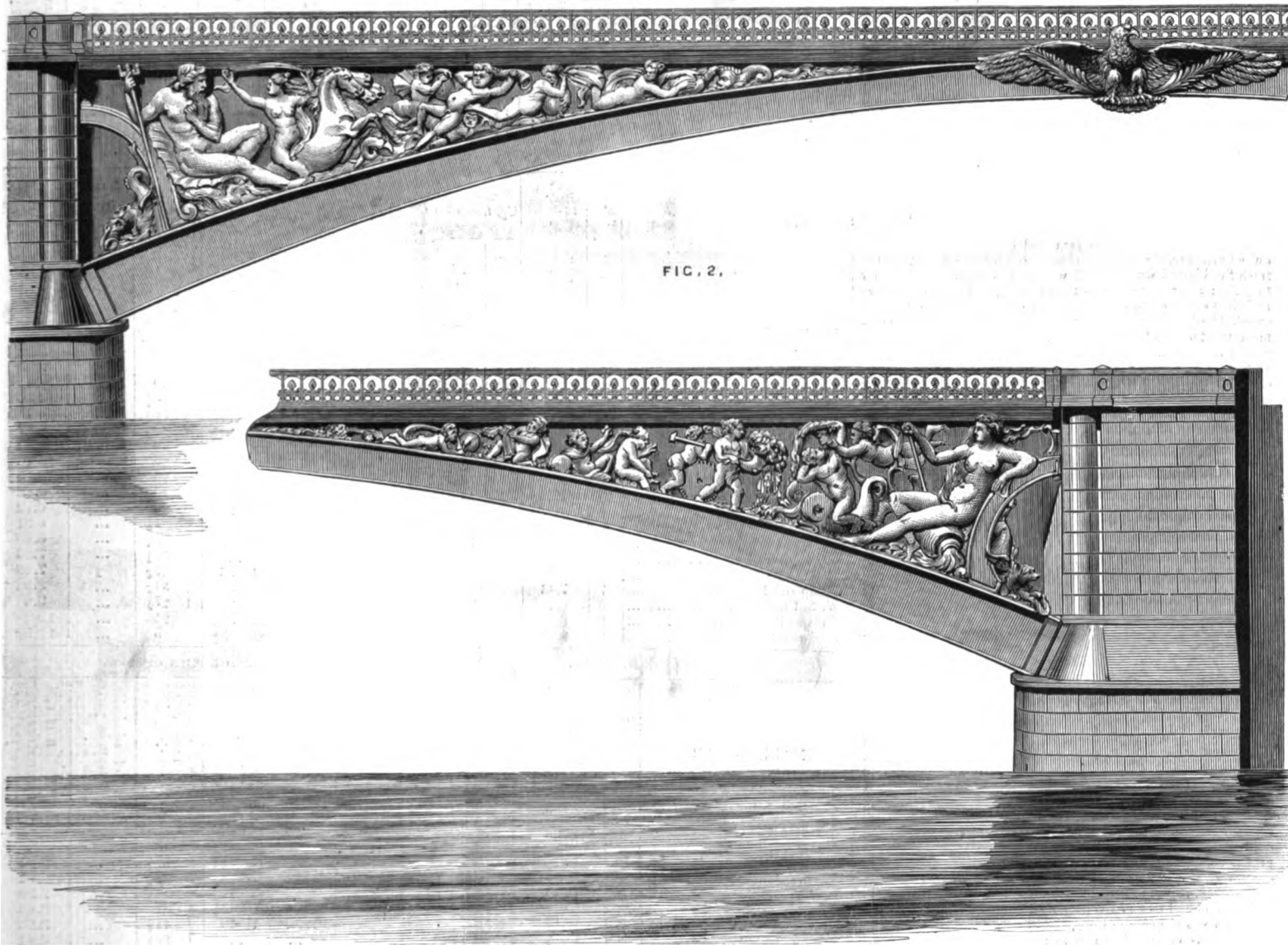


FIG. 2.



THE design exhibited by M. Georges Martin, in the Paris Exhibition, of a cast-iron bridge with solid spandrels, has attracted much attention from engineers, and has raised lively discussion as to its fitness and good taste. This fact has induced us to reproduce the design, in order that a wider circle of English engineers may judge for themselves. It is not so greatly different in its leading idea from that of Mr. G. G. Page's accepted design for the Carlisle bridge, Dublin, although the details are, of course, different. In masonry bridges the haunches are necessarily solid, unless lightened by openings after the manner of William Edwards's famous bridge in Wales; but in iron it has been heretofore supposed that only open spandrels, generally of the ugliest design, as in the Southwark and Vauxhall bridges, would answer. Yet why should not the tympanum of an arch be solid, and enriched by sculpture, as well as the frieze of a Doric entablature? The question is, after all, what will please, and in the present case the decision can only be left to our readers.

RAILWAY AMALGAMATION.—Telegrams were received in Glasgow on Tuesday night announcing the rejection by the Lords' Committee of the Midland and South-Western Amalgamation Bill. Latterly public opinion had been setting against it, though the committee have caused surprise by their assigning only a general reason for the casting out of the Bill.

CHEVALIER'S STEAM BOILERS.

WE give, on the opposite page, engravings of two forms of steam-boiler constructed by M. L. Chevalier, of Lyons, and exhibited by him at Paris. In the one boiler, that marked A in Figs. 1 and 2, and which is shown in section in Fig. 4, two fires are used, these being situated one at each end of the main internal flue. The two fires are separated by a brick bridge, and the gases from them pass into bent tubes communicating with the main flue, and through them to the ends of the boiler. The arrangement of the tubes will be seen from Figs. 2 and 4. From the ends of the boiler gases are conducted down to the space below the boiler, where they act upon the two lower barrels, and from this space they are led to the chimney.

In the other form of boiler—shown in section in Fig. 3, and marked B in Figs. 1 and 2—one fire only is employed, this being placed in its usual position at one end of the internal flue. This flue extends about two-thirds the length of the boiler, and it is terminated by a tube-plate, from which tubes lead to the boiler end. The gases are conducted from the end of the boiler to the space below it, as in the other form. Both the boilers shown are seated upon cast-iron bearings, and both have a capacious steam-tube placed above the main barrel, and connected to it by vertical tubes as shown. One of the main features of M. Chevalier's boiler is that the joints connecting the barrels and flues are so arranged that the

latter can be readily taken out for the purpose of cleaning. We shall have something more to say about M. Chevalier's boilers and their working on a future occasion.

COMMERCIAL MIDDLE MEN.—It notoriously takes a long time to introduce mechanical novelties, however intrinsically valuable, to the favourable notice of farmers. It requires well informed agents, possessed of tact, patience, and generally of superior business capabilities to do so, and even these commonly find the task a long and arduous one, and of necessity costly. A co-operative association has been formed to sell farm machinery to farmers at wholesale prices, and we observe that Messrs. Howard, of Bedford, have, and we think justly, declined to sell their goods at all for this purpose, whereby a hard-working and deserving class of middle men, to whom the trade in agricultural machinery really owes so much, would be displaced. Were it likely that the number of farmers ordering direct would be considerable, or approaching those who now buy from agents and travellers, the co-operative society would deserve encouragement, but it is practically certain that but a comparatively small number would avail themselves of this means of lessening the cost of the machinery and implements bought by them. Indeed, a much less number than at present would buy at all, in the case of many of the more novel implements.

ENGINE TRIALS AT BURY ST. EDMUND'S.

We described, last week, the arrangements which had been made at the show-yard at Bury St. Edmunds for testing the various engines and implements submitted for trial, and we now intend to give some account of the trials themselves. According to the conditions laid down by the Royal Agricultural Society, the engines to be tested were divided into three classes, namely, fixed engines, portable engines with two cylinders, and portable engines with one cylinder. The trials of these three classes were carried on simultaneously; but it will be convenient that we should consider them here in the order above named. It was intended that the trials should have been begun last Wednesday week, and continued by Saturday; but the arrangements were not finished in time, and consequently no fair commencement could be made until the morning of yesterday week, and the proceedings being further delayed by bad weather, the concluding trial of the second series was not made until the evening of Tuesday last. The results of the trials were as follows:

FIXED ENGINES.

According to the published list, twenty fixed engines were originally entered for trial, but of these only six were ultimately tested. The engines were supplied with steam from the boiler belonging to the society, this boiler being arranged as we described last week, and being fired by the representative of each maker in turn as his engine came under trial. By the society's rules, the diameter of the cylinder of each fixed engine tested was not allowed to exceed 11½ in., and the power was estimated at the rate of one horse power for each 10 circular inches of piston area, the power thus obtained being that upon which the allowance of fuel was based. This allowance consisted of 14 lb. of coal and 1 lb. of wood per horse power, an engine with a 9 in. cylinder thus having allotted to it 8.1 lb. of wood and 81 lb. of coal. The maximum pressure of steam permitted was 50 lb. per square inch. In commencing each trial, the connexions having been made between the engine to be tried and the boiler, steam was got up in the latter until the allowed pressure was attained. At the same time the engine was connected to the friction-brake, and the latter loaded so that, when the engine was run at its nominal speed, it would develop a dynametrical power equal to the power at which it was estimated by the society's rule. When steam had been got up to the required pressure, the fire was cleared out of the boiler, and a fresh fire kindled with the fuel which had been weighed out for the trial; and the engine was then started, and run as long as sufficient steam could be maintained to work it at its nominal speed. The level of the water in the boiler was noted at the commencement of each trial, and it was required to be at the same level at its termination. The time run by each engine was calculated not by the actual time which elapsed between the beginning and end of each trial, but by the number of revolutions recorded by the counter attached to the brake, this number, divided by the nominal number of revolutions of the brake per minute, giving the number of minutes of what was termed, for convenience, "mechanical time." During the trials of the fixed engines, the boiler was in all cases fed with cold water, and it is to this that the diminished duty performed by the fixed engines as compared with the portable engines per pound of coal is to some extent due. The loss of heat from radiation from the surfaces of the steam-pipes, &c., was also greater in the case of the fixed than in the portable engines, although some of the makers, and Messrs. Clayton, Shuttleworth and Co. especially, took every care to guard against this as far as possible, by covering the connecting steam-pipe and cylinders with felt laid over them. The powers of the fixed engines tried, together with the results of the trial, are given in the annexed table, No. V., in which the engines are arranged in the order of the duty performed by them.

The fixed engine submitted for trial by Messrs. Clayton, Shuttleworth and Co. was, like the other engines sent by that firm, excellently proportioned, and a beautiful specimen of workmanship. It is a horizontal engine, with the cylinder and covers steam-jacketed. The cylinder has short steam-ports, there being an exhaust-port for each end; and the slide-valve is fitted with an expansion-valve working on the back, the main slide and the expansion-valve being each driven by an eccentric. It had been intended by the makers to run the engine at a speed more greatly in excess of the nominal speed than that at which it was actually worked during the trial, but an objection having been made to this, the eccentrics were altered at the last moment, and the engine run without any preliminary trial to test the adjustment of the valves having been made. The speed of the engine having been thus altered necessitated its being worked with the governor disconnected. At the reduced speed at which it was worked, it will be seen by the table that the engine "over-ran" its nominal rate to the extent of a little over 16 per cent. When, as was the case at Bury, the boiler from which the steam is obtained is of sufficient size to furnish an abundant supply without forcing the fire, "overrunning" is a decided advantage, as it lessens the loss of heat by radiation during a trial, by reducing the time during which that radiation goes on. In the case of Messrs. Clayton's fixed engine, however, the actual running time was greater than that of any of the other competitors, and the amount of overrunning was by no means excessively great.

The Reading Ironworks Company's engine, like Messrs. Clayton, Shuttleworth and Co.'s, was a horizontal engine, with the cylinder and covers steam-jacketed, and it was fitted with a somewhat similar arrangement of slide and expansion valves, the main slide-valves, however, having the pressure taken off the back of them by rings working against faces on the steam-chest cover. To enable these rings to be applied, without interfering with the expansion valve, the main slide is in the form of a kind of skeleton box, open at the ends. The pair of main valves, one for each end of the cylinder, form the side of this box next the cylinder face, and the expansion valves work directly on the back of them, whilst the opposite side of the box carries the rings bearing against the steam-chest cover. In the Reading engine, the cut-off is regulated by the governor, by an arrangement which we may probably describe at some future time. The workmanship of the engine was very good throughout, and it probably would have made a still better run, if it had not been for one of the crank-shaft bearings running rather hot at the beginning of the trial. The fan, by which, as we mentioned last week, the draught was maintained in the

TABLE NO. I.—PORTABLE ENGINES WITH DOUBLE CYLINDERS.—1ST SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power by Royal Agricultural Society's rule.	Size of Cylinders.		Average dynametrical power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.	Mechanical time run = total number of revolutions ÷ nominal speed.	Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.							
Clayton, Shuttleworth and Co.	12	15.12	8½	12	17.79	110	125.3	hrs. min. 4 0	hrs. min. 3 4	...	lb. 2.97
Ransomes and Sims	12	15.12	8½	12	16.44	120	134.4	3 19½	3 8	...	3.76
Tuxford and Son's	14	14.22	8	12	14.12	125	123.8	3 30	3 28	...	4.04
Brown and May	12	12.5	7½	12	13.21	130	137.4	3 11	3 22	...	4.15

TABLE NO. II.—PORTABLE ENGINES WITH DOUBLE CYLINDERS.—2ND SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power to which the engine was to be tested according to the Royal Agricultural Society's rules.	Size of Cylinders.		Average dynametrical power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.	Mechanical time run = total number of revolutions ÷ nominal speed.	Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.							
Tuxford and Sons	14	21.33	8	12	...	125	...	hrs. min. 1 38	hrs. min. 1 59	about 1/4	lb. 3.17
Ransomes and Sims	12	22.18	8½	12	26.93	120	144.7	2 38	2 59	...	3.35
Clayton, Shuttleworth and Co.	12	22.18	8½	12	26.11	110	129.4	1 30½	1 46½	...	3.75
Brown and May	12	18.75	7½	12	...	130	...	1 30½	1 30½	...	4.42

TABLE NO. III.—PORTABLE ENGINES WITH SINGLE CYLINDERS.—1ST SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power by the Royal Agricultural Society's rule.	Size of Cylinders.		Average dynametrical horse power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.	Mechanical time run = total number of revolutions ÷ nominal speed.	Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.							
Clayton, Shuttleworth and Co.	8	8.1	9	12	11.03	120	163.4	hrs. min. 3 17½	hrs. min. 4 29	...	lb. 3.12
Tuxford and Sons	8	8.1	9	12	8.26	125	127.4	3 51½	3 56	...	3.55
The Reading Ironworks Company	10	10	10	18	10.05	120	123.5	3 5½	3 10	...	4.42
Ransomes and Sims	10	10	10	13	10.37	150	155.5	3 1½	3 4½	...	4.55
W. Allchin and Son	8	8.1	9	14	7.93	120	117.6	3 1	2 58½	...	4.7
Brown and May	8	8.1	9	14	9.55	120	141.6	2 22½	2 48½	...	4.97
Holmes and Sons	8	8.55	9½	14	8.55	...	...	2 44	2 44	...	5.12
Marshall, Sons and Co.	8	7.87	8½	12	...	130	...	2 29	2 29	...	5.63
Ruston, Proctor and Co.	8	9.5	9½	12	9.8	120	123.8	2 20	2 26	...	5.75
Barrows and Carmichael	7	7.22	8½	13	7.65	120	127.1	2 7½	2 15	...	6.22
Charles Burrell	8	8.1	9	14	8.9	125	131.2	1 59	2 5	...	6.72
Riches and Watts	8	7.65	8½	12	6.88	120	108	2 15	2 15	...	6.91
Catchpool and Thompson	8	8.55	9½	12	9.64	120	135.4	1 47	2 0½	...	6.95
E. R. and F. Turner	10	10	10	12	...	130	...	1 51½	1 51½	...	7.53
Nalder and Nalder	7	6.4	8	12	6.18	220	212.5	1 53	1 49½	...	7.69
Philip and Henry Philip Gibbons	7	7.43	8½	13	7.69	125	129.3	1 31	1 34½	...	8.91
W. S. Underhill	6	6.4	8	12	6.66	120	125	1 24	1 27½	...	9.6
William Pickford Wilkins	8	6.4	8	12	5.88	145	133.4	1 30½	1 24	...	10
Frederick Savage	8	8.32	9½	12	8.51	130	134.2	1 3½	1 5	...	12.92

TABLE NO. IV.—PORTABLE ENGINES WITH SINGLE CYLINDERS.—2ND SERIES OF TRIALS.

MAKER'S NAME.	Nominal power by maker's rule.	Power to which the engine was to be tested, according to the Royal Agricultural Society's rules.	Size of Cylinders.		Average dynametrical horse power developed during trial.	Nominal speed of engine in revolutions per minute.	Average speed of engine during trial in revolutions per minute.	Actual time run.	Mechanical time run = total number of revolutions ÷ nominal speed.	Period of admission of the steam in parts of the stroke.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.							
The Reading Ironworks Co.	10	15	10	18	16.06	120	128.5	hrs. min. 2 27½	hrs. min. 2 39½	...	lb. 2.54
Clayton, Shuttleworth and Co.	8	12.15	9	12	18.22	120	179.9	1 38½	2 27½	...	2.71
Tuxford and Sons	8	12.15	9	12	12	125	123.5	2 15	2 13½	...	2.98
Ransomes and Sims	10	15	10	13	14.79	150	147.9	1 48½	1 47	...	3.64
W. Allchin and Son	8	12.15	9	14	12.36	120	122.1	1 40	1 41½	...	3.93
Brown and May	8	12.15	9	14	...	120	...	1 40	1 30½	...	4.41
Marshall, Sons and Co.	8	11.8	8½	12	...	130	...	1 20	1 20½	...	4.95
Barrows and Carmichael	7	10.83	8½	13	13.14	120	145.7	1 6½	1 20½	...	4.95
Holmes and Sons	8	12.82	9½	14	13.02	...	...	1 18	1 19½	...	5.04
Ruston, Proctor, and Co.	8	14.25	9½	12	14.43	120	121.6	1 14½	1 16½	...	5.29
Charles Burrell	8	12.15	9	14	12.51	125	128.7	0 58½	1 0	...	6.66
Nalder and Nalder	7	9.6	8	12	10.89	220	249.7	0 51½	0 58½	...	6.8
W. S. Underhill	6	9.6	8	12	9.05	120	113.2	0 53	0 50	...	7.99

TABLE NO. V.—FIXED ENGINES.

NAME OF MAKER.	Nominal power according to maker's rule.	Power by the Royal Agricultural Society's rule.	Size of Cylinders.		Average dynametrical horse power developed during trial.	Nominal speed of the engine in revolutions per minute.	Average speed during trial in revolutions per minute.	Actual time run.	Mechanical time = total number of revolutions ÷ nominal speed.	Consumption of coal per dynametrical horse power per hour.
			Diameter.	Stroke.						
Clayton, Shuttleworth and Co.	10	10	10	20	11.66	110	128.3	hrs. min. 2 42	hrs. min. 3 9	lb. 4.44
The Reading Ironworks Company	10	13.22	11½	20	14.5	100	109.6	2 13½	2 26½	5.73
Tuxford and Sons	10	10	10	14	10.57	125	132.2	2 14	2 21½	5.92
Deacon and Wood	8	7.86	8½	14	7.91	110	110.6	2 10½	2 11½	6.4
J. J. Rawlings	8	7.86	8½	16	8.35	115	121.5	1 41½	1 47½	7.81
Henry Kinsey	10	10	10	16	10.98	100	109.8	1 37	1 46½	7.88

chimney of the boiler, also failed for some minutes through the spindle seizing, whilst the Reading Company's engine was being tested, and thus caused the steam pressure to fall about 15 lb. The fact of the cut-off being adjustable, however, enabled the engine to be kept steadily at work, notwithstanding this fall of pressure, at the expense, of course, of a certain extra expenditure of steam.

Messrs. Tuxford and Sons' engine was another good specimen of workmanship. Like those above mentioned, it is a horizontal engine. The cylinder is steam-jacketed, and the distribution of the steam is effected by a slide-valve, with expansion-valve working on the back. The engine worked very steadily and well; but the pressure of steam was rather below the mark during the whole of the trial, the average pressure probably not being more than 47 pounds.

The engine sent by Messrs. Deacon and Wood, of the Kennet Iron Works, Reading, differed from any of the others exhibited, being a horizontal oscillating engine, fitted with a peculiar arrangement of valves patented by the manufacturers. The cylinder is provided on one side with faces formed on it near the end, these faces bearing against the one side of an oscillating plate, the other side of which it, in its turn, bears against fixed faces on the engine-frame. These last mentioned faces have steam and exhaust ports formed in them, which, if it were not for the interposed plate, would admit steam to and release it from, the ports in the cylinder faces in the same manner as in many oscillating engines in which the distribution of the steam is effected by the oscillation of the cylinder. The interposed plate, however, has openings formed in it; and having an oscillating motion imparted to it by an eccentric on the crank-shaft, it acts the part of an expansion-valve, and effects the cut-off at any desired point, according to the position in which the eccentric is set. The arrangement is an ingenious one; but we fear that the rubbing surfaces will be found to wear unequally, and that they will consequently be difficult to keep tight after the engine has been at work some time.

The two remaining engines, namely, that by J. J. Rawlings, of Melbourne, and that of Henry Kinsey, Nottingham, were both of the ordinary horizontal type, fitted with common slide-valves and no expansion-gear. They were of good plain workmanship, and construction generally. Kinsey's engine has a hollow base-plate, which serves as a water-heater, the exhaust steam being turned into it; and this base-plate is of very neat and substantial design, as, indeed, are all the details of the engine.

DOUBLE-CYLINDER PORTABLE ENGINES.

In this class, as in that of the above noticed, the number of entries greatly exceeded that of the engines actually tried, the former number being ten and the latter six. The conditions of trial were somewhat different to those adopted for the fixed engines. The pressure of steam permitted was 80 lb., and the power of the engines was estimated at the rate of one horse power for each 9 circular inches of the combined area of the two pistons. The engines had also to be tested with two different loads, the first load being such that each engine, when working at its nominal speed, developed a dynametrical power equal to that estimated by the rule just mentioned, and the second load being 50 per cent. in excess of the first. The method of carrying out the trials was also somewhat varied. In the case of the portable engines, each engine of whatever size had an uniform quantity of 8 lb. of wood and $\frac{1}{4}$ cwt. of coal weighed out to it, as much of this fuel as might be necessary being used for raising steam to the working pressure, and the remainder being weighed back, and the quantity thus returned noted. The engine to be tested being connected to the friction-brake, and steam being up, the engine was started, and run as long as it could work under its load at a proper speed, care being taken that the throttle-valve was full open, and that the most possible had been made of the fire, or, in other words, that the fire had not been allowed to become dull, with a view of allowing the steam pressure to fall, and at the same time storing up in the firebox a quantity of fuel which would be available in the ensuing trial.

When the engine had been thus "run down," a further supply of coal was weighed out to it, the quantity being, for the first or light-load series of trials, 14 lb. per horse power, estimated by the society's rule, this corresponding, as we have said, in the case of the double-cylinder engines, to 14 lb. for each 9 circular inches of the combined area of the two pistons. It was at first intended that the same allowance should have been made for the second series of trials; but owing to the delays which had taken place before these second trials were commenced, the allowance was, to save time, reduced to 10 lb. per estimated horse power. As the load on the brake had at the same time been increased one-half, this allowance corresponded to 6 $\frac{1}{2}$ lb. per dynametrical horse power developed by the engine when running at its nominal speed. The time run by each engine was calculated in the same way as in the case of the fixed engines, and the results of both series of trials, as far as the double-cylinder engines were concerned, are given by the annexed tables, Nos. I. and II.

In the first series of trials the best duty was done by Messrs. Clayton, Shuttleworth and Co.'s engine; but in the second series this engine fell into the third place, a result to a great extent due to the fire having become clinkered up during the early part of the trial. The engine was in fact short of steam during the whole of the second experiment, and the pressure rarely exceeded 77 lb. Like the stationary engine by the same firm, Messrs. Clayton's double-cylinder portable engine is well designed, and the workmanship is of the best class throughout. The cylinders are steam jacketed, and are moreover placed in the upper part of the smokebox where the exterior of the jackets are exposed to the hot escaping gases. This arrangement has been long used by these makers with very good results. The cylinder covers are also jacketed. In their engines tried this year Messrs. Clayton and Co. have added a steam dome placed on the top of the firebox casing, the steam for the cylinders being taken from this dome. The steam-jackets have a separate communication with the boiler, and from their position they must to some extent act as superheaters. The position of the cylinders also allows of the exhaust being conducted away very directly. The arrangement of slide and expansion valve used on both Messrs. Clayton's portable engines tested at Bury was the

same as that employed on their stationary engine, and the eccentric working the expansion valve was shifted after the completion of the first series of trials, so that both their engines worked with a later cut-off when driving the heavier than they did when working under the lighter load. In connexion with their portable engines Messrs. Clayton used a feed-water heater, into which a portion of the exhaust steam was turned. This heater consists of a wooden box fitted with connexions for the steam-pipe leading from the exhaust and for the pump suction pipe. That portion of the exhaust steam, which is not condensed by contact with the water entering the top of the box passes up through a number of small tubes, almost closed at their upper ends, and surrounded by a larger tube having a bell-mouth at its upper end. Into this tube the water to be heated was constantly poured by hand during the trials at Bury, this water absorbing a portion of the heat from the steam escaping through the small pipes, before it entered the box, and was brought directly in contact with the exhaust steam. The arrangement is very effective, the water being heated very nearly to the boiling point; but in regular practice it would, of course, be impracticable to keep a man employed pouring in the water a canful at the time, as was done during the trials. For regular work, therefore, Messrs. Clayton omit that portion of the apparatus which necessitates the hand-feeding, at the same time sacrificing a few degrees of temperature imparted to the water.

Messrs. Ransomes and Sims' double-cylinder portable engine was of the same class as that exhibited by them at the Paris Exhibition, of which we gave an illustrated description in a recent number (*vide* page 682, vol. iii.). We then described the principal peculiarities of this class of engine, so that it will not be necessary to dwell upon them here. The cylinders and covers are steam-jacketed, and the slide-valves have the pressure taken off the back by rings working against the steam-chest covers. The arrangement of main slides and expansion-valves is, in fact, very similar to that which we have already described as being used by the Reading Company, but, instead of the back of each valve being fitted with four small rings, one large ring only is employed—a more simple arrangement. One of the main features of Messrs. Ransomes and Sims' engines is their feed-water heater, which is neatly arranged in the smokebox. This heater consists of a copper vessel of Ω form, the top of this vessel being connected with the exhaust by a short pipe. The pump with which each engine is fitted has two independent barrels and plungers, both of the same size, one of these pumps lifting the water from the supply-tub and delivering into the heater, and the other drawing it from the heater and forcing it into the boiler. The water raised by the first pump is delivered into the heater through a perforated pipe, which throws it in fine streams through the exhaust steam as the latter enters the heater. The pumps are fitted with a very neatly designed arrangement of cock, by which the supply of water to the boiler can be regulated, and which enables either hot or cold water to be pumped into the latter at pleasure. During the trials at Bury, Messrs. Ransomes' engines ran very steadily, and did their work well. We give on page 49 (Fig. 1) some indicator diagrams taken from the double-cylinder engine by the makers previous to the trials, and these diagrams show an exceedingly good distribution of the steam. The full and dotted lines respectively show diagrams taken from the engine when working against loads corresponding to those used in the first and second series of trials, the point of cut-off being in the one case at one-eighth and in the other at about one-fifth the stroke. The pressure of steam in the boiler when the diagrams were taken was 77 lb. per square inch.

Messrs. Tuxford and Sons' double-cylinder engine was chiefly remarkable for the great size of the boiler, which far exceeded that of any of the other engines. The cylinders, which were placed horizontally on the top of the firebox, were steam-jacketed, and the slide valves had expansion valves working on their backs. The arrangement of feed-water heater employed was similar in principle to that used by Messrs. Clayton, and the temperature of the feed was generally from 200° to 210°.

The double-cylinder engine submitted for trial by Messrs. Brown and May was one of their ordinary engines without special "racing" appliances, and considering this, its performance was exceedingly good. The cylinders, which were cast together and placed on the firebox with the steam-chests outside, as in Messrs. Ransomes' engine, were not steam-jacketed, and the slide valves were of the ordinary kind, there being no separate expansion valve. The feed-water was heated by turning a portion of the exhaust steam into the vessel from the suction-pipe of the pump was led. In the course of the second trial the belt connecting the engine to the brake came off twice, and this caused some loss of time, and no doubt lessened to some extent the duty that would have been performed.

SINGLE-CYLINDER PORTABLE ENGINES.

The trials of the single-cylinder portable engines were conducted in precisely the same manner as those of the engines with two cylinders; but the pressure of steam allowed was only 50 lb. per square inch, and in giving out the allowances of coal, and proportioning the loads on the brakes, the power of each engine was estimated at the rate of one horse power for each ten circular inches of piston area. The single-cylinder engines, like those with two cylinders, were each tested with two loads, the second being 50 per cent. greater than the first; and the results of the two series of trials are given in the annexed tables, Nos. III. and IV. We shall make a few remarks upon the engines in the order in which they stand in the first of these two tables; but the space at our disposal will not allow us to do more than touch upon some of the more prominent features.

The single-cylinder engines exhibited by Messrs. Clayton, Shuttleworth and Co., Messrs. Tuxford and Sons, Messrs. Ransomes and Sims, and Messrs. Brown and May, practically embodied the same principal features of construction as the double-cylinder engines by the same firms, and as we have already alluded to these features, it will be unnecessary for us to say more about them. We, however, give on page 49 (Fig. 2) some indicator diagrams taken from Messrs. Ransomes' single-cylinder engine, when working against loads corresponding to those under which it was tested at Bury. The diagrams shown by dotted lines were taken with the steam cut off at one-third, and those shown in full lines with it cut off at one-fifth of the stroke; the boiler pressure being in both cases 50 lb., and the speed of the engine 150 revolutions per minute.

In their single-cylinder portable engine the Reading Company have embodied most of the features of their fixed engine already mentioned. The expansion-valve, however, is not acted on by the governor, but it is adjustable by hand whilst the engine is running. Towards the end of the first trial the engine was, by thus altering the degree of expansion, kept running until the pressure of steam in the boiler fell to 18 lb. In the second trial the expansion-valves were not touched after the engine was started. The duty performed by this engine on its second trial was the greatest performed by any of the engines tested, the consumption of coal per dynametrical horse power per hour being, as will be seen by referring to the table, only 2.54 lb. We have adverted to this duty elsewhere in the present number, so that we need only say here that it speaks well for the design and workmanship of the engine, as well as for the care and judgment with which it was worked during the trial.

In Allechin's engine the cylinder is placed in the smokebox, but it is not provided with a steam-jacket; the expansion-valve, which works on the back of the main valve, is adjustable by hand whilst the engine is running. The engine is carried on springs at the firebox end.

The engine sent by Messrs. Marshall had a mishap, on the occasion of its first trial, the nozzle having been, by some negligence, removed from the blast pipe. The consequence was that, in order to maintain steam, the jet had to be kept going a great part of the time, and the duty performed was, therefore, somewhat less than it otherwise would have been. The design and workmanship of Messrs. Marshall's engine is very good throughout. The cylinder is steam-jacketed, and the piston rod, valve spindles, and guide bars are of steel. The feed-water is heated by turning a portion of the exhaust steam into the supply tub, and also by forcing the water through a heater placed in the upper part of the smokebox. The boiler is strongly made, and it is intended, under ordinary circumstances, to be worked at a pressure of 80 lb., the steam being then cut off in the cylinder at one-sixth of the stroke.

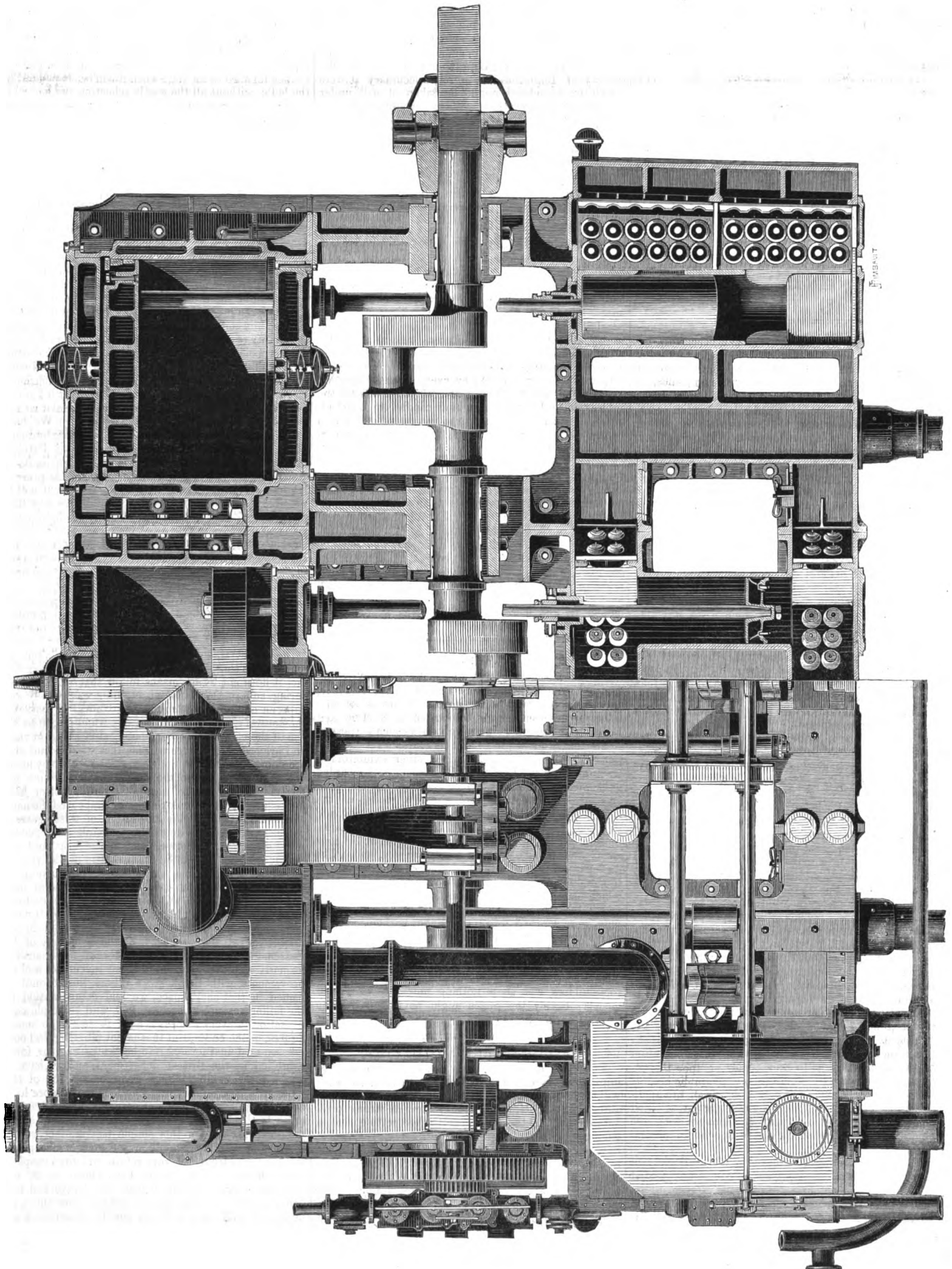
Messrs. Ruston, Proctor, and Co.'s engine was one of their ordinary class, and it was chiefly noticeable for strong proportions and good plain workmanship. It was fitted with a new and simple arrangement of shifting eccentric, of which, as we intend giving an illustration of it next week, we shall defer any description for the present. On the completion of the first trial of Messrs. Ruston, Proctor, and Co.'s engine, some interesting experiments were made to determine the power to which the engine could be worked. For this purpose the pressure of steam was increased to 75 lb. and weight added to the brake, the result being ultimately that when running at 133 revolutions per minute, the engines developed 24 $\frac{1}{2}$ dynametrical horse power without inconvenience; there being an abundant supply of steam. The engine was, as will be seen by the table nominally of 8 horse power only; but Messrs. Ruston, Proctor, and Co.'s employ much larger cylinders than other makers in proportion to the nominal power of their engines.

In Barrows and Carmichael's engine, the underside of the cylinder is exposed to the steam, and a steam belt, equal in width to about half the length of the cylinder, is also carried round it. The crosshead is guided by a single-slotted guide-bar placed below it, the crosshead being arranged so as to clip this bar—a simple and neat arrangement. The feed-pump is of the long stroke class, and is worked from the crosshead. Riches and Watt's engine has the cylinder placed in the smokebox, but without a steam jacket. It is fitted with an expansion valve, working on the back of the main slide, and there is a steam dome on the top of the firebox casing. The feed-water is heated by a heater composed of six brass tubes placed across the smokebox. Catchpool and Thompson's and Turner's trial engines were of the ordinary class constructed by those makers.

The engine sent for trial by Messrs. Nalder and Nalder, probably included a greater number of peculiarities of construction than any engine exhibited at Bury. It was specially intended by the makers for working at a high speed; but the design is in many respects defective. Thus the cylinder is not steam-jacketed, and the distribution is effected by an ordinary slide-valve cutting off at half-stroke. This lateness of the cut-off renders it necessary to wire-draw the steam considerably when the engine is running with a moderate load, and it is probable that it was this, combined with want of protection for the cylinder, which made the engine take a comparatively low place in the trials at Bury. On Nalder's engine the eccentric-rod, instead of being coupled to the valve-spindle by a joint and pin in the usual way, is connected to it by a flat spring which bends to allow of the angular movement of the eccentric rod. A similar form of attachment is used for connecting the pump-rod and plunger. The safety-valve lever is formed of a spring, so that no spring-balance is required. We fear that this arrangement allows the valve to have but a very small amount of lift. The governor is of a peculiar construction, which we could scarcely explain without drawings. The balls are carried by a pair of spring arms fixed to the crank-shaft, and as they open they shift a sliding collar along this shaft, the motion of the collar being communicated by an arm and light spindle to the throttle-valve. The wheels on which the engine is mounted have cast-iron bosses and rims and very light wrought-iron spokes. The rims have a number of slots cast through them, one between each spoke, these slots allowing the drags when put on the wheel being secured by bolts passed through them. When the engine is at work also it is securely fixed by connecting the top of each hind wheel to the bottom of the corresponding front wheel by means of a pair of bars placed one on each side of the wheels and secured to them by bolts passing through the slots in the rims. The engine is altogether one which will well repay examination.

Of the remaining engines, those by Gibbons and Underhill are of the ordinary class; and of Savage's, which is a traction engine, we have spoken elsewhere. Wilkin's engine differs from any of the others exhibited in the peculiar shape of the firebox, which is formed by a gradual deepening of the boiler. The latter thus has in side elevation a shape resembling that of a funnel, the barrel representing the spout and the enlarged portion the firebox casing. The firebox proper is thus entirely enclosed by a water casing. The back end of the boiler is secured by bolts, so that by driving back the tubes the firebox can be taken out for the purpose of cleaning.

ENGINES OF THE "FRIEDLAND," 960 H.P.: IMPERIAL NAVY OF FRANCE.
CONSTRUCTED AT THE IMPERIAL WORKS AT INDRET, FROM THE DESIGNS OF M. DUPUY DE LOME,
(For Description, see Page 51.)



PUBLISHER'S ANNOUNCEMENT.

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ENGINEERING.

FRIDAY, JULY 19, 1867.

THE SOCIETY OF ENGINEERS.

A NEW society of engineers, a few practising on their own account, many holding appointments under local boards and public and private companies, and a still larger number of whom are assistants, has been growing up in London during the last twelve years, and now numbers nearly 450 members. So far, all the members, and many non-members of known ability, have been invited; and often, indeed, pressed to contribute papers for reading and discussion, and there is both greater opportunity for, and greater freedom of, discussion than it is possible to have at the Institution of Civil Engineers. Although the papers read are but seldom accounts by engineers of works actually executed by themselves, but are more generally essays upon various branches of engineering, and are sometimes speculative, they draw good audiences, and are, on the whole, creditable to their authors and to the society. Lately the transactions have improved, and some really excellent papers, worthy any professional body, have been read, and in some cases very ably discussed. These, however, are but the ordinary conditions of infancy and childhood in the lives of such institutions, and no doubt the Society of Engineers, as a means of disseminating professional knowledge, now possesses much greater influence than did the parent Institution, or Society, when its founders first met, nearly fifty years ago, at the King's Head Tavern, Cheapside.

The growth of the Society of Engineers has called for sufficient permanent accommodation for its meetings, and it is obviously desirable that it should have some abiding place of its own. To this end it must have the power of holding property, and of suing and being sued. This can best be obtained by royal charter, and one is now being sought. These are all the privileges, too, which the Institution of Civil Engineers now enjoys from the Crown. The Institution, it is to be borne in mind, is not a royal institution in any other sense than that it obtained the privilege from George the Fourth of suing and being sued as a corporate body, and of holding property to the value of one thousand pounds yearly—privileges which might, we incline to believe, be now secured by registration under the Limited Liability Act. The Institution has no power to enforce examinations, to grant degrees, nor, therefore, to prosecute engineers practising without its diplomas. It exercises no other than a moral control over engineering practice.

It will surprise many of our readers to know that the petition for a royal charter, now preferred by the Society of Engineers, is being opposed by the Institution of Civil Engineers, and that while a deputation of the former body is to wait to-day upon the President of the Board of Trade (of all public bodies for the purpose!) to explain the real objects of the application, a deputation from the Institution of Civil Engineers is to follow them, presumably with the object of undoing what they have sought to accomplish.

Whether the present application of the Society of Engineers succeed or not, it will of course be repeated if opposed; and no more certain mode of securing its final grant could be devised than the opposition of the Institution. The latter, despite its position and the

respect which all engineers like to feel for it, is not a homogeneous body. Indeed it is almost too large to permit of sufficiently general discussion among its members. There are members of council, too, whose stubbornness, last year, in the matter of a new house lost the Institution 25,000*l.* already subscribed. There are members of council who have promoted a recent deplorable scandal; dragging the Institution into a matter with which, under the circumstances, it had no business, and these same members, we have reasons for believing, are opposing the application of the Society of Engineers for purely pecuniary powers which, we apprehend, might be taken at will, under the Limited Liability Act. We are wholly at a loss to discover what *locus standi* the Institution has in this matter. We can conceive of no ground, except that of a narrow jealousy, upon which it can act. And we are certain that the great body of members, who at present know nothing of this, would disapprove of such action upon such a reason.

SUBWAYS.

CAPITAL evidence was given, the other day, before the House of Commons' committee, charged, among other things, with the consideration of subways. Dr. Percy was asked to give his views upon the subject, and he did so, stipulating, merely, that he should appear as an unpaid and independent witness. He nearly knocked over Mr. Hemans's bill by proposing to try an experiment in the great subway in South-wark-street. The committee accepted the hint, and made the experiment on Saturday week. Two 1½ in. gas pipes were opened, and every opportunity afforded for diffusion, and there were several gentlemen in the subway with lighted cigars and candles to court ignition. The only result of the escape of gas was a perceptible current, due to the induced movement of the escaping jets. Nobody was blown up. Then, also, on one of the hearings, an inspector of the Imperial Company was sworn to the effect that even where there was the smell of gas it formed an explosive mixture with air. This witness, however, was quickly disposed of. He was first asked, "What proportion of gas to air can be detected by smell?" He couldn't say. "Can the one-thousandth part be detected by smell?" He thought not, or was not sure. "Does an empty gas main, having been in use, smell of gas when exposed in the open air?" There was but one possible answer to this, and the theory of the detection of danger by the mere *smell* of gas was at once disposed of.

THE PRIZES AT PARIS.

THE more the awards of prizes at the Paris Exhibition are examined, the more they show the inability, partiality, or neglect of the juries. There is not now a better traction engine known than Aveling and Porter's, and theirs were the only ones which performed reasonable tasks in the Champ de Mars. Yet they are put off with a silver medal, while other exhibitors of traction engines, English and French, are awarded gold medals. Thwaites and Carbutt exhibit good specimens of steam hammers, and a model of the largest steam-hammer yet made in England—that made by them for the Bessemer Works at Crewe—a Ramsbottom duplex hammer, having two tups of 30 tons each. For all this they get a silver medal, and a like medal is awarded to a little hammer of inferior design, by Tannett, Walker, and Co., of Leeds—a hammer which had broken down when the jury saw it, and in which the steam and exhaust pipes, of common gas pipe, were screwed into the cylinder without flanges, stud-screws, or bolts. A well-known firm of makers of wood-working machinery, who have done much to improve that class of machinery since 1862, are dismissed with a bronze medal, while a Leeds firm of tool-builders, who show nothing new, receive a gold medal! Surely the prizes might as well have been drawn from a wheel in a lottery.

ROLLING LIQUID STEEL.

THERE are reasons for believing that the next great improvement in connexion with the Bessemer process will be the rolling, or otherwise shaping under pressure, of cast steel in the liquid state. A strong pressure or nip of the steel, just before setting, has a wonderful effect upon its strength. Mr. Whitworth is seeking to effect this by hydrostatic pressure. One of Mr. Bessemer's experiments, made long ago, was that of pouring a small ladle of melted steel between a pair of rolls, in rapid revolution. The steel was rolled into a thin plate of extraordinary toughness, which could not only be bent over

flat, but yet again across the latter bend, so as to make a sharp corner of four plates in thickness, and this without cracking. It might be difficult to deal in this way with heavy teemings of metal, and it might be that each weight would require its own time, distance apart of rolls, &c., to cool to the nice point at which, while entering as a liquid, it would come out a tough solid. Yet this mode of working steel is not unlikely to have a great future, and after the miracles which have been wrought in steel, and especially in Bessemer steel, it is not, possibly, too great a stretch of the imagination to look forward to the time when it will be shaped out of the ladle, without all the costly reheating and hammering, and rolling which is now usual in the manufacture of articles from cast steel.

THE PARIS EXHIBITION.

PARIS, July 17, 1867.

THERE is nothing easier than to throw out a few hasty remarks about the general lessons that the engineering profession of this country, and our nation at large, may derive from the present Exhibition. We have had many plausible statements of the kind laid before us, and we have more than once considered it our duty to refute the assertions and conclusions precipitately arrived at by superficial observation. On an occasion like the present, when the number of the objects of study and the variety of the branches of science and industry to which they belong prevent all possibility of immediate generalisation, we can arrive at correct conclusions only by industriously mastering the details. We can in this manner only gradually, and step by step, climb up to a point of view sufficiently elevated to overlook a certain, even then still limited, sphere, and ultimately by a succession of similar mental operations we may reach the desired end. We have for this reason endeavoured to collect in those branches of our profession which are represented at Paris as many of the most interesting facts as the limits of time and space have permitted to publish. At present, while continuing our accounts of the details, it will be possible, from those that have been more or less fully described already, to point out some of the more general features which may be observed in the great *ensemble* of articles of the same kind brought together for comparison. To commence with coal, the first and most important natural basis of our present engineering, we see the indications of an increasing price of this material in this country, while we notice an increasing production and a corresponding diminution of prices elsewhere. This cannot fail to alter the relative position of this country and its neighbours as far as the direct trade in coal itself is concerned; but we at the same time can see the indications that from this fact it does not by any means follow that our manufacturing superiority, which at one time was due to our superior and abundant supply of coal, will be lost. On the contrary, the same indications which prove to the eye of the careful observer that coal is rising in value and price show at the same time that science and skill are doing their best to realise a greater economy in the use of fuel, to utilise the dust and slack which formerly were thrown to waste, to gain a better heating effect by the employment of improved furnaces and grates, to study the utilisation of waste gases in the blast furnaces, to apply the principle of regeneration for the more effective utilisation of heat, and ultimately even to decompose the products of the volatilisation in the Siemens furnace for the purpose of removing those which are mere absorbents of heat, and leaving the combustible gases in a better condition to act and give out their useful effect. We find in steel manufacture the quantities of fuel used in the production of steel reduced by the invention of the Bessemer process below one-quarter of the quantities formerly employed, and in all these inventions and improvements, with the host of others that cannot be named in that short space, we find compensation for the failing resources of cheap fuel, and an ample compensation in every respect it is, if it comes to actual figures, in the end. But that is not all. We find compressed coal-dust formed into bricks of regular forms exhibited in the British department, and we have no doubt those exhibitions of superior articles of that kind sent to Paris by other nations will, before long, be made a lesson of for our own colliery proprietors, much to their own advantage and to the benefit of the public. We see in this simple fact another source wherefrom to derive millions of tons of cheap and excellent fuel from the very refuse and dust-heaps of our collieries. The Swedes have shown us at this Exhibition how a welding furnace can be worked with damp sawdust, and we may in return show them, ere long, how well such a lesson can be understood and

appreciated in this country. Only one necessity exists, and it has become a condition *sine qua non* for our future national existence. We must not be slow to learn. Let this, then, be one of the first lessons to be drawn from the Paris Exhibition, and we believe all the others will teach themselves.

TECHNICAL EDUCATION.

THE Schools Inquiry Commission have published the answers of various English jurors at the Paris Exhibition to a question officially put to them as to whether they concurred in the substance of Dr. Playfair's letter to Lord Taunton, which lately appeared in the *Times*, and which was to the effect that the continental nations were gaining great advantages over Great Britain in consequence of a better system of technical education. To this inquiry several replies have been made, and we give the substance of most of these as follows:

From JOHN TYNDALL, Esq., F.R.S.

I hardly think that an Exhibition in Paris furnishes the means of accurately testing the comparative merits of English and French education.

The simple inconvenience of transport tends to render England worse represented than France.

Still on other grounds I would express a general concurrence in the views of Dr. Playfair. The facilities for scientific education are far greater on the Continent than in England; and where such differences exist, England is sure to fall behind as regards those industries into which the scientific element enters.

In fact, I have long entertained the opinion that, in virtue of the better education provided by continental nations, England must one day—and that no distant one—find herself outstripped by those nations both in the arts of peace and war. As sure as knowledge is power, this must be the result.

From EDWARD FRANKLAND, Esq., F.R.S.

As a juror in Class 44 of the present Paris Exhibition, I was not only forcibly struck by the want of evidence of progress in the different branches of chemical manufactures carried on in Great Britain, but still more so at the great advances made by other nations, but more especially by Germany, France, and Switzerland, in respect of such manufactures since the year 1862, when, as a juror in the corresponding class, I had also an opportunity of comparing the chemical manufactures of different nations.

I quite agree with Dr. Playfair in referring this want of progress in the manufactures of this country chiefly to the almost utter lack of a good preparatory education for those destined to take part in industrial pursuits. This great defect in the school and college education of England affects the masters and managers of our factories even more deeply than the workmen themselves. The former have but rarely had any opportunities of making themselves acquainted with the fundamental laws and principles of physics and chemistry; they therefore find themselves engaged in pursuits for which their previous education has afforded them no preparation, and hence their inability to originate inventions and improvements. It is true that such men not unfrequently imagine themselves inventors, and the yearly files of patent specifications abound with instances of their so-called inventions. The great loss of time and money attending these futile patents would be rendered impossible by a very moderate, if accurate, knowledge of chemical and physical science.

In the polytechnic schools of Germany and Switzerland, the future manufacturer or manager is made familiar with those laws and applications of the great natural forces which must always form the basis of every intelligent and progressive industry. It seems that at length this superiority in previous training is more than counterbalancing the undoubted advantages which this country possesses in raw material.

From JOHN FOWLER, Esq., Pres. I.C.E.

I do not quite agree with Dr. Playfair that a comparison can be usefully made between Exhibitions so nearly together in time as those of 1862 and 1867, nor that "little inventiveness" and "little progress" in the peaceful arts have been lately made by this country.

With these reservations, however, I may say that I agree generally with that which may be considered the substance of the letter, viz., that foreign nations have made greater manufacturing progress than England since the Exhibition of 1851.

This, in fact, was the opinion which I publicly expressed on the 8th May, at the annual dinner of the Institution of Civil Engineers, and I have been glad to see a confirmation of it by Dr. Playfair and others.

From JAMES E. MCCONNELL, Esq., C.E.

I agree with Dr. Playfair in his views generally, and am satisfied as to the comparatively small progress we have shown since 1862, and the great advance which continental nations have made during that period.

In the class of which I was juror for England (No. 63) I made a very careful examination and comparison of our locomotive engines, carriages, and railway machinery, apparatus, and material as shown by this country, with the same articles exhibited by France, Germany, and Belgium.

I am firmly convinced that our former superiority either in material or workmanship no longer exists; in fact, there are engines shown there made in France and Germany equal to those of the best English makers.

It requires no skill to predict that, unless we adopt a system of technical education for our workmen in this country, we shall soon not even hold our own in cheapness of cost as well as in excellence of quality of our mechanical productions.

I found that on the Continent there are now a number of workmen's schools established, in which a clever mechanic can qualify himself for any scientific position in his business.

In England our mechanics' institutions are more like reading clubs. Classes are neglected, and, in consequence, when a good workman is selected for a foreman's place, he is generally found wanting in technical knowledge.

We have treated our workmen too much like a machine; but this must be remedied if we are to maintain our ground.

Having for about 25 years superintended large numbers of English workmen, I can speak on this point practically.

Fully impressed with the great importance of this subject, I invited several of my brother jurymen and exhibitors to meet at our hotel in Paris, to consider the best course to adopt in the matter. At one of these meetings we had the pleasure of Dr. Playfair's attendance.

I may mention that I hear a movement has already begun to draw the attention of the public in England to the subject, and sums of money have been offered by individuals to assist the object. It appears to me, however, that Government should take the matter in hand, and the public funds should be forthcoming to establish these technical schools, not in London, but in the districts where the operations requiring such knowledge are being carried on.

Thus there ought to be mining schools in South Wales, Staffordshire, and Durham, and machinery and engine schools in like manner placed in Manchester, Glasgow, &c.

From CAPT. FREDERICK BRAUMONT, R.E.

Speaking only with reference to machinery, the department with which I am immediately connected, there can be no doubt as to the immense strides which foreign mechanical engineering has lately made, notably, I think, in the case of France and Belgium, and by which they are rapidly overtaking the industrial power of Great Britain.

My impression is that this advance has been greatly owing to a successful copying of English designs, and to the use of English machine tools. Of course, did the foreigners merely confine themselves to copying, they would never surpass us; but while following that which in our mechanical designs is good, they are also seeking (and that not unsuccessfully) to apply theoretical knowledge in a way which, to my humble judgment, shows that they will soon have little to learn from us.

I would allude notably to the economical use of steam, though no doubt their inventive faculties have there been quickened by the high price of fuel on the Continent.

I trust I may not be deemed presumptuous in stating what I believe to be a very great want in England, viz., such an institution as the well known "Arts et Métiers" of Paris. I know of no national institution where the public of our own country may study practical mechanics and the arts appertaining thereto. Such a one would, in my opinion, be valuable not only to working men and their superiors, but to engineers. It should be an evidence of the most advanced mechanical knowledge of the country; and while teaching primarily through the eye by the models and machines exhibited, it would naturally form the focus of other means of instruction by lectures, classes, &c.

I apprehend it is only when taken up by Government that such an institution would assume proportions sufficient to be really effective as a means of national education.

From WARINGTON W. SMYTH, Esq., M.A., F.R.S.

Having gone carefully, as juror, through the objects exhibited in Class 47 at the Paris Exhibition, and having also examined with much interest many of the productions in Class 40, as well as other portions of the Exhibition, I am bound to admit that our British portion of the display was generally meagre and defective, partly from tolerably obvious causes. I was not so much struck by this lack of fair representation of many of our branches of industry, as I was by the decidedly greater progress which had been made of late years by several of the continental nations, and that, too, in several departments which used formerly to be considered almost exclusively our own.

As regards the broad question of technical education, I will only add, that the greater proportional advancement made by France, Prussia, and Belgium in mining, colliery working, and metallurgy appears to me to be due, not to the workmen, but in great part to the superior training and attention to the general knowledge of their subject, observable among the managers and sub-officers of the works. No candid person can deny that they are far better educated, as a rule, than those who hold similar positions in Britain.

From DAVID S. PRICE, Esq., Ph.D.

As far as relates to chemical products, I consider that the exhibition made by Great Britain is a "deficient representation," and will not enable foreigners to form a correct estimate of the nature and extent of chemical manufactures now carried on in this country.

In reference to the British exhibition of iron and steel, it must not be overlooked that most of our largest ironworks are unrepresented—Mr. Bessemer's, Coalbrook Dale, Weardale, Earl Granville's, Shelton, Ebbw Vale, Aberdare, Plymouth, and many others too numerous to name; that Sheffield is only represented by two or three makers—a fact that was considered so remarkable at the time that space was applied for by intending exhibitors, that it was brought to the special notice of the Associate Commissioners invited to confer with his Royal Highness the Prince of Wales at the South Kensington Museum; and that what is shown in Class 44 is, as a rule, injudiciously exhibited, contrasting painfully with the taste and spirit evinced by the French in their arrangements in the same class. Great credit is also due to the French ironmasters for the skill displayed in some departments of manufacture, especially in that of girders—a branch of rolling to which our countrymen have not yet seriously devoted their attention.

Those interested in the metallurgy of iron are much impressed at the wide dissemination which the Bessemer process has attained on the Continent as evidenced in Paris. In reference to the rapid spread of this remarkable invention, it would be instructive if the history of its introduction abroad could be published. The treatment which our eminent inventor has received—more particularly in Prussia—if it were known, might occasion grave reflections in the minds of Englishmen as to how far they are justified in granting the protection of their patent laws to the subjects of a kingdom which shows so little regard for the inventive genius of their own. More than this I should not like to state. The finest specimens of Bessemer steel

are exhibited in the Austrian department, and are from the Neuberg works.

In connexion with these splendid achievements, it may be well to inform your lordship what I have learnt from Mr. Bessemer respecting the introduction of his process into Austria. Mr. Bessemer informs me that the Government erected model works of his process, and invited the iron and steel manufacturers to inspect them, and to forward samples of their pig iron, in order to have them tested as to their adaptability for the process. The success of the enterprise is complete, and the Austrians may congratulate themselves upon the brilliant prospect which it promises for the development of their iron industry.

There is one little thing, however, which they have omitted to do, and that is to reward the inventor for the great benefit he has conferred upon the empire. Possibly a knowledge of the history of the iron and steel manufactures in our own country may have afforded both Austria and Prussia a plea as well as a precedent for their injustice and ingratitude to British inventiveness.

It is unnecessary for me to say anything respecting the exhibition made by England in ceramics, as an unanimous verdict of approval has been given as to the manner in which our leading manufacturers have supported the reputation they had acquired at former Exhibitions. As regards the British exhibition of ordnance, there must be many opinions as to the merits of our guns, but as regards the display there can be but one, and that is, that it redounds to the credit of the officials at the Arsenal.

Before leaving the subject of the Exhibition, I would wish to state my conviction that it is most important that these international competitions should not be allowed to degenerate into a means for advertising, and that it behoves those who are intrusted with their organisation to see that the several departments of industry are intrusted to men who take an active interest in them, and are thus a guarantee that every endeavour will be made to have them fairly and properly represented, which is not the case on the present occasion, so far at least as refers to Classes 40 and 44.

In reference to the second part of Dr. Playfair's letter, recommending that an official inquiry should be made into the means "by which the great states are attaining an intellectual pre-eminence among the industrial classes, and how they are making this to bear on the rapid progress of their national industries," I would beg to observe that I believe the sooner we are acquainted with the facts the better.

Whilst assenting to the proposition, I must distinctly state that I do not agree with Dr. Playfair that the technical education of working men is the most important method for the maintenance of our industrial supremacy. The information gleaned by acting upon his suggestion would be instructive, and great good would result from its application, but what is really wanted for this country, and is of vital consequence to our future prosperity, is a higher scientific culture of those who are likely, in the natural course of events, to be master manufacturers, so that when discoveries are made they may fructify and not stagnate or decay, as has too often been the case, for want of intelligence on the part of those who command capital and works to perceive their merits; and that they, the manufacturers, may be able to appreciate and adequately remunerate the scientific talent that this country is, and always will be, able to afford them.

I would add further, that no reformation bearing upon industrial progress is more required than in the legislature, and it is a reproach to the country that science is not represented in Parliament.

It is only a few years since that our classic and commercial statesmen repudiated the idea of the exhaustion of coal in England, whilst last year they, in a fit of alarm, organised a commission to inquire into its probable duration.

It would be well if an investigation were made as to what have been the results of the teachings in science of the German universities; what Liebig has done for modern chemistry, and how the system inaugurated by him at the small University of Giessen has spread throughout the world, and what benefits have resulted from it; what we owe to the teachings of other chemists, the physicists, metallurgists, and geologists of those excellent seats of learning. Whilst advocating the necessity for the dissemination of scientific training in England, I must not omit to bestow a passing tribute of commendation to the success of those institutions of recent date, which were established to supply a want that existed many years since. I allude to the Royal College of Chemistry, of which the late Prince Consort was the president, the School of Mines, and the colleges in the metropolis where scientific departments have been founded. Of the two former I can speak from positive knowledge. In the first named, many of the men who have taught, and not a few of those who have studied there, have not only enriched chemical science by their researches, but have left a permanent mark upon the leading industries of this country. From the School of Mines have emanated men who in metallurgy and geology have greatly extended the application of those sciences, nor is this to be wondered at, when we consider the reputation of the professors under whom they have studied. It is, however, a well-known fact that the public do not rightly appreciate the education that this institution is capable of affording, and that comparatively but few of the sons of manufacturers avail themselves of its advantages.

Before concluding, I would beg to call your lordship's particular attention to a plan proposed by the eminent chemist, Professor Frémy, of the Institute. It is one most just and wise. He proposes that young chemists of talent who are desirous of devoting their time to the advancement of science, and therefore for the benefit of mankind (and there are always many, not only willing, but anxious to do so), should be liberally supported by the State.

In conclusion I must express my firm belief that extended scientific education is of the highest consequence to us if we wish to retain our present position in the scale of nations, that it will mostly benefit the future master manufacturer, that it must tend to elevate the social position of the intelligent working man, and to create a greater sympathy between master and man than at present prevails, and if it do this, the evils which threaten to impede, if not to paralyse, our national progress may be averted.

From J. SCOTT RUSSELL, Esq., F.R.S.

I have to state that in much that Dr. Playfair has said I entirely agree, and that from my own recent personal inquiries into the state of technical education in Switzerland, Germany, and France, I have reluctantly come to the conclusion that it is much more advanced in those countries than in ours.

As a juror in the Paris Exhibition, I have come to the conclusion that the higher class of education given in each of those countries to the workmen in its skilled trades, as well as the superior professional education given to the higher classes of men employed in technical professions, is everywhere visible in the works exhibited by those countries. And I attribute the surprising strides those countries have been making for the last ten years in many of the great staple branches of mechanical construction and manufacture to the admirable scientific and practical training which the Governments of those countries provide for their working classes.

The fourth great International Exhibition has afforded an excellent opportunity for marking the relative progress of different countries in the arts, manufactures, and trades which contribute to the wealth and power of nations. We have especially noted the progress of other nations in those mechanical and constructive arts and trades in which, in 1851, England exhibited pre-eminent excellence. We have to record that in many of these some other nations appear to have made much more rapid progress than ourselves, so that we are *relatively* falling off. And we especially note that our falling off is not in unimportant departments, but in some of those which had formerly constituted our staple excellence.

We have to specify that those branches in which other countries have now shown more rapid advancement are some of our own great manufactures of steel and iron, steam machinery, locomotive engines, and tools and manufacturing machinery in general. We do not say that in all of these other nations have excelled us; in some they have not yet equalled us. But what we do feel, and therefore frankly state is, that their progress has, in the last sixteen years since the first Exhibition of 1851, been remarkably greater than ours.

There are other branches of arts and manufactures in which possibly the reverse is the case. Glass and pottery, and the arts of design and construction of beautiful patterns, both in form and colour, have made remarkable progress throughout England during the same period; we therefore confine our present remarks to the mechanical and constructive arts, not commonly called fine arts.

Dissatisfied with our national progress, we have naturally turned our minds to search for the cause of the progress of other nations and for the cure of our own deficiency. We find that during these years some nations have been occupied in diligently promoting the national education of the various classes of skilled mechanical workmen, for the purpose of giving skill to the unskilled and rendering the skilled more skilful. We find that some nations have gone so far as to have established in every considerable town technical schools for the purpose of teaching all the youths intended to be craftsmen those branches of science which relate most nearly to the principles of their future craft. Workers in metal are taught the nature of the mechanical powers with which they will have to work and the chemical properties of the materials they will have to operate upon; engine builders are taught the principles of heat and steam, and the nature of the engines they have to make and work; shipbuilders are taught the laws of construction, hydraulics, and hydrostatics; and dyers and painters are taught the laws of chemistry and colour. All skilled youth are taught geometry, drawing, and calculation; and in many countries every youth who shows great talent in any department is promoted to a higher training school, and there educated at the public cost.

Besides these local schools, other countries have technical colleges of a very high class for the education of masters and foremen in engineering, mechanics, merchandise, and other practical and technical professions.

We have not failed to notice that it is precisely those nations which have been systematically giving a course of preparatory training and education to their population in their skilled trades that have shown the most marked progress in national industry in these successive Exhibitions.

Prussia, Switzerland, Belgium, France, America seem to make progress in proportion to their excellence of educational training—Prussia in steel, iron, and general engineering work; Switzerland in scientific engineering, machinery, and watch and telegraph work, and in textile manufactures; Belgium in metal working and mechanical trades; France in metal work, and in steam engines, engineering structures, naval architecture, and steam navigation. All these nations seem to exhibit growing skill and progress in proportion to the excellence of the education and training they give to their manufacturing population.

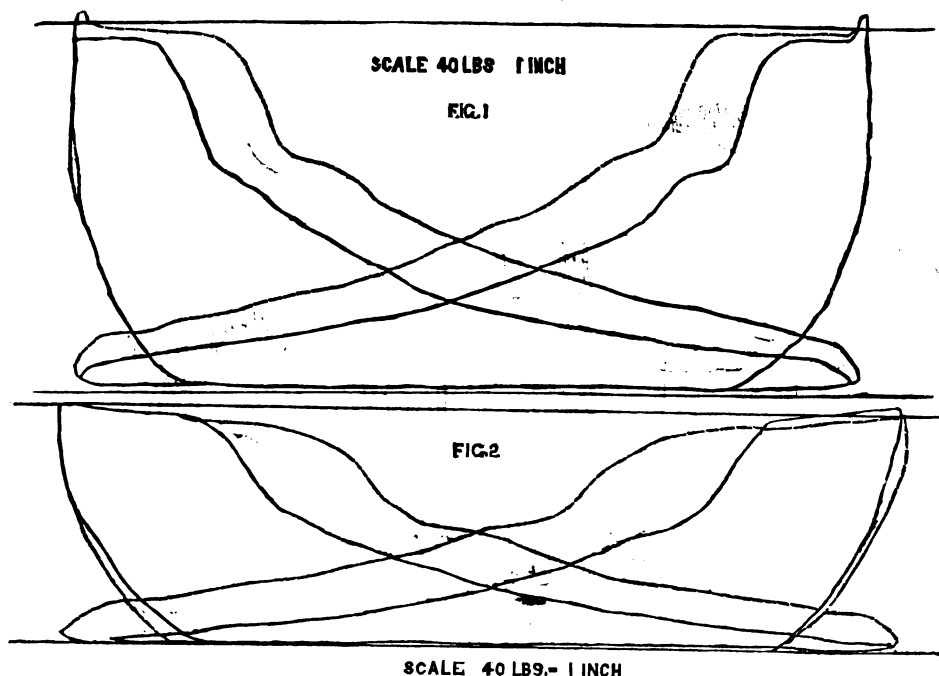
It becomes, therefore, a serious national question for England and the English, whether they have or have not been wise in neglecting to take adequate measures of a national character for the complete technical training of all the youth destined to skilled trades and occupations. By this training we do not on the one hand mean elementary education, nor on the other hand do we mean any substitute for a practical working apprenticeship. We mean a schooling midway between the elementary day-school and the workshop, which the youth should enter after he knows reading, writing, and counting, in order to learn to apply his reading, writing, and calculation to the purpose of acquiring such knowledge of mathematics, mechanics, mineralogy, chemistry, drawing, &c., as shall fit him more aptly and perfectly afterwards to learn and to profit by the teaching of the workshop and the office. It is unquestionable that apprentices to trades, coming into the workshops with this preparation, will make greatly more rapid and certain progress than those who enter direct from the elementary school.

But in England we can scarcely as yet be said to possess such schools. Certainly they are not uniformly distributed over the towns of England; and it seems that in no country have they thriven or even existed except when organised and sustained by nations at large, acting through their Governments.

We have therefore to recommend to the serious attention of the British nation the consideration of the importance of establishing a national system of technical and trade education.

INDICATOR DIAGRAMS: RANSOMES AND SIMS' PORTABLE ENGINES.

(See Page 45.)



From JAMES YOUNG, Esq., of Bathgate.

I am bound to say that my experience accords with that of Dr. Lyon Playfair. So formidable did the rate of progress of other nations appear to many of us, that several meetings of jurors, exhibitors, and others, took place at the Louvre Hotel on the subject. The universal impression at these meetings was that the rate of progress of foreign nations in the larger number of our staple industries was much greater than our own. But it must be stated that a large number of our first-class machine and other manufacturers are not exhibitors in Paris, whereas other nations, I believe, have taken care to bring forward their very best; still, the great progress of other countries is evident. The season for this increased rate of progress is the excellent system of technical education given to the masters of workshops, sub-managers, foremen, and even workmen. England for a long time excelled all other countries in the finish of her machines; but now we find that foreign machine-makers are rapidly approaching us in finish, and, having skilled and intelligent labour cheaper than ourselves, are progressing in all the elements of manufacturing.

Permit me to use my own case as an illustration. Originally I was a working man, but have succeeded in increasing the range of manufacturing industry. The foundation of my success consisted in my having been fortunately attached to the laboratory of the Andersonian University in Glasgow, when I learned chemistry under Graham, and natural philosophy and other subjects under the respective professors. This knowledge gave me the power of improving the chemical manufactures into which I afterwards passed as a servant, and ultimately led to my being the founder of a new branch of industry, and owner of the largest chemical manufacturing works of the kingdom. It would be most ungrateful of me if I did not recognise the importance of scientific and technical education in improving and advancing manufactures. Many men without such education have made inventions and improvements, but they have struggled against enormous difficulties, which only a powerful genius could overcome, and they have been sensible of the obstacles to their progress. Stephenson, who so greatly improved locomotives, had to be his own instructor, but he sent his son Robert to Edinburgh University, and the son did works at least as great as the father, and with far less difficulty to himself.

The improvement in locomotion has necessarily created great competition in the industries of the world, and unless we add skilled instruction to manual labour, England cannot expect to maintain her position in the industrial race.

THE CINCINNATI SUSPENSION BRIDGE.

(Continued from p. 23.)

WHEN the Cincinnati excavation was commenced, a strong oak sheet piling was driven along the river front, to guard against the pressure of water. This, together with a solid embankment, proved a most efficient coffer-dam on the river side. Owing to its low stage, the river gave us no trouble at all. But, by the great depth and extent of the foundation, most of the wells along the rising ground, back of Cincinnati, were laid dry. We drained their supplies, and had to pump them out; and this copious influx came from a quarter totally unexpected. The excavation, however, proceeded rapidly day and night, until all the clay and sand was removed, and a deep layer of coarse sand and gravel was laid bare. Soundings were made by driving long iron bars to the limestone shale underneath, which proved to be about 12 ft. lower. A depth of over 12 ft. below extreme low water was reached, and the question now arose whether to go to the rock, to pile, or to lay down a solid timber platform.

A compact bed of gravel, if left undisturbed, and protected against undermining and washing, stands next to a solid rock foundation, provided that unequal settling is guarded against. Had this tower been located inside of low-water mark, I should have decided upon going down to the rock, although one season's loss would have been the consequence. Piling I consider inferior to the plan adopted, to say nothing of the loss of time. It

was, therefore, decided to stop at the gravel, and to build a solid timber foundation up to low-water mark, thence to commence the masonry. If the timber could be obtained in time in sufficient quantity, the success of this kind of foundation was much more certain to be achieved, and with less risk and cost, than any other plan.

The timber foundation, thus laid, forms a platform of 110 ft. long by 75 ft. wide, composed of twelve courses or layers next the river, but stepped off towards the land side to eight courses, in consequence of the greater hardness of the gravel, almost equal to hardpan. We were obliged to employ all kinds of timber, soft and hard, mixed, as white pine, oak, maple, hickory, buttonwood, elm, beech. The length of logs also varied from 25 ft. to 40 ft. They were all flattened and counterbored to an even thickness of 12 in., leaving the other two sides rough. The courses were crossed at right angles; each stick was thoroughly secured by iron rag-bolts of 18 in. long and 1 in. diameter. The vertical joints were left open and filled with clean gravel and broken stone. Every course was levelled off with the adze, and then thoroughly grouted with cement grout, before the next course was laid down. Care was also taken in breaking the longitudinal joints efficiently. A solid platform of timber, 110 ft. long, 75 ft. wide, 12 ft. deep on the river side, and 8 ft. on the land side, well put together in the manner described, offers a foundation nearly as good as rock, provided it is guarded against undermining.

The result has fully justified my expectation. I have not been able to discover any settlement during the progress of the masonry; its condition to-day proves the excellence of the foundation. There are 16,000 perches of 25 cubic feet, equal to 400,000 cubic feet of solid masonry in each tower. Allowing 150 lb. as the average weight of one cubic foot, the total weight of one tower is 60,000,000 lb., or 30,000 tons neat. The area of the timber foundation being $110 \times 75 = 8250$ superficial feet, the weight upon each foot is 3.63 tons, or 7272 lb., or 50½ lb. per superficial inch. This is equivalent to a solid mass of iron of 15 ft. deep. Now experience proves that such a weight of iron will be supported upon a clay floor, if its surface is well consolidated by stamping. In the case of high chimney stacks, elevated 300 ft. to 400 ft., a still greater pressure is sometimes produced upon each superficial foot.

As to the strength of timber to support the above pressure, my own experience, often repeated, has satisfied me that good sound oak will safely carry 50 tons per foot, without exhibiting the least sign of failure, except a slight compression. The hard and soft logs have been so intermixed, that a full average resistance is obtained. The concrete, settled down into the open joints by crowbars, and the copious cement-grouting of every course, must also be considered as an important means of increasing the supporting power of the whole mass. Cement has the property of hardening as well as preserving woody fibre. And the experience of past centuries has also settled the question of the indestructibility of all kinds of timber in fresh water.

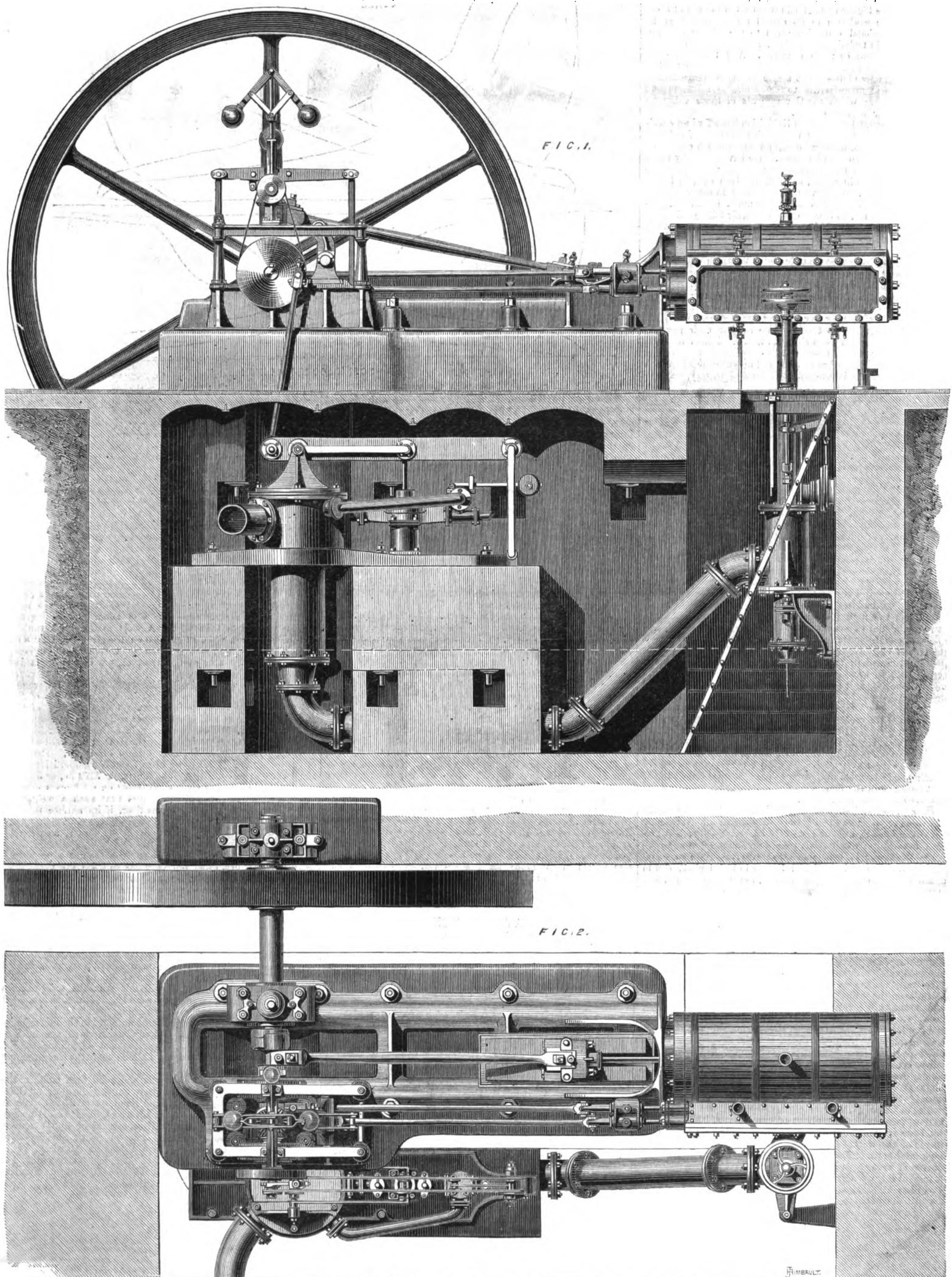
To the weight of masonry must be added the weight of the superstructure and loads. This item, however, can never exceed 2000 tons, and consequently will only be an addition of one-fiftieth.

On the Covington side much less difficulty was experienced in the foundation than on the Cincinnati side. The extensive bottom, upon which the city of Covington is built, is so much broken and intersected by ravines, that no subterranean water-courses, which have their sources in the surrounding hills, can reach the river front. Little pumping was required to keep the pit dry. After digging down through the clay and a stratum of fine running sand, we reached a heavy deposit of mixed sand and gravel, very uniform in its composition, and this was levelled off 6 ft. below water mark. Some twenty iron bars of 1½ in. round were driven down to ascertain the resistance below. The depth of the solid shale appeared to be 11 ft. below the bottom of the pit. It was concluded not to sink any lower, and seven courses of timber were laid down in the same manner as on the Cincinnati side.

(To be continued.)

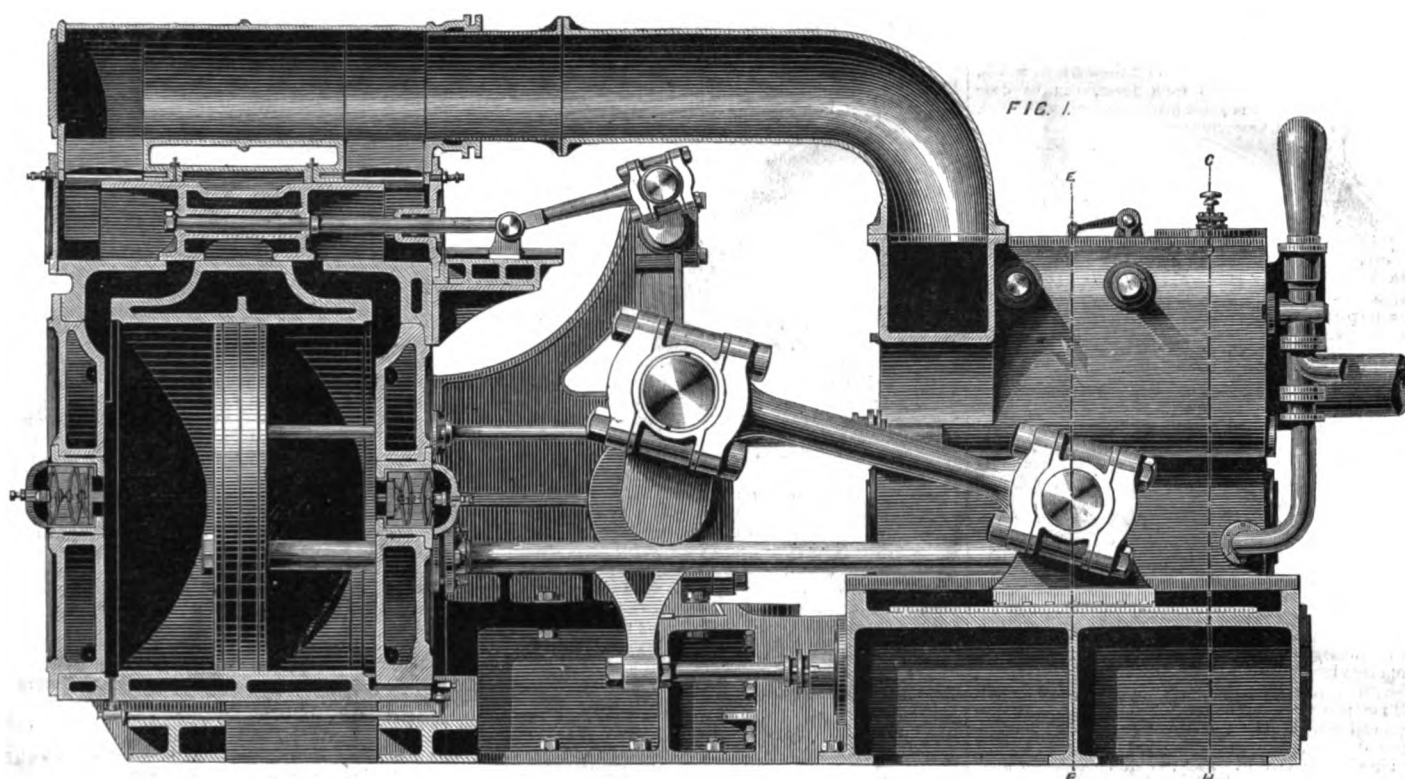
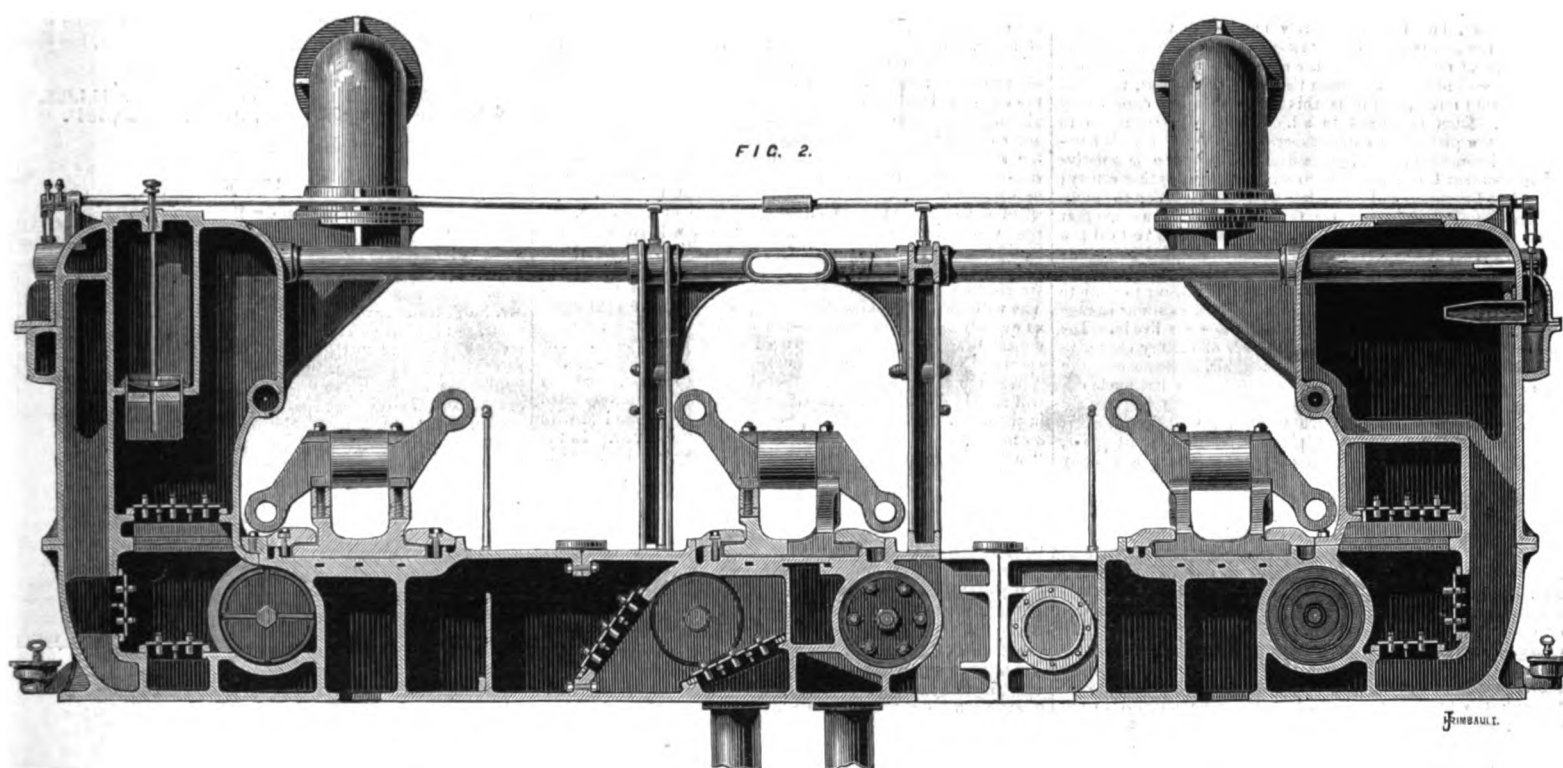
HORIZONTAL ENGINE, AT THE PARIS EXHIBITION.

CONSTRUCTED BY M. ALPHONSE DUVERGIER, ENGINEER, LYONS.

(For Description, see opposite Page.)

ENGINES OF THE "FRIEDLAND," 960 H.P.: IMPERIAL NAVY OF FRANCE.

CONSTRUCTED AT THE IMPERIAL WORKS AT INDRET, FROM THE DESIGNS OF M. DUPUY DE LOME.



THE three-cylinder engines of the Friedland, in the Paris Exhibition (82 in. cylinder, 4 ft. 6 in. stroke), were described in considerable detail in *ENGINEERING* of May 10th and May 17th last. The cranks are set at 120° apart. The full-pressure steam from the boiler is admitted only to the middle cylinder, and at one-third stroke is expanded into one of the other cylinders of equal size. When the second piston has also made one-third of its stroke, the admission to it is shut off, and the steam then remaining in the first cylinder is again expanded upon the other or third piston, then at the beginning of its stroke. The valves are worked from a shaft over the main crank-shaft, the former driven from the latter by a pair of spur wheels of equal diameter. In other respects the engines have much in common with Mandelay's double piston-rod engines.

The objection to this type of engine—and it is a grave one—is that, practically, the amount of expansion, and therefore the total power, can be but little varied to suit the varying requirements of the work. To English eyes this must appear a well-nigh fatal fault, and so long as the French adhere to this type of engine, so long may we expect to sail round and ram their ships in case of war with our faithful allies. The Crenet Company exhibit a set of three-cylinder 960 horse engines, of

much the same design; and Massaline, of Havre, has also worked to it in engines for the French navy, the design being that of the "type Marengo." The general structure of the engines is sufficiently described by the engravings.

DUVERGIER'S HORIZONTAL ENGINE.

WE give, on the opposite page, engravings of a horizontal engine, constructed by M. Alphonse Duvergier, of Lyons, which was engaged by the Imperial Commission to furnish power to Classes 50 and 51 of the Paris Exhibition. This engine embraces many peculiar points of arrangement and construction, and these we intend to describe in detail next week, when we shall give further engravings, showing the valve gear, &c.

WATER SUPPLY.—A correspondent of the *Times*, paying the Grand Junction Water Company 11l. a year for his water, states that on eight days in May last he received no water. On one occasion the interruption extended over four days, and on another for three days.

EXPORTS OF RAILWAY IRON.—The exports of railway iron from the United Kingdom were pretty well maintained in May, having amounted in that month to 65,412 tons, as compared with 67,749 tons in May, 1866, and 47,245 tons in May, 1865. In the five months ending May 31 this year, the total exports in this branch of the iron trade were 199,287 tons, as compared with 203,552 tons in the corresponding period of 1866. The exports have, however, only been maintained in the increasingly large deliveries made to the United States, which amounted to 87,299 tons to May 31 this year, against 43,666 tons to the corresponding date of 1866 and 12,288 tons to the corresponding date of 1865.

SHIPS BUILT.—Of the vessels above 50 tons built in the year 1866, 121 of 68,194 tons were built at the port of Glasgow, 149 of 59,254 tons at Sunderland, 44 of 27,961 tons at Newcastle, 88 of 23,667 tons at Liverpool, 82 of 17,734 tons at London, 18 of 14,276 tons at Greenock, 88 of 13,548 tons at North Shields, and 19 of 5087 tons at South Shields, 89 of 13,288 tons at Hull, 16 of 11,571 tons at Aberdeen, 24 of 10,689 tons at Port Glasgow, 9 of 6659 tons at Stockton, 8 of 6559 tons at West Hartlepool, 11 of 6476 tons at Middlesbrough, and 12 of 5997 tons at Dundee.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent, "C. F. Gower," is perfectly right, in his letter of July 6th, by saying that provision must be made for the drainage of waste water. Both rain water after it has been mixed with street dirt and household "slops" (especially those coming from the kitchens) retain many elements which forbid their discharge in such a condition in river's ear.

Where sewers on the old plan already exist, nothing better can be done than to continue to use them for these fluids, which, if the sewage proper is withdrawn from them, can be done without danger of any noxious gases arising, when the kitchen and street gullies are only properly trapped to detain remnants of food or other similar matter. As carts must be kept on hand in a town, any how, to remove ashes and household rubbish, such waste substances can be periodically taken out of the traps and removed by these carts at the same time without additional expense. The fluid will then not have any ingredients liable to rapid decay, the chief impurities being used up soap, &c., and can, without any agricultural loss or disagreeable exhalations, be made entirely pure by passing it, at the sewer-outfall, through a bed of Spencer's magnetic carbide. This is, I believe, a preparation of peroxide of iron, and has given, where tried for purifying river water for City Water Works, every satisfaction. Not only that the water is then really pure but the process is cheap.

When a city has no sewers, an arterial system of earthenware tubes will best and cheapest remove these fluids, which then also can be treated as described above. In either case, faecal matters must be removed by a separate set of pipes, as in Menzies's and my system, for it is only thus that the sewer gas nuisance can be prevented, and the full agricultural value of these substances retained.

I am, Sir, respectfully yours,

CHARLES T. LIERNUR.

2, Royal Exchange-buildings, E.C., July 15, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—I think little need be said further on the improvements suggested by Mr. Liernur. I will grant him that if he makes the vertical pan large enough, no refuse will adhere, but I will likewise add that it will require to be at least 15 in. in diameter, if not larger, consequently many things could be dropped down that would not pass through the 6 in. main pipes to reservoir. I need not mention what these things may be, as it is foreign to the question at issue, namely, keeping our houses in a sweet state, and likewise our streets. I say, in all kindness to your correspondents, that dry conveniences will never be introduced into London, or any other large town, when the said closets are placed in the house. I will not say that your correspondents are ignorant, but I would merely suggest to them to visit a place of the sort in some of our large factories, which, probably, one thousand men daily make use of, and they will find, though the back wall may be 2 ft. from the front of the seat, that it is covered with refuse, and it is this that makes dry closets very offensive. Such is patent to all. I was once requested to measure the quantity of water evaporated by one of Bury's four-wheeled locomotive rickers, years back. I told the locomotive superintendent I could not, upon which he got rather crusty; but when I stated that I had taken a dose of medicine the night before, he politely informed me that he would excuse me that day. Need I mention that no conveniently sized vertical pan would suit. The members of the Institute of Civil Engineers severely censured the engineer of Dundee for not introducing ventilating shafts in the main sewers. I beg leave to state to Mr. Bazelgette, the head that I presume controls our sewage works, that the traps are a disgrace to the age we live in. The town of Dundee is provided with hundreds of factory chimneys that will effectually draw out all the foul air, if means are only taken to do so. I may state that that gentleman has made experiments to that effect himself (there is nothing like reading up, I see, when such is not one's vocation), therefore, I state, erect such shafts in convenient places in this great metropolis, and he will effectually purify and keep London in a healthy state, but not before all or most of the traps are closed, and the gullies properly made. The most economical method of creating a draught I will leave for a future occasion.

And now about the "cholera epidemic." How does it reach us, and how are we in a measure to prevent it? Does it come floating in the air? Is it engendered in our filthy sewers? And will some good disinfectant destroy it? If so, then distribute such. Scour the air with, say, chloride of lime vapour, or some other powerful agent; puff it all up the towering chimney or shaft until the atmosphere above a town is thoroughly impregnated; and if the sewers are the cause, let the vapour in at one end, draw it through at the other, pass it through the purifying furnace, and let it go purified to the clouds; and where the shafts reach up as high, or nearly so, as the one at St. Rollox Chemical Works, at Glasgow, there is no fear of the slight smoke that may issue at the top troubling us. Your correspondent, Mr. Gower, is perfectly correct that the refuse from gas, chemical, paper factories, &c., kill the fish and pollute our rivers. When nothing but house refuse was precipitated into our rivers, of a sufficient breadth and current, there were lots of fish—that will not kill them, neither will the scavengers of the ocean. "O. O." sends greeting to "O." and begs leave to state he is a little wrong, as rain water is soft, and that in a well is hard; and in bidding adieu to Mr. Liernur for the present, I say, use the stuff for manure. I have done so on a small scale myself, and used to ken brawly how to cut and plant potatoes with the stuff, but it had an unco smell. I merely hinted at the expense of doing so on large farms, but if farmers are contented, so am I, and think I can yet let him see how to collect it far out at sea.

Respectfully yours,

O. O.

P.S.—You drew attention some time back to the bricks at the docks down at the Isle of Dogs. Look to the rubbish the sewers of Southwark are being built with; they have the consistency of dry mould, pressed together without passing through a kiln. Why they are cracked, ill-shapen; some have large stones imbedded in them; they are soft and porous, crumbling away before our very noses. Let those who doubt look themselves.

TO THE EDITOR OF ENGINEERING.

SIR,—Having once undertaken the advocacy of Captain Liernur's system for removal and utilisation of faecal matters, I cannot do otherwise but answer the objections of your correspondent "O. O." I must, however, confess to a great dislike in doing so, on account of his hiding himself under initials, and being evidently afraid or ashamed of putting his name and address under his curious productions. How do I know that I am not answering some poor lunatic, indulging, with the consent of his keeper, in a little harmless literary amusement? or, perhaps, some innocent schoolboy who merely likes to see others spar and kick and fight shadows? Surely his singular letters might well warrant such a supposition. There is nothing more irksome than to fight an individual whom you cannot well hit back, or, which is the same thing, to answer the wilful representations of an irresponsible anonymous scribbler. When, on the contrary, your adversary comes out boldly and shows his face like a man, you cannot but respect him, and treat him accordingly.

I can well understand Captain Liernur's statement to Mr. Taylor, "that he would be glad to come to Romsey and take a 'glass of wine with him.'" He evidently appreciates Mr. Taylor's gallant facing the attacks made on that unlucky British Guano scheme, and feels that, though this process is not all that could be desired, still its inventor, as his letters show, is a man and a gentleman. The case is just the reverse with "O. O." Not only that he persistently hides himself, but he wilfully misrepresents. His description of Captain Liernur's arrangement is untrue, and no engineer could possibly so misunderstand the matter.

It would be hopeless to follow "O. O." through his twisted sentences, obscure allusions, and mystifying entanglements, and, therefore, I cannot better refute "O. O.'s" misrepresentations than, instead of specially answering him, by simply giving your readers a brief description of that portion of Captain Liernur's plan which he has made reference to, namely, the privy arrangements. Under the seat there is a short wide tube without bottom, made of white stoneware. This tube, or funnel, is so shaped that the excreta cannot strike its sides, the rear being bent far back and the front part having a gentle slope; the opening of the seat being, besides, smaller than the upper circumference of the tube, falling excrements cannot but pass *free* through the lower end. This short funnel debouches into a vertical pipe leading into a cast-iron bend below, and being likewise large enough for allowing the excreta to fall without striking the sides of this pipe, there is never any water required to wash or rinse the funnel and vertical pipe, because never can any matter possibly adhere to either.

The excreta dropping down directly into the bend from a height more or less great, pound themselves into a mass of uniform consistency, which, on account of the large preponderance of urine, will at once be turned into a thin slimy slush, the paper mixed with it giving it a certain cohesiveness just sufficient for easy removal. This mass collects during the day in the cast-iron bend above alluded to, which is syphon-shaped, and placed just vertically beneath the opening of the privy-seat, the lower end of the bend connecting with a pipe which leads into the subterranean street-main. Where this pipe crosses the side-walk a valve is placed, the normal condition of which is to be always shut, hence there is no draught upwards. Now when a vacuum is made on the rear side of this valve, and the valve is suddenly opened, the result will be that the liquid faecal mud will be forced by atmospheric pressure out of the syphon, through the pipe, past the valve, right into the street-main and subterranean reservoir connected therewith. The valve, by means of a stout lever, is opened and shut again as quickly as a man can do it—the quicker the better, a mere second being sufficient, as repeated trials have shown. The operation corresponds exactly to the discharge of an air-gun.

When nothing has been collected in the syphon, air alone will rush in and assist in propelling forward the matter collected in the main. From the valve, the pipe and main are laid with a constant descending gradient to the street reservoir. In the "main" the excreta will move downward by gravitation as in Menzies's system, until, by the opening of a valve, a sudden pressure is brought to bear on the mass and push it through. The air is used here to supersede water and to prevent stoppages; it is admitted by a pipe which immediately connects with the large vertical privy pipe, and is prolonged up to the roof of the house.

When the cover of the privy-seat is removed, a draught of air sets in downward through the funnel, and then upward through the air-pipe above the roof, and thus removes whatever slight exhalation may arise from the fresh excreta below. Trials have repeatedly shown that all matter collected in the bend of the syphon is completely removed by the sudden rush of air when the street valve belonging to that house is opened. Past the valve, some of the matter may collect at the bottom of the pipe, and may even, as in Menzies's system, nearly or completely fill it up; but the moment a valve is opened, that matter will of course be driven towards the reservoir by the powerful and never-failing agency of atmospheric pressure.

To maintain the vacuum in the reservoir and street mains while the various valves belonging to the drainage group (of which the small reservoir forms the centre) are consecutively opened, the steam-engine continues to work the air-pump, while the sewage labourers are engaged in their work of opening and shutting valves without allowing a moment's loss of time between the up and downward move of their levers. Thus if there is anything in a syphon it will be removed without fail; if not, the street main will only so much the quicker be cleared out.

Captain Liernur's system is precisely like that of Mr. Menzies, with this most valuable difference, that pneumatic force instead of water is used for flushing the sewage pipes. This great improvement, in the first place, saves expensive water, and, in the second, prevents the dilution and consequent spoiling of the manure; it besides—and this is no mean consideration—avoids the deep location of pipes, which is indispensable in Menzies's system, to obtain sufficient hydrostatic head. The principle is undoubtedly good and correct, and there is no earthly reason why it should not be executed and accomplished just as proposed.

The manure obtained is, in the shortest and straightest way

possible, collected in handy air and water tight barrels, which, upon the advice of practical farmers, are made to contain just 5 cubic feet, weighing in all some 345 lb. Such a barrel is laid upon a little wagon or cart, and thus drawn over the land to be fertilised. The excreta, by repeated violent churning and moving, through atmospheric pressure, has acquired an uniform fluidity, and, therefore, flows easily and evenly from the barrel, through a short pipe strapped to it, into the furrows. By turning this pipe slightly to the right or left, the labourer may deposit the manure between the wheels of the cart wherever he pleases. By a small regulating valve the manure stream can be made as thin or thick as required. If the soil is light, a little ploughshare fastened to the same wagon can easily make the furrows for the reception of the manure; if, on the contrary, the soil is heavy and sticky, offering great resistance, a separate plough must drive ahead. In either case the manure is mixed with freshly ploughed land, and covered immediately afterwards by means of a small scraper, or any other light contrivance, fastened to the rear of the wagon, so as to follow the stream. The reasons for all this are obvious to every unbiased mind.

There is nothing whatever in the whole arrangement which is not perfectly simple and practicable, as even the most stupid farmer's lout understands to drive a little cart from which manure thus flows. Any arable land of sufficient stability to sustain a wagon is fit for this simple way of manuring. Any little farmer's cart can be made to serve this purpose, and no English farmer is so stupid as not to see at once, that to lay a barrel on a small cart and drive it over the land in the manner indicated is a far better way of handling manure, and mixing it with the soil, than the old fashion of first collecting the material on a dunghill, then carting earth to it to absorb the gases, then after a while shovelling the compost back again into carts and driving these over the land, then shovelling it once more out of the carts and spreading it over the soil as far as his arms can throw it, and then at last ploughing it in. What an amount of heavy labour will be saved by Captain Liernur's simple process! But "O. O.," who, to judge by his twisted language, seems to be fond of complication, will of course prefer the good old-fashioned style. There is no accounting for taste!

It is evident that, in the old mode, the farmer has to cart the manure over the land anyhow, whilst in Captain Liernur's plan the labour of carrying earth and the manure itself fore and backwards and handling both half a dozen times is saved; and therefore the latter mode is by far the simplest, and should be adopted by all progressive farmers.

I have not written this explanation for the satisfaction of "O. O.," whose lucubrations would really not be worth that trouble; but I deem it just that such a sensible, simple, and practicable scheme, within reach of every one both as to understanding and means of adopting it, should not be so grossly misrepresented as, for some reason best known to himself, has been done by our friend, O. O.

I am, Sir, yours respectfully,

FRANK C. KREPP, M.I.R.E.

6, Graham-terrace, Ridley-road, Dalston, July 10, 1867.

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—I have been an attentive reader of the controversy about the Corliss engine which has been going on in your pages, and I agree with your correspondent "Anonymous," in the opinion that much needless acrimony has been imparted into it. Mr. Salt's testimony in favour of the Corliss system is to the point, so far as it goes; and no doubt he must have thought favourably of the "rattletrap" valve-gear (as he terms it) before he consented to adopt it. But I cannot at all acquiesce in the justice of the remark you append to the correspondence, that the *onus probandi* rests upon those who think unfavourably of this system to make good their objections, the fact being that the onus lies upon those who advocate this novelty to show that it is really better than existing systems. All innovation upon established articles of belief is very justly subject to challenge and doubt, and if it has any valid title to the public confidence and approbation, it ought to be able to exhibit such reasonable grounds for acceptance as will be conclusive in the estimation of informed and unbiased minds. But it is rather a novel doctrine to maintain that no one is competent to give an opinion upon a new engine or machine unless he has first made or worked a similar one, as if all the knowledge acquired of engines in general was unavailing in illustrating the qualities of some particular one, and as if, in judging of mechanism, there were no such thing as general principles at all. If the Corliss engine finds it necessary to shield itself from criticism by a plea such as this, the circumstance is tantamount to a confession that it is unable to stand against independent criticism at all, since on what other ground could it claim to be judged only by its disciples and supporters? But not only would such a plea, if urged, be unwise, it would be wholly unavailing; and there is enough mechanical intelligence and independent engineering thought in this country to upset the verdict of any partisan jury who arrogated to themselves the exclusive possession of the knowledge necessary to discuss such subjects. Should you think proper to close your pages against the comments of all those who are unable to profess their faith in the Corliss system, other channels of discussion can no doubt be found; and it is incumbent upon those who advocate that system, either to show that it possesses points of superiority heretofore unattained, or to recede from the exuberant pretensions to excellence they have set up.

It is maintained by those who have been unable to discern the superior advantages of the Corliss system, that the valve-gear is complex, noisy, and a "rattletrap," which must either impose a low speed on the engine or else soon wear out. Mr. Salt says he drives his engine at a high speed; and no doubt any engine may be driven at a high speed for a time. But if the engine is ill adapted by the peculiarities of its construction for high speed, will not rapid driving increase the wear? And can any engine be well adapted for high speed, the gear of which is complex, and works with noise and concussion? It is true there may be compensating advantages to these drawbacks, and,

after all, if some momentous benefit is realised by this method of construction, the balance may be in favour of the system.

Now, there is no difficulty in making engines work with any desired equability. For some purposes great equability of motion is of little importance. But, where it is desirable, it can be obtained to any required degree of precision by using a sensitive governor, a heavy flywheel, and a swift piston. It is not necessary, therefore, to employ a complex valve-gear for the attainment of any such object as this, and the main purpose of the Corliss arrangements appears to be economy of fuel. It will be proper therefore to inquire what is the amount of economy obtained by the Corliss plan beyond that subsisting in other engines. It appears from the letter of Mr. Inglis in your last number—and the same thing has also been stated by other persons—that the consumption in the Corliss engines is about 2½ lb. of coal per indicated horse power per hour; and although we have no evidence adequately vouched for of so small a consumption, I am disposed to believe that this performance is not overstated. In many of the Cornish engines the consumption, however, is less than this. But dismissing those engines, which are single-acting engines, as not exactly comparable with the Corliss ones, and taking the case of ordinary rotative engines of moderate size, it will be found that the economy attained by the Corliss arrangements is not singular or unprecedented. On the contrary, it will not be difficult to adduce cases where the old-fashioned Boulton and Watt rotative engine without novelties in the arrangements at all is able to work with still greater economy than the Corliss even claims. For examples of such engines it is not necessary to go further than the New River Works, where several double-cylinder engines by Simpson and Co. and several single-cylinder engines of the common type by James Watt and Co. are regularly at work, and both of which varieties of engines, with the same measure of expansion, are found to work with equal economy. Some years since the late Mr. Joshua Field was professionally employed to ascertain the performance of some of these engines, when he found the duty to be 103.9 millions of pounds lifted 1 ft. high by 112 lb. of coal. But the Corliss engine, according to its own advocates, gives a duty of only 78.7 millions of pounds raised 1 ft. high by 112 lb. of coal, so that, on this showing, the Corliss engine burns one-third more coal than some ordinary engines heretofore in use. Wherein, then, is the compensating benefit of the system? If it is more complex than the old system, more liable to injury or derangement, and less economical in fuel, on what conceivable ground can its adoption be recommended? If, in spite of seventeen years of such argument, it has nevertheless gained a prominent position abroad, what does that prove? Only that the short-lived enthusiasm of ignorance is yet alight; that there are people who will have a new fashion, though it should be a worse; and that there are still persons in the world whom nothing short of their own painful experience will finally teach.

I am, &c.,
A CIVIL ENGINEER.

TO THE EDITOR OF ENGINEERING.

SIR,—Permit me to occupy a small space in your columns to reply to Mr. Douglas's letter in your paper of the 5th instant, and also, with your permission, refer very briefly to the letters published in last week's paper.

Mr. Douglas says I am despondent; I, on my side, think him over-sanguine as to his discovering the *beau idéal* of steam-engines.

If he has found perfection, I have not; and this may, in some measure, account for the difference between his views and mine. He says I approve of the principle of the Corliss engine. I confess it never entered into my head that any new principle was in question; all that the Corliss engine does has been done, more or less well, before; the only novelty being, as he calls it, the "unfortunate valve gear." In it I count no less than eighteen pins and joints, exclusive of those in the governor itself—ten to work the valves, eight to connect the governor. Now these same pins, however carefully fitted and hardened, are of all parts of a steam-engine those most subject to wear, and require to be replaced before any others show the like symptoms. When, therefore, I see the ordinary difficulty increased to such an extent, I may perhaps be pardoned for entertaining doubts as to the durability of the arrangement.

Then, as to the disengaging of the valve-rods, it appears to me highly probable that in a very short time the square and sharp edges of the projecting pieces on the springs must become rounded off, and leave a certain amount of play between them and the notches into which they fall.

Your correspondent, Mr. Inglis, in speaking of the engine referred to by Mr. Gill, agrees with me that the increase of power mentioned could not have been due to the superior cut-off valves. Of course not; he, however, makes no attempt to explain the anomaly pointed out by me.

I am, Sir, your obedient servant,

JOHN PINCHBECK.

27, Leadenhall-street, E.C., July 15, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—As your correspondent "W. H. N." asks me to explain the meaning of working "night and day," allow me to explain to him that it means "day and night." The engine referred to in my letter of 2nd inst. commences its week's running about one o'clock in the morning of Monday, and runs on till a late hour on the Saturday following, only stopping for oiling, or any other necessary purpose, within these periods. As most of our great industries are only carried on for ten hours out of the twenty-four, I think I was justified in saying that in three and a half years this Corliss engine worked equal to seven years' running of an ordinary factory engine.

Here are the terms in which the proprietor of this engine has written down his opinion of it after the above period of trial: "Every paper-maker who has seen it has been astonished at the work it does; if I had to put up another large engine, I would rather pay a good price for a Corliss than accept one on any other principle for nothing."

At present I am putting in a 24 in. Corliss cylinder to a modern beam-engine, in London, which has now a slide-valve and variable cut-off. Some of your correspondents may, per-

haps, care to see this when finished, as I verily believe ignorance is at the bottom of their opposition.

Bowing to your advice as to brevity, I must not dilate on the simplicity of "Observer" in mistaking for a Corliss engine an engine with quite different gear and poppet valves in the Swiss annexe. I trust he will repent his rash condemnation before he passes that bourne from which no traveller returns.

I am, yours truly,

ROBERT DOUGLAS.

Dunnikier Foundry, Kirkcaldy, July 16, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—Would it not assist the evidence respecting Corliss and other engines designed to effect economy in fuel, &c., if Mr. Salt, whose letter appears in your paper of the 12th inst., will obtain, for the benefit of your numerous readers, reliable information from the engine he names (as having "22 in. cylinder, 3 ft. stroke, 100 revolutions, and 100 lb. steam pressure in the cylinder," and cut-off at any part of stroke) as to the respective merits of condensation and non-condensation, either with or without superheating; in other words, what is the consumption of fuel per horse power per hour in this engine, with 100 lb. steam pressure in the cylinder, when producing an effective vacuum therein by condensation; and also the fuel consumed under the same circumstances, excepting that the steam is allowed to be discharged into the atmosphere at atmospheric pressure; and, further, the fuel expended when the pressure in the cylinder is 115 lb., to make up for loss of atmospheric pressure by condensation, the pounds water evaporated per pound of good coal at the same time being stated?

Will Mr. Salt also kindly state what pressure he will use in his boilers, and what pressure he will admit into the cylinders, of the "four large beam engines in course of alteration to the Corliss system of valve-gear"?

The attention Mr. Salt has always devoted to subjects of engineering interest, together with the ample means at his command, must be my excuse for pressing these questions.

Yours truly,

Leeds, July 17, 1867.

ECONOMY.

THE CORLISS VALVE GEAR.

TO THE EDITOR OF ENGINEERING.

SIR,—We scarcely need Mr. Inglis's assertion to believe that "in the operation of the Corliss engine there is no mysterious principle concerned." Nor is the consumption of coal he mentions exceptionally low, as many well-authenticated examples will prove. No doubt 640 feet of piston speed is very good, but many engines not on the Corliss system are working as fast, or faster, without noise or shock. I doubt how long the engine will work at that speed, and Mr. Inglis also mentions that this engine is *not yet* at work.

As "in the working of the Corliss engine there is no mysterious principle concerned," perhaps Mr. Inglis will explain how it can be "that a Corliss valve engine of the same size cylinder, and with the same pressure and speed, can do the work which an ordinary slide-valve engine will fail to accomplish." I see nothing in the Corliss system which would render this at all likely.

I conclude that your correspondent "Anonymous" is not an engineer; his letter is very unlike the production of one of these "obstinate, obdurate, in fact, iron and steel" class of men he so cleverly pictures. And were he an engineer, he would know that "massive framing," "greater length of stroke," and "well-balanced" valves, upon which he bases his opinion of alleged superiority of the Corliss system, are not peculiar to that system, nor are they novel features at all.

It is very little to say in the engine's favour that "the wear and tear during the first two years of its working is practically nil," since the same may be said of almost every well-made engine, nor does his comparison of the engine with the one displaced count for much in the way of additional evidence, as that is the same example instanced by Mr. Gill, and I fear that "Anonymous's" comparison may be as exaggerated as the tone of his letter. Such an engineer as he mentions must be a very useful man. If it be such a "pleasing labour of love" to examine one "idol," what would he feel if he were to examine the Pantheon to be put up at Saltaire?

With regard to your appended note, I scarcely know how to construe it. Allow me to say that as "in the working of the Corliss engine there is no mysterious principle concerned," I do not think it needs "extended experience" of that engine to enable one to form an opinion of its merits. However, I may mention that I have carefully watched the working of these engines, and have seen them both at home and abroad, and am certainly in a position to show that engines without Corliss complications, have long been able to perform all that the advocates of that gear assert that engines possessing it are able to do.

I am, Sir,

W. H. N.

July 16, 1867.

THE NORWEGIAN RAILWAY SYSTEM.

TO THE EDITOR OF ENGINEERING.

SIR,—While acknowledging the very able manner in which the 3 ft. 6 in. railway system, as adopted in this country, has been illustrated and described in your journal, I beg permission to draw your attention to a few minor points in your description, for the correction of which, in a future number, I should be obliged to you.

The length of sleepers is stated to be 5 ft. 7 in., which, according to my French description of the line, as given to you, is the length given. This, however, is an error which I had not observed before I saw your figures, their length being 6 ft. 7 in.

With regard to my introduction of spring cushions or india-rubber pads on the axle-boxes, my object has principally been that of easing the action of the rolling weights over the road, and thus in some measure reducing the wear and tear on rails and tyres, which is of great moment with us, principally in winter, when the hard frozen road proves most destructive for both. As a proof of this I may state, that the constant use of our wheel-lathes in winter can barely supply the demand on them, while

in summer they have comparatively easy work; now this I attribute to the entire absence of elasticity in the road, and my object in the use of these cushions has been to remedy in some measure this entire absence of elasticity in the road, and its effects upon the rolling weights on it, the springs alone not being quick and sensitive enough to effect this object, and remove the jarring action so well known in winter.

As I told you personally, my experience with this has been of too short a duration to give decided data of the results; yet from our trials we have every reason to expect much satisfaction from their use, the erection of the rolling stock being now very similar to that where Attock's body springs are used, but the spring cushions being applied under the framing, or immediately above the axles, are therefore more effective in reducing the wearing action, and at the same time are equally applicable to the whole stock.

In conclusion, allow me, Sir, a few words upon the mooted question of gauges. Although I agree in the main points of your remarks, you do not, in my opinion, give sufficient allowance or justification for the use of any other than the ordinary gauge. You will surely admit that, when circumstances such as an already developed system of the 4 ft. 8½ in. or any other gauge do not prevent it, another system of gauge, such as the 3 ft. 6 in., can undeniably, from its smaller proportions and its greater pliability in following the course of the country, be made at a less cost than a broader gauge, and therefore be a fit and proper one, when proved to be proportioned and sufficient for the requirements of the country.

Believe, me, Sir, yours truly,

C. PIHL.

Fra Jernbane-Direktoren, Kristiania, July 11, 1867.

ASSISTANT ENGINEER'S AND DRAUGHTSMAN'S BENEVOLENT ASSOCIATION.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad to see the above society appears in a fair way of being put in working order. Could we not have branches established in the various manufacturing towns throughout England?

I should be glad to hear if Mr. Bancroft (the first promoter) has given this a thought, or any other particulars he may think worthy of communication.

Manchester, July 15, 1867.

W. G. B.

TO THE EDITOR OF ENGINEERING.

SIR,—It is now about nine months since the above society was first suggested by R. M. Bancroft, and I am glad to see it is likely to take root and flourish.

I should like to ask the proposer, Mr. Bancroft, through your columns, how he intends to deal with country subscribers.

By putting this in your next issue, you will oblige,

Yours, &c.,

Derby, July 15, 1867.

AN ENGINEER.

[We know nothing of Mr. Bancroft nor of his scheme, and we think that draughtsmen will do well to await the co-operation of gentlemen of well-known standing and respectability before subscribing to such an association.—ED. E.]

THE ENGERTH ENGINE.

TO THE EDITOR OF ENGINEERING.

MONSIEUR,—Le numéro du 14 Juin de votre intéressant journal a publié, sous le titre "The Engerth Engine," un article fort judicieux.

Permettez-moi seulement d'y rectifier une légère inexactitude. Après avoir rappelé la transformation opérée dans les machines Engerth du Semering, l'auteur de l'article ajoute:

"Soon afterwards, the altering of Engerth engines got into 'fashion.' The Chemin de Fer de l'Est in France altered its Engerth locomotives in a similar manner."

Le découplément du tender, avec application d'un lest à l'avant pour assurer une bonne répartition, a commencé sur le chemin de l'Est, non pas quelque temps après l'opération analogue faite sur les machines du Semering, mais un an avant qu'il en fut question sur cette ligne. C'est dans le mois de Juillet, 1863, que j'ai provoqué, de la part de la compagnie de l'Est, la transformation d'une de ses vingt-cinq machines Engerth en machine lestée avec tender indépendant, et j'ai fait connaître les résultats de cette expérience dans l'article inséré aux "Annales des Mines," tome xvi. (5. série), 1859, page 141, sous ce titre, "Examen et Transformation des Machines Engerth," par M. Couche.

Aujourd'hui, toutes les machines de l'Est sont transformées. L'expérience m'a donné trop complètement raison pour que je ne tienne pas à revendiquer l'initiative d'une opération qui avait donné lieu d'abord à tant de critiques, et qui a été sagement imitée au Semering.

Agréez, Monsieur, l'assurance de mes sentiments très distingués.

E. COUCHE,

Ingénieur en chef, professeur à l'Ecole des Mines, membre du jury international, rapporteur de la classe des Chemins de Fer à l'Exposition de 1867.

Paris, le 15 Juillet, 1867.

VELOCITIES OF SHOT FROM AMERICAN ORDNANCE.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to my letter published in your number of May 24th last, enclosing results of some experiments made with American ordnance, my attention has been drawn to your note appended to these experiments, expressing doubts whether the initial velocity of 1572 stated in connexion with the kind of powder employed—the "Hazard"—was ever obtained, and it is explained that this is only a conventional number well known to artillerymen as expressing the strength of this class of powder, as may be inferred from the fact that in all the experiments, and with all the different charges and calibres, the number expressing this conventional velocity is precisely the same—a result not likely to occur, and, indeed, impossible to happen, in the experiments recorded. The American service it is represented is very

strict in determining the kind of strength of powder used in such experiments, which is known to the officers by certain marks always reported in reporting experiments with target practice; and during the experiments at the Washington navy yard, the initial velocity actually attained by the shot formed no part of the investigation, which was limited to the discovery of the power of certain shot, propelled by a given weight of powder of a given strength as indicated by a number expressing a conventional velocity to pierce the target. The actual velocity may be deduced with sufficient accuracy for ordinary purposes from the weight of shot, diameter and length of bore, charge and strength of powder.

July 17, 1867.

I am, Sir, &c,
JOHN BOURNE.

MONITORS.

TO THE EDITOR OF ENGINEERING.

SIR,—It is hardly necessary that I should take much notice of the minute carpings of Mr. William Watt, C.E., of Washington city, at the exposition I have laid before the public of the superior advantages of the monitor system of construction in ironclad vessels. No doubt if Mr. Watt thought he could answer any of my arguments he would have made the attempt; but, declining that task, he expends his ingenuity in the manufacture of insinuations. Now it in no way concerns any of my statements, whether the machinery of the Dictator is bad or good, or her speed great or small. I stated that her armour was thicker than that of any of our own ironclads, and that it was only by the monitor method of construction that great thicknesses of armour were sustainable. I objected to the Dunderberg in common with our own war vessels as being too thinly plated, but I never imputed imbecility to Mr. Webb, the designer of that vessel, any more than I did to the designers of our own ironclads, many of which are excellent specimens of construction, but are nevertheless too weak to repel the ordnance of the present day. I do not suppose that Mr. Watt or Mr. Webb himself would claim for the Dunderberg the attribute of beauty. On the contrary, she is a kind of "monster of the deep," and although the construction of such monsters is not only excusable but commendable where greater efficiency can be shown to arise from the irregularity, yet it is undeniable that in the case of the Dunderberg there is not even as much strength as in some more symmetrically formed vessels. Mr. Watt states that the armour of the Dunderberg is $4\frac{1}{2}$ in. thick, and he censures me for not having informed the public that 3 ft. below the surface of the water the armour of the Dictator and Puritan is only 2 in. thick, within 2 ft. of the surface only 3 in. thick, and within 18 in. of the surface only 4 in. thick, such concealment being, according to Mr. Watt, a disingenuous reservation, and merely one of the advocate's tricks to which he supposes I have descended. To all this I have only to reply that it would have been impossible for me to have made the statement which Mr. Watt blames me for withholding, for the simple reason that it is untrue. If the armour of the Dictator had been thinner than that of the Dunderberg, then she would, in this respect, have been a weaker vessel. But where the main desideratum is the power of carrying thick armour, I cannot see how the Dunderberg, with her $4\frac{1}{2}$ in. armour, if that is the thickness, can be preferable to the Dictator, with her 10 $\frac{1}{2}$ in. armour, if that is the thickness. Now the true thickness of the armour of the Dictator, which is 10 $\frac{1}{2}$ in., is shown in the transverse section of that vessel, published in my "Treatise on the Screw Propeller," and which section was also copied into your pages. Any one referring to that section will see that Mr. Watt's assertion that the thickness of the armour decreases in steps to 4 in., 3 in., and 2 in., is quite erroneous if my delineation is correct; and it ought to be so, as I obtained it from Ericsson himself. If, then, Mr. Watt impugns the accuracy of that drawing, let him distinctly say so when the fact of the true thickness can be established by independent evidence. If he does not impugn the accuracy of the drawing, then let him confess that he has been indulging in statements which are wholly erroneous.

But the monitor system is not to be hampered or resisted by such small cavils as these. Naval ordnance is growing in size and power, and armour, if applied at all, must be of adequate strength to resist these great engines. To enable the armour to be the thickest possible with any given displacement, the protected area must be reduced to a minimum, and this is precisely what the monitor system aspires to do and practically accomplishes. However bad or slow any individual vessel might be proved to be, that would weigh nothing against the system, for we know already that we can construct vessels that will be tight and fast, whether on the monitor system or any other; and the imputation of any accidental defect, even if it should exist, would be irrelevant to the main issue. I have no doubt Mr. Watt would say something very severe against the monitors, if he could only find it to say, but the mere manifestation of a hostile animus will not damage the system in the public appreciation. In our own country we have begun the construction of monitors at last, a result for which, I believe, we have mainly to thank Mr. Reed's perspicacity; for, whatever may be Mr. Watt's difficulties, Mr. Reed appears to be able to believe that, other things being equal, thick armour will be stronger than thin, and that, with a given displacement, the smaller the protected area, the thicker the armour may be made.

July 15, 1867.

I am, Sir,
JOHN BOURNE.

BRASIER'S FLAX-BREAKING MACHINERY.

TO THE EDITOR OF ENGINEERING.

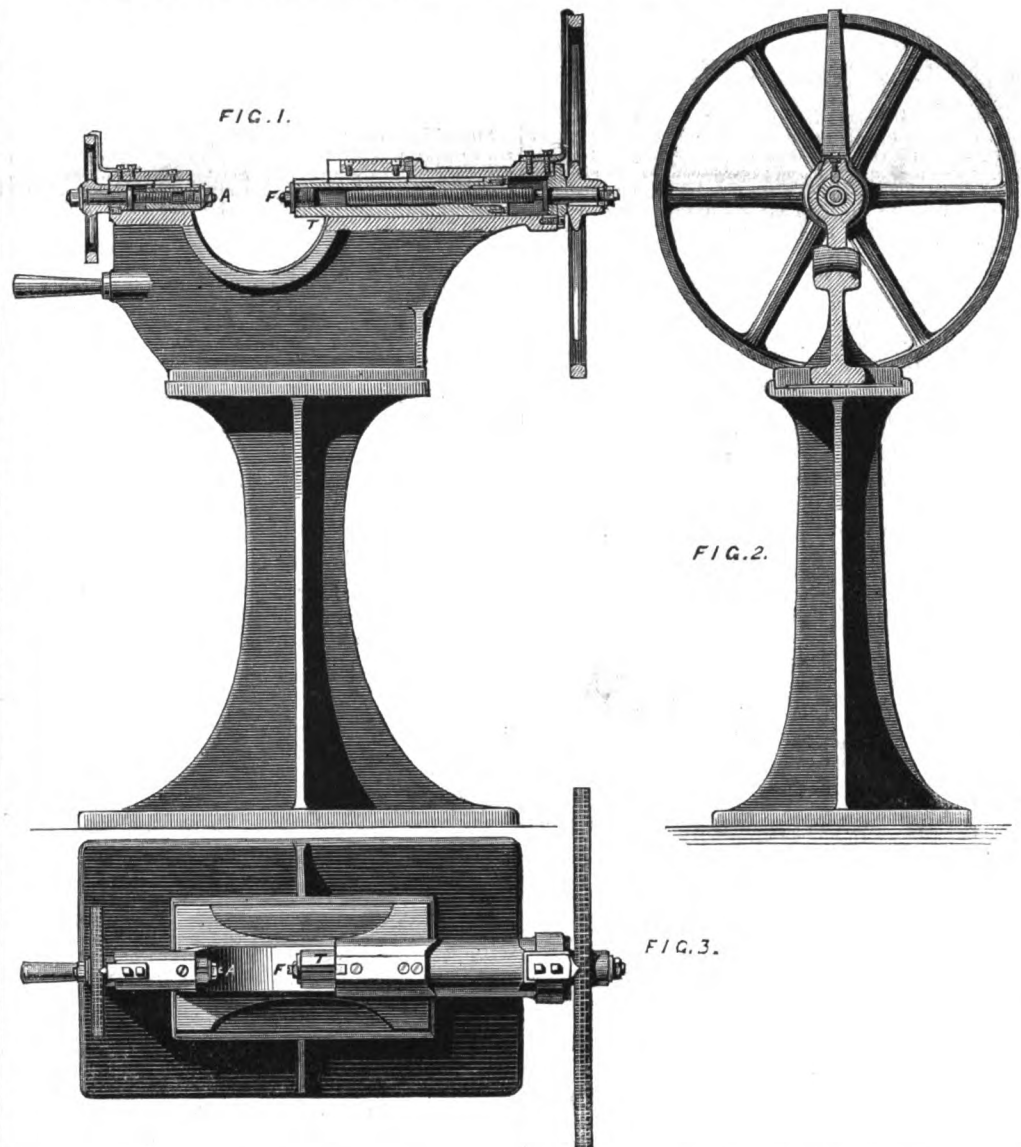
SIR,—We observe in your journal of last week a statement that "Brasier's flax-breaking and scutching machines in the Paris Exhibition were manufactured by J. E. Hodgkin, West Derby, Liverpool." We wish to correct this, as they were manufactured by us.

We are, Sir, your obedient Servants,
GARDINER AND MACKINTOSH.

Railway Foundry, New Cross, London, S.E.,
July 16, 1867.

MEASURING MACHINE.

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



WE give, above, engravings of a simple measuring-machine, made by Messrs. Smith and Coventry, of the Gresley Ironworks, Manchester, and used by them for finishing their cylindrical gauges to the standard sizes. The machine illustrated is capable of measuring sizes up to 6 in. in diameter or 6 in. long; and whilst it is strongly proportioned, it has at the same time been made as light as possible, so that it can be easily carried from place to place, and set up by the side of any bench where it may be required. The machine is intended for measuring by the sense of touch, and its parts are as follows: A and F are two cast-steel "feelers," the faces of which are hardened and finished so as to form a pair of perfectly parallel surfaces. The feeler, A, is adjustable by a hand-wheel, and screw; but when once set, it is fixed. The other feeler, F, is connected with a large micrometer wheel, divided at its circumference into 1000 equal parts, every tenth division being figure 1. This wheel is keyed on a perfectly accurate cast-steel square-threaded screw, $\frac{1}{4}$ in. diameter, this screw having 10 threads to the inch. As will be seen by Fig. 1, provision is made for taking up any backlash between the collar of this screw and the wheel. The screw works into the tube, T, which has an internal thread formed in it, and which is provided at one end with a screw-cut bush, which can be adjusted longitudinally, so as to take up any slackness caused by wear. The upper outside surface of the tube, T, has a V-groove formed in it, and this groove is nicely fitted with a key, so that no rotary motion of the tube can take place. The end of the tube, T, is bored out, and the steel feeler, F, is carefully fitted into it, a thread being chased upon the end of the feeler, which fits into the tube, so that it can be drawn tightly into its place. The hand-wheel on the left of Fig. 1 is also connected to the feeler, A, in a manner very similar to that above described.

Each ten turns of the micrometer wheel moves the feeler, F, longitudinally $\frac{1}{10}$ in., one turn moves it the tenth of an inch, a movement through one of the circumferential divisions, or $\frac{1}{1000}$ of a revolution, moves it $\frac{1}{10000}$ in., and a movement of the wheel through a quarter of a division—a distance readily measured by the pointer—moves the feeler $\frac{1}{40000}$ in. In using the machine, the tube T is screwed out to its full extent, and the zero division of the large wheel brought exactly opposite to its pointer. The small wheel should then be turned so as to force out the small tube until the feelers come precisely in contact with each other, but, as this cannot be done accurately enough by sight, it is practically easier to turn the large wheel back exactly ten revolutions, = 1 in., and then apply a 1 in. standard-size inter-

nal cylindrical gauge. If this will just pass down between the two feelers by its own weight and yet not stick between them so as to require to be pressed through by the operator, the machine may be considered set, and is ready for measuring. To measure the different sizes, the larger wheel is turned to the requisite number of degrees and the smaller one is left at rest.

THE WILSON FURNACE.

MR. E. B. WILSON, so well known as the former proprietor of the Railway Foundry, Leeds, is at last taking the iron-making world by storm with his furnaces. We have published several drawings of his puddling, re-heating, and boiler furnaces in different stages of perfection, and his last and best is now working at the Bolton Steel and Iron Company's Works, Bolton, puddling iron.

From reports before us, it appears that one of these furnaces, lighted at 2 A.M., July 8th, and laid off at 1 P.M., July 13th, made 75 heats, all pigs, consuming 31,588 lb. of coal, while the pig iron charged was 31,788 lb., or nearly ton for ton with the coal burnt. And the 31,788 lb. of iron charged gave 30,040 lb. of yield, with 15 cwt. of scraps besides. The furnace was heated, ready for charging, in one hour and a half, with 15 cwt. of coal, not of the best quality. This low consumption of coal, absence of smoke, and slight waste of iron in puddling are remarkable, and are causing much inquiry on the part of ironmasters at the works of the Bolton Iron and Steel Company.

MINING DISTRICTS.—The workmen of the Coltness collieries were locked out on Monday, and it is feared that the lock-out may become general in the lower and middle wards of the county, unless Messrs. Scott and Gilmour's men at Wishaw, who have been supported in their strike by the other colliers resume work at the reduced rate of 4s. per day.

DERING'S SPRING FASTENINGS FOR RAILS.

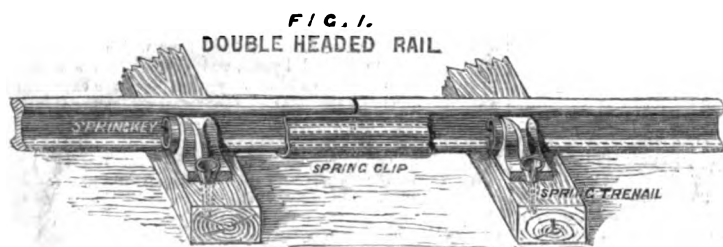


FIG. 3.

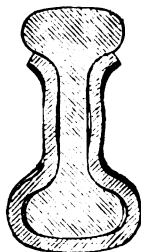
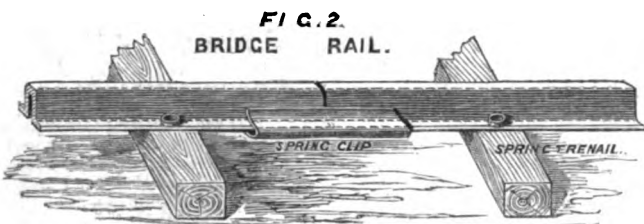


FIG. 4.

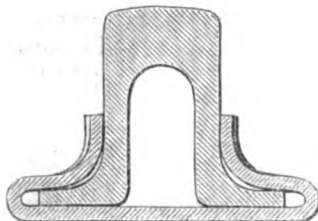
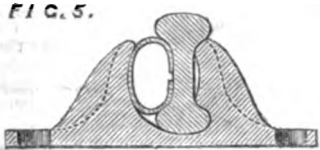
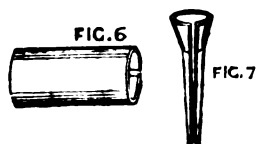
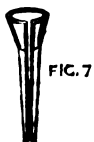


FIG. 5.



ABOVE are various illustrations of Dering's spring-clip fish-joints, spring keys, and spring trenails for railways, as exhibited at Paris, and which replace the iron fish-joints, and the wooden keys and trenails commonly used on railways by spring substitutes of tempered steel. These expedients are not now absolutely novel, having been before shown in the London Exhibition of 1862 and the Dublin Exhibition of 1865. But they will be quite new to many engineers now visiting Paris, and they proceed so much in the direction in which improvement must follow, by the substitution of steel for wood and iron, that we think no apology necessary for here reproducing them. Figs. 1 and 2 show the application of the spring-clip to both the double-headed rail and the bridge rail and examples of this method of junction are shown in some of the railways within the main building. It is plain that, if it be thought desirable, there is nothing to prevent the old joint-chair from being used simultaneously with these spring-clips.



Figs. 3 and 4 are cross sections of the same rails with spring-clip applied; and Fig. 5 represents a section of a railway-chair with spring-key applied to retain the rail, instead of the species of wooden key commonly used, and which is liable to shake loose, especially in very dry and warm weather. The spring-key itself is shown in Fig. 6; and Fig. 7 represents a spring trenail. These figures so fully explain themselves as to supersede the necessity of further description. To give efficacy to the spring-clip, the heads of the rails should abut against one another, especially if the joint be unsupported by a joint-chair. Probably some modification in certain of these expedients may be suggested to increase the efficacy. But, as they stand, these devices certainly constitute a step in the right direction, and in some form or other they will force themselves into more extended use.

RAILWAY ACCIDENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—Few engineers will have read of the recent dreadful railway collision, near Warrington, without asking themselves what steps have been taken to prevent the recurrence of such a catastrophe. It appears from the details brought before the public, that this accident is very similar to many others that have happened at various times from similar causes.

I can venture to state, the preventive for such accidents is very simple and inexpensive. It is merely to apply some method of locking the switch and signal in conjunction, such as the apparatus invented by Mr. Owen, and described in *ENGINEERING* a few months ago, under the title of "Switch and Signal Locking Gear." This, if applied, would, at a small cost, render it impossible for the switchman to leave open the points without having the signal locked to danger. If this simple apparatus had been in use at Warrington, it would, in all probability, have prevented the last terrible occurrence.

It is now coming greatly into use, but unfortunately in many cases not until some accident of this nature has occurred to point out its necessity.

Apologising for encroaching on your space,

Crumlin, Mon.

I am, Sir, yours obediently,

HENRY N. MAYNARD.

THE RUTHVEN HYDRAULIC PROPELLER.

TO THE EDITOR OF ENGINEERING.

SIR,—In replying to the observations which you did me the favour of inserting in your last issue, you have stated that you "attach no importance to the so-called competitive trials" of the hydraulic, as against other vessels with the screw or paddle; but "confine yourself to the fact that the Waterwitch showed 'miserably low co-efficients, and that it is clearly demonstrated 'from the data adduced that there was an enormous waste of 'power in driving her.' Permit me to say that you are completely in error in supposing that the Waterwitch showed 'miserably low co-efficients,' as compared with her sister vessels, the Viper and Vixen, the only three vessels in H.M. navy like each other, and capable of being, fairly, so compared with each other—in fact, they were built for the purpose. The co-efficient of the Vixen was 299, while that of the Waterwitch was 342, thus showing a very much higher and better co-efficient than her sister ship with the twin screw. And as for the 'enormous waste of power' that you mention, whatever waste there actually was, the twin screw must have wasted much more, seeing that she had such a very much worse co-efficient.

I leave it for you to reconcile, if you can, your opinions, founded on the evidence to which you refer, with these established facts.

W. B.

London, July 15, 1867.

[On her trial in October last, the displacement co-efficient of the Waterwitch was 101, and the midship section co-efficient 293½ (see *ENGINEERING*, vol. ii., p. 314). We leave professional readers to judge whether these were not 'miserably low.' Ed. E.]

THE PRIZES AT PARIS.

TO THE EDITOR OF ENGINEERING.

SIR,—I am glad you have taken up the subject of the awards to exhibitors at the Paris Exposition, and as a first step I would recommend you to publish, first, how the jurors were appointed; and, secondly, who the jurors were. I mean in the classes respecting machinery, engines, and steel and iron manufactures.

In 1862 every exhibitor had a voice in the choice of his jurors; in fact, they were elected by the votes of the exhibitors themselves. At Paris the exhibitors know nothing about them. I believe the class I exhibited under had for English jurors a couple of artillery officers, and a gentleman who, whatever his theoretical knowledge may be, has never been able to make it practically successful. Let us know by whom we have been judged, let us know who appointed them our judges, let us know also their qualifications for the office, and then we shall be able to form some opinion as to the worth or worthlessness of the honours conferred on

Yours faithfully,
N.

THE AMERICAN 15 IN. GUNS.—The *Army and Navy Journal* has an article on the 15 in. Rodman guns, in which it states that the American "mammoth" powder is so much weaker than ordinary cannon powder that 50 lb. of the former are practically equal to but 35 lb. of the latter. In the navy, however, the charge of ordinary cannon powder has now been increased to 60 lb., and in the American army, charges of 100 lb. have lately been fired from these guns, giving to the solid shot of 450 lb. an initial velocity of about 1600 ft. per second.

RAILWAY SPEEDS.

TO THE EDITOR OF ENGINEERING.

SIR,—You have frequently urged in your journal an increase of speed on our long-journey railways.

I enclose a tabulated statement of the present running of express trains to the chief towns on our nine principal railways, by which your readers may see what progress has been made towards the ultimatum propounded by you—60 miles an hour running speed, 50 miles an hour through speed on long journeys, including stoppages. The Great Western still holds the head of the list, though it has slowed all its principal trains very considerably this season. The South-Western, with its easy gradients, its splendid permanent way, and its admirable locomotive superintendent, only attains a through speed of 80 to 35 miles an hour.

Your obedient Servant,

Notting-hill, W., July 12, 1867. G. J. T.
TABLE of Speeds of Express Trains to the chief Towns on the nine principal Railways having Termini in London.

GREAT WESTERN.

Name of Town.	Distance.	Time.	Miles per Hour.
	miles.	hrs. min.	
Reading	36	0 44	49.1
Oxford	63½	1 23	45.9
Bath	106½	2 24	44.5
Birmingham	129½	3 0	43.1
Exeter	193½	5 0	38.8
Gloucester	114½	3 20	34.8
Birkenhead	228½	6 50	33.4
Weymouth	168½	5 15	32.1
Milford	285	10 0	28.5
Penzance	328	11 52	27.8

NORTH-WESTERN.

Rugby	82½	2 0	41.4
Chester	178½	4 23	40.7
Holyhead	264	6 40	39.6
Edinburgh	400	10 30	38.1
Perth	469½	12 19	38.1
Glasgow	405½	10 42	37.9
Birmingham	113	8 0	37.7
Manchester	188½	5 0	37.7
Liverpool	201½	5 30	36.7
Aberdeen	559½	15 55	35.2
Inverness	618½	18 5	33.9

GREAT NORTHERN.

Peterborough	76½	1 37	47.2
Manchester	201	4 45	42.1
York	191	4 40	40.9
Newcastle	275	6 55	39.8
Edinburgh	399½	10 30	38

GREAT EASTERN.

Colchester	51½	1 15	41
Cambridge	57½	1 30	38.2
Norwich via Cambridge	126	3 30	36
Yarmouth via Colchester	121	3 35	33.8

SOUTH-EASTERN.

Dover	88	1 55	45.9
Ramsgate	97	2 50	34.2
Hastings	74	2 12	33.6
Maidstone	43	1 20	32.3
Reading	67	2 45	24.4

BRIGHTON.

Brighton	50½	1 15	40.4
Portsmouth	85	2 25	35.2
Hastings	76	2 15	33.8

MIDLAND.

Leicester	97½	2 10	45
Leeds	201	4 45	42.3
Manchester	182	5 5	35.8

CHATHAM AND DOVER.

Dover	78	1 58	39.7
Clapham	34½	0 55	37.4
Margate	73½	2 25	30.5

SOUTH-WESTERN.

Basingstoke	47½	1 15	38.2
Exeter	171½	4 58	34.5
Southampton	78½	2 20	33.8
Portsmouth	74	2 20	31.7
Weymouth	147½	4 50	30.5
Reading	44	1 36	27.5

CIRCULAR METROPOLITAN RAILWAYS.

CRYSTAL PALACE.

London Bridge to Victoria (express)	17	0 35	29.2
" " (stopping)	17	0 55	18.5

NORTH LONDON.

Broad-street to Camden (express)	5	0 13	23.1
" " Kew (stopping) ...	15	0 48	18.7
" " Chalk Farm (stop.)	5½	0 25	13.8

SOUTH-WESTERN.

Cannon-street to Kensington ...	8½	0 27	18.9
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CHATHAM AND DOVER.

Ludgate-hill to Victoria (express)	7½	0 28	15.6
" " (stopping)	7½	0 37	11.8

SOUTH LONDON.

London Bridge to Victoria ...	8½	0 25	14.6
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METROPOLITAN.

Moorgate-street to Hammersmith	7½	0 37	12.6
" " Bishop's-road ...	4½	0 22	12.3

AERONAUTICAL SOCIETY OF GREAT BRITAIN.

A GENERAL meeting of members, under the presidency of the Duke of Argyll, took place on the 15th inst., at the Lecture Hall of the Society of Arts, for the reading and discussion of "papers" upon Aerial Navigation and the Principles of Flight.

The French aerial screw, brought from Paris by M. Butler, as promised at the last meeting, was now exhibited. Mr. Bright claimed it as his own invention, but it failed to elicit any remarks in its favour as an elevating and sustaining power, except from Mr. Bright.

The following communication from F. D. Artingstall, of Manchester, addressed to Mr. Frederick W. Brearey, the honorary secretary, was read by him to the meeting.

It may be remembered that the author's interesting experiments were described, under the initials of F. D. A., in the published Transactions of the society.

"Since I last wrote to you, I have been thinking over the experiment I made with an engine and wings attached to the end of a movable steam-pipe (as mentioned in my first letter to you). At the time when this experiment was made I did not attach so much importance to it as you might think it deserved, for this reason, that I supposed the power used to produce the effect of flight was tremendous compared with the small weight raised, and therefore in this respect no better than the aerial screw, for this would also fly beautifully at the end of a movable steam-pipe, yet, in my opinion, it is not a true flight. On more mature consideration of what I will call the "pipe experiment," I suspect I condemned it too hastily, and that it contained the elements of true flight, though not well developed. The steam was suddenly let upon the piston through wide ports by the valve flying suddenly open, therefore causing the wings to strike the air somewhat like a hammer, or the motion in cracking a whip. This is what I call the percussive action of the wing. The effect of such a stroke upon the air did not give an opportunity for "slip," and the buoyant power remained longer than the impact of the stroke. The affair may be said to have been an aerial steam hammer, of which the air was the anvil and the wings the hammer. Perhaps on this plan buoyancy could be maintained by very short strokes, and consequently with but little expenditure of power. I am no draughtsman, but I will endeavour before long to send you diagrams of the "pipe experiment," as it will, no doubt, be interesting to the Aeronautical Society, and perhaps instructive, for I begin to think it involves a vital principle.

Dr. W. Smyth, L.R.C.P. Edin., next read a paper entitled, "Experiments practically demonstrating the Laws by which Birds fly, and their application to an Aerial Machine."

Although it may be impossible to discover by experiments the actual power expended by birds during flight, yet if we can determine with a good degree of accuracy the greatest amount of power the muscles by which a bird is enabled to fly are capable of exerting, we must have an approximate idea of the power required to raise the bird perpendicularly from the earth, during which the muscles employed in flying are put to their greatest strain.

Strong-flying birds, as the pigeon, are able to raise themselves perpendicularly in still air, or fly at a velocity exceeding most birds, under which circumstances they exert their greatest power. During the flight of birds in a direct line, the resistance of the air is perpendicular to the surface of their wings, therefore neither of the pressures from either wing impels the bird in a straight line, but it moves in their resultant, and at a great waste of power.

A strong-flying pigeon, weighing 12 oz., with an extent of wing surface of 70 in., was fixed in such a way as to permit the face use of its wings, an arrangement was attached to both wings at a known distance from the insertion of the pectoral muscles, and to this a dynamometer, the wings being placed in the natural extended position; a current of electricity was transmitted along the line of the nerves leading to the pectoral muscles; the wings were instantly and strongly flexed on the body, or, in other words, struck downwards as in the act of flying, which the strain on the dynamometer showed the power exerted by the muscles was capable of raising 120 lb. one foot high in a minute.

Now it is to be remembered that if a falling body be taken as the standard by which to estimate the power necessary to raise the figure perpendicularly, it would require to use a power equivalent to 990 lb., which the pigeon certainly does not possess.

This was not from one experiment, as the paper would seem to read. The strain on the dynamometer was taken at different points in the arc through which the wing moves in its stroke, and the sum of all the efforts reduced to the mean for one gives the above sum.

The weight of the muscles by which this weight was raised was 986 grains, or about 2 ounces. The weight of a steam-engine to accomplish the same would be about 1½ lb. An electro-magnetic engine of any considerable power would weigh perhaps more than that of steam, while the weight of a non-metallic engine hereafter to be described would be about 1½ ounce.

The weight of the entire mechanism of the bird employed in flying was 4½ ounces, thus leaving 6½ ounces comprehended in the remainder.

It has been said that the mere perpendicular impulse of a plane is utterly inadequate in supporting a weight in air, and the use of artificial wings has been repudiated by some. This is strictly true in regard to most aerial machines that have been constructed, and though we had a power equal to ten horses for every pound in weight, it must remain so for all others as long as the conditions necessary to render them effective are not attended to.

The function of flight in birds is accomplished by means of an elaborate mechanical arrangement, delicately guided by nervous sensation, as the following experiments will show:

The wings of a pigeon, dried in the extended position, can be attached to a spring capable of putting them in motion (for a very short space of time, as it must necessarily be very light). And though this motion may resemble very much a pigeon's wings in the natural state, it will generally be found that they will be unable to raise any weight whatever, perhaps, in a series

of experiments. All at once they would seem to have caught the secret, and astonish the experimenter; generally, however, it would be only once. Now what is the virtue by which the pigeon is able to sustain such a weight, when the wings are attached to itself, and without which they can sustain nothing when attached to our machine? If we take the wing of a bird, dried in the extended state, in the hand and strike it against the air, by attending to the sensations communicated to our hand, we will feel that, during the stroke, and shortly after its commencement, the wing will experience considerable resistance from the air; in proportion as we pass this point will the resistance diminish; and when the wing is suddenly stopped, if the stroke has been a long one, we will experience pressure in the opposite direction from the column of air put in motion by the wing tending to impel it downwards; the further resistance during the extreme stroke added to this would render it utterly useless as a supporting machine. To derive effect, therefore, from the motion of a plane against the air, it is necessary that we should be able to arrest it directly we experience the maximum of resistance, which will be when the motion of the plane has overcome the inertia of the air, as compared with its velocity. There is a beautiful provision for this in the wing of a bird, as another experiment will show. The nerves of sensation in the wings of a bird convey to the nervous centres an impression when their wings have attained their maximum of effect on the air, and this by reflex action through other nerves cause the muscles to arrest the wings, and bring them back for another effort.

It follows that if nervous sensation preside over the act of flying as above mentioned, if we impose that function flight must become imperfect. It is difficult in a small animal like the pigeon to isolate the nerves of sensation from those of motion. However, there are some small branches, principally concerned in sensation, which can be divided, and their division renders flight almost impossible. The motion of the wings is in no way impaired, the bird beats the air more violently than before, and sometimes as if by chance it sits the proper measure and rises for a moment awkwardly, but the next strokes are ungaurded and bring it to the ground. It has become, in fact, an aerial machine. It is important here to notice that the wings of the pigeon are all this time putting an enormous quantity of air in motion, which is the case also with the wings attached to the spring, and is not so with the pigeon before the nerves are divided, even though it is fixed to prevent its rising.

Next, by irritating the ends of the sentient nerves connected with the trunk we excite muscular action in the extensors of the wings.

Beyond a doubt, could we divide every sentient nerve in the wing of a bird, flying would be impossible with all its perfection of mechanism and power unimpaired.

How much truth then is in the saying that a bird's wings seem to "feel the air," which they actually do!—an expression used by Mr. Artingstall in a paper read before the society.

In birds where the shape of the wing approaches to that of a plane, as the swallow and pigeon, there is a movement during the upward stroke, which permits the return of the wing with less resistance than if it were raised in a perfectly extended state, while in birds where the wings are much curved, as the heron and gull, no such movement exists, because the contour of the upper surface of the wing allows of its being withdrawn with the least possible resistance. The upward stroke of the wing differs from the downward in coming more slowly to a close. Birds disturb the air but little even with their most powerful strokes; otherwise with them flight would be impossible.

The importance of the resistance of the air on the inclined angle of the wing in supporting birds during flight has been fully shown by Mr. Wenham. We cannot place nerves in the wing of an aerial machine, but we can determine by experiment for each pair of wings, according to their size, form, and power, the proper angle and arc at which they will be most effective.

This must be at a great waste of power, as the conditions vary under which we are placed; but the same is true of every piece of machinery we possess. And we cannot admire too strongly the wonderful provision Providence has placed in the wing of a bird by which it is enabled, under ever-varying conditions, to fly with the smallest possible expenditure of power.

There are three practical difficulties in the way of aerial navigation: 1st, to rise into the air; 2nd, to remain there at wing; and 3rd, to get down with safety. Mr. Wenham has removed one of them; he has placed beyond a doubt that, had we an aerial machine constructed with "aéroplanes," once in air, provided we propel it at a given velocity, it must be self-sustaining, but it never would come down without being broken to pieces. There are a few elaborate planes by which it could be raised from the earth, those only possible at a very few places, but not one by which you could get down with safety.

The screw-propeller has been shown to be almost useless for the purpose of raising a weight, and therefore it is equally useless for letting down one. There remains no way but by means of wings to raise a body from the earth, and let it down again with safety. One great advantage we have over birds, we have a propeller superior to anything with which they are provided, and once in air have no occasion to use the wings, but fix them to act as "aéroplanes." Many persons when they calculate the extent of wing required for an aerial machine are confounded at their size. They say, why they would stretch from here to—Well, even they do stretch to any place you choose to name; put them on, there is plenty of sea-room in the ocean of air, and certainly no breakers ahead. We can construct them lighter in proportion to their size than those with which any bird is provided.

If we take a pigeon and bind its feet so as it cannot use them, after the first awkwardness of its position is over, it can rise from a stand 2 in. high by the efforts of its wings.

The following is a description of an aerial machine, the principle and design of which have received patent protection:

It was discovered, after a number of experiments, that it was possible to explode mixed gases in elastic india-rubber cells without injury to them, provided they did not exceed a certain size, were allowed to collapse, and a lot of water admitted after each explosion. Now, if we take an arrangement like an ordinary concertina and place it in an almost collapsed position, place as many of those cells as possible inside, and fill the sur-

rounding space with water; next, if we draw out the concertina a little, a small quantity of air will rush into the cells, and should they then be connected with a gas-holder containing hydrogen or coal gas, and the concertina drawn out a very little further, a much less quantity of gas will rush into the cells. Then suppose the mixed gases occupying the cells to be exploded by electricity, the expansion resulting from which would extend the concertina to its full length, and thus become a source of power. It is well known how every pound of force expended on water is exerted on the sides of the vessel containing it, and if some of them be immovable they become fixed points from which it acts to others, and thus renders effective all the force resulting from the expansion of the cells, which is one small advantage in the face of the many obtained through Tencor's metallic engine. Sheet No. 1 shows one form the engine may assume. In Fig. 1 the cells are in an expanded state, and in Fig. 2 collapsed. The means by which the air, gas, and water are severally admitted and out off can be efficiently performed without the use of metals. The calculated weight of a one-horse power engine of this description allowing one-fourth more than the actual sum would be 20 lb., which, compared with a steam-engine of the same power equalling 400 lb., shows a vast advantage in its application to aeronautics.

The form of the aerial machine to be as shown in the photographs, viz., cylindrical, with hemispherical ends adapted to the contour of least resistance, at one end a screw propeller, and at each end of the body a pair of wings proportionate to the size of the machine. The power as described above, and applied to move the wings, as roughly shown in sheet No. 2. The seats to be movable, and placed in a single row along the bottom of the machine, and arranged in such a manner so that by turning a wheel similar to that used for steering a ship, their positions may be altered at will, and the level of the machine preserved (sheet No. 3).

The entire framework of the car and wings to be composed of whalebone, over which gut has been very tightly woven. This is very important; any person who is acquainted with the manner in which it is done in the case of whips, is aware that the gut can be applied over whalebone with an enormous strain, thus diminishing its elasticity, and increasing its strength several times. In no other way can you construct wings of any great size, and have them effective, and thus made, with fine silk as a covering, they are lighter in proportion to their size than those of any bird.

The framework of the machine to be covered with silk, supported at the ends by a strong network of the same material. Suppose a machine constructed as above, to be 35 ft. in length by 5 in. diameter, with a propeller driven by a one-horse power engine at one end, two pair of wings moved by two horse power each, in all equal to five horse power, and weighing only about 100 lb.; 16 ft. in the body of the car to be filled with coal gas, which would supply the engine for four hours, or if prepared hydrogen, developed from zinc and sulphuric acid, which would add nearly another 200 lb. to the weight of the machine. It may here be observed that the weight of zinc necessary to be burned in sulphuric acid to obtain a given power in an engine of this nature equals the weight of coal to be burned in atmospheric air to obtain the same power. Now, it may be remembered that in the case of an electro-magnetic engine, it has been shown as the result of a great many experiments, that the best theoretical result from the heat equivalent to the solution of a grain of zinc in a battery is 80 lb. raised one foot high, while a grain of coal in a steam-engine raises 143 lb. one foot high.

A machine so constructed should raise over 10 cwt., including its own weight, from the earth, and would travel with a velocity far exceeding any bird. The supports on which it rests when on the ground are curved, so that when raised from the earth they can be turned round, and will then coincide with the body of the machine.

In experiments with the non-metallic engine, I have used cells from the capacity of a drachm to an ounce; and though the fastenings in every case have been made with elastic glue, which softens below a temperature of 100°, they have never given way.

Accustomed as we are to the steam-engine, working with all the power and accuracy which metallic resistance gives, we can scarcely think of an engine composed of light material without feeling very much akin to the ridiculous. But assuredly we must apply power without the use of metals, otherwise we may close our investigation in aerial locomotion.

There is one objection likely to be used against the non-metallic engine, viz., the want of resistance of the materials to be used in its construction. Now it has been shown by a number of experiments that a cylinder of hemp cordage, 1 in. in diameter, and glued together, can bear a strain of 92,000 lb., while a cylinder of wrought iron of the same size can only bear a strain of about 55,000 lb.

THE CLEVELAND IRON TRADE.—There are now nine furnaces in blast in the Cleveland district, leaving twenty-one out of blast. The depression in the home railway market is affecting the rail trade. Shipbuilding prospects are, however, considered better.

REPORTS BY ENGLISH ARTISANS ON THE PARIS EXHIBITION.—A laudable effort is being made by the Paris Excursion Committee of the Working Men's Club and Amateurs' Union to turn to good account the visits of the large bodies of English workmen whom they are sending to the French capital. By the exertions of Mr. A. H. Lazard, M.P., the president of the committee, the French authorities have been induced specially to open several valuable institutions to these excursionists, as well as to give every aid in the acquisition of information. A prize fund is also established by the committee for awards to the authors of the best reports on certain specified branches of industry, towards which a grant of 250l. has just been made by the Science and Art Department. Information regarding this important subject may be had at the offices of the committee.

THE RUSSIAN RAILWAYS.—A despatch from St. Petersburg, published in yesterday's Times (18th inst.), states that the St. Petersburg and Moscow Railway has been sold to Messrs. Wymann, an American firm. This is more probably the Messrs. Wymann, who have so long worked the line by contract. They are the owners of the well-known Winans yacht, or cigar ship.

AGRICULTURAL ENGINES.

In the language of the turf, all horses after the first three or four in a race are said to be nowhere. They must be either first, or very near the first, or nothing. Yet the losing horses are somewhere, and generally not very far behind; for while the best horse in the Derby will go 32 miles an hour, few are entered which will not do their 25, and most of them are safe for 30 or very near it. But the differences in horses are constitutional, although much may be done by breeding and training to lessen them. In the case of steam-engines, however, there are fixed laws to work upon from the beginning to the end, and why should not one engineer make as good an engine as another? The answer, of course, is, that different engineers have not the same knowledge and skill; and, which is also important, the same ambition to excel, and, in the case of some, indeed many, manufacturing engineers, they have not sufficient capital. And yet, in the case of agricultural engines, the makers copy one another in true Chinese fashion, and the great object with most of them appears to be to keep as closely as possible to the outward forms adopted by the one great leading firm. Why, then, at the Derby of the Royal Agricultural Society, were not the engines tolerably well together at the winning-post? Why were so many literally nowhere?—too far off to be seen with the naked eye. Look at our own carefully calculated columns of results, as given in our last number. Take the nineteen single-cylinder engines in the first series of trials. One engine burning four times as much coal as another for a given work! But two burnt less than 4 lb. of coal per effective horse power per hour; four were between 4 lb. and 5 lb., three were between 5 lb. and 6 lb., four were between 6 lb. and 7 lb., two between 7 lb. and 8 lb., and four more actually ranged from almost 9 lb. to almost 13 lb.! We shall have something to say, presently, of the nature of this first series of trials, but even in the second series, which was better calculated to bring out the real capabilities of the engines, the range of consumption of coal was from 2.54 lb. to 7.99 lb., while three of the greatest delinquents in the first series did not show up at all. We will not repeat the names of those who so failed in their duty—and engineers know what we mean by duty, and that failure in duty constitutes delinquency. It would have been merciful to those who burnt beyond 6 lb. of coal per horse power per hour to have made no entry of their performance, but we had our own duty to perform, and this demanded the publication of all the facts. A contemporary has given a most thundering account of the trials, in which (apparently in order to spare the feelings of the unhappy engineers who were nowhere, gentlemen whose further services to the profession might well be dispensed with, except the greatest service of all—that of taking themselves off altogether, to Australia or anywhere) the results are so skilfully hashed that it is impossible to make head or tail of them, and the engine which swallowed its 13 lb. of coal per horse power per hour, and of which the mechanical structure is nearly as bad as the dynamical performance, is thus spoken of:

"Agricultural engineers have not yet learned how to build racing traction-engines, and Mr. —'s engine is certainly not in any sense a racer, but simply a commercial engine, and the distinction is not without its importance."

Confound your "commercial engines," you ten gentlemen and firms at the end of the list, not because you happen to be at the end, for defeats are often honourable, but yours are every one of them inexcusable, and at least four of them are most disgraceful. Stick it in your catalogues, "This is the engine, or a brother of it, that burnt its 8 lb. of coal per horse power per hour at Bury." "This burnt 10 lb., and 'this 13 lb.!" That famous locomotive engineer of thirty years ago, John Gray, of the Liverpool and Manchester Railway, maintained that the consumption of fuel was a tolerably close measure of the working expenses generally, and experience with most kinds of steam machinery has shown this to be very often true. And the farmer should register a vow, and religiously act upon it, never to deal with an engineer whose engines burn more than 6 lb. of coal per horse power per hour. Every member of the Royal Agricultural Society—and it numbers over 5000 members—has already received a copy of last week's *ENGINEERING*, in which the competing engines are set down in their order of merit, in hard compact tables of inexorable figures, dealing out omnipotent criticism, not such as frail human opinion may clothe with words, or, to be Frenchified, in *chic*, still less the ignorant twaddle of the pretended pro-

fessional criticism from which we have quoted above, and to which a small section of agricultural engineers were treated last week by an obsolete authority.

Among a large number of agricultural engineers—for we must call them so by courtesy—there is a great want of knowledge of what is going on within their engines when at work. What can be expected of engineers who never use an indicator, who think it a conjuring contrivance or a finical rattle-trap which they don't need or can't afford? What of makers of portable engines who have no friction-brake in their works, and perhaps would not know what one was if they saw it? "Oh no," they say to the now and then, but not often, credulous farmers, "we don't make 'racers, but good commercial engines.'" Commercial with a vengeance, and what a mantle of engineering incapacity is that long-suffering word! And, poor souls, these agricultural "engineers" actually knew no better than to go to the brake at Bury like lambs, or sheep rather, to the slaughter, and well-nigh a dozen of them are cold mutton now, and unsaleable at that! What revelations would indicator diagrams from some of their engines afford! Water, perhaps, going through the cylinder by the bucketful, or the steam taken nearly all at one end of the cylinder, or the engine choked with back pressure and compression till it is almost a wonder the fly-wheel does not run backwards of its own accord! What curious proportions of lap and lead, what allowances of steam and exhaust openings, what miracles of valve-setting, what jamming or else what blowing of piston-rings, &c., &c., &c.!

Why is there not more "talent," or rather common knowledge? One of the leading agricultural engineers in the kingdom has asked us within the last three days to find for him a draughtsman who is well up to the best practice and in the theory of high-pressure engines; a thorough mechanic and a man of sound judgment; and although an advertisement would instantly bring five hundred applications, we do not know where to lay our hand upon the right man, unless it be that we have just such a one in our own office, and are, indeed, asked for a copy of him; for we cannot part with him, nor is it likely that the salary, though reasonably good as such things go, would tempt him. And how few capable designers there really are! So many must go in leading-strings, and so many who think they can go alone, are so crotchety, and if they had their own way would have their employers in the *Gazette* in six months. The schooling for engineering draughtsmen now-a-days is a Chinese school, and it consists in copying, sometimes from the best models, oftener from indifferent works, sometimes from the worst. See the draughtsmen cribbing sketches. Although many are too lazy, and therefore like to say they are too honest, for such work. Honesty! We never yet saw an ambitious draughtsman who was over-honest in sketching. But nobody teaches them principles. They get something from Rankine, and although personally he is not a curmudgeon (*non! non! pas de cœur méchant*), he is professionally a brack. His books are good stuff, to those who can read them and understand them, and there are not many who can. If the Institution of Mechanical Engineers were not so exclusive and close in the publication of their papers, some of these would form good food for draughtsmen. We say some, but not many. Few deal in principles. There are but few such as Buckle's splendid paper, the first ever read before this Institution, on blowing-fans, or Froude's on the friction-brake, or Thomson and Pole's on compound engines. We need a school of steam engineering—even more important to us than our school, already established, of naval architecture.

But we have a word to say of the system of trials of portable engines, as established by the engineers of the Royal Agricultural Society. They have done good, as we said, last week, by stimulating the efforts of agricultural engineers, and no doubt they are fair, being the same for all engines. But as tests of the real working economy of ordinary engines they are ridiculous, and only those who build their engines expressly for these trials, and not for sale, can hope to win at them. The ordinary run of portable engines are entered for trial at a number of revolutions corresponding to a piston speed of from 240 ft. to 300 ft. per minute, and the higher the speed entered the worse for the engine in most cases. If we take a mean piston speed of 280 ft. per minute (that is, 120 revolutions per minute for a 14 in. stroke), we shall find that single-cylinder engines are loaded on trial to but 15 lb. mean cylinder pressure per square inch, over and above that, perhaps 3 lb., necessary to overcome the friction of the engine while working at that pressure. In other words, with 50 lb. steam in the boiler, only

a mean of about 18 lb. is allowed in the cylinder, the brake being loaded to correspond only to that amount. Unless the engine be set to cut off very early on the stroke, and single-cylinder engines going at a slow speed (for 120 revolutions is slow) seldom are, the waste of steam by throttling and wire-drawing is simply enormous, the back pressure bearing a very high proportion to the total pressure. The interest of the agricultural engineer lies in entering his engine at the lowest permissible speed, and thus getting a brake load in the same inverse proportion greater, and in then overrunning as much as the judges will let him; and, take note, that Clayton and Shuttleworth were allowed to overrun their nominal revolutions, on one trial, nearly 50 per cent., giving an hour and a half of mechanical time for every hour of actual time. We have shown, elsewhere, how Nalder and Nalder defeated themselves by entering, in their Wiltshire honesty, their engine to run at 440 ft. of piston per minute, whereupon just 9.6 lb. of mean cylinder pressure, over and above that due to the friction of the engine, was allotted them. They have much to answer for by thus damaging the cause of high piston speed by their consummate simplicity. But even at two-thirds or one-half the speed, no engine without great expansion could hope to win at the first series of trials, merely because the assigned load corresponds only to a wastefully low mean cylinder pressure. Come, you agricultural iron-founders and implement-makers, dabbling in steam-engines, get yourselves an indicator at Elliott's, and a book to tell you how to use it, or hire a lad from Penn's, or a young man from Crewe. Learn how to make the most of 50 lb. of steam, and then, under the present ridiculous system of trials, enter your engines at a nominal speed corresponding only to the mean cylinder pressure which gives the best work from this steam, expanded as much as you can profitably expand it. Do you twig, or do you need to be thrashed again at the brake, at the next trials, four years hence? As for the second series of trials, with 50 per cent. load above the nominal power, they gave better results all the way through; but engines which had been made to do their very best on the first set of trials did not come off quite best on the second set. The Reading Ironworks Company really made the most wonderful performance. Their engine was fitted with an adjustable cut-off, and in the first series of trials, when the steam had fallen too low to keep up the prescribed rate of revolutions, the admission of steam was altered by hand, while running, so as to follow longer on the stroke, and in this way the engine gained a few minutes beyond what would have been possible with a fixed cut-off.

If the little agricultural engineers are teachable, and have a particle of ambition to stand somewhere near the great firms, they will find a world of teaching in the results booked at Bury, and how tremendously they will have to pull up before another trial comes off.

THE TELEGRAPH TO INDIA.

We have on more than one occasion commented on the defective administration of the telegraphic service between this country and India; and, in spite of the probable advantages to be derived from this country forming one of the signatory powers to the Paris telegraphic convention, we have all along been impressed with the conviction that nothing short of an independent line, under the exclusive management and control of an English company, or the Government, and with an entire staff composed of British subjects, could, in the long run, satisfy the demands of the public, and secure to this country a line of communication, not liable to interruption, with our Eastern possessions.

Among the first joint-stock companies of any importance, which the restoration of confidence in the money market has induced their promoters to submit for the support of the public, are two schemes for effecting this very object, the one by the Anglo-Indian Telegraph Company, and the other by a company promoted by the Messrs. Siemens, of London and Berlin, whose prospectus, however, has not yet been issued; besides which there is another company about to seek the support of capitalists under the title of the India, China, and Colonial Telegraph Company, with a proposed capital of 700,000*l.* for the construction and laying of a cable from Falmouth to Gibraltar, and thence to Malta. As many doubts may arise as to which of these companies should receive the greatest amount of public patronage and support, it is our intention now to examine into the relative merits of the proposed schemes, and in doing this it will be necessary to divide the subject into three heads, viz.: 1st, as

to the cost of construction and maintenance of the proposed lines; 2nd, the probable ultimate employment of the lines; and 3rd, the value of the lines from a commercial and political point of view respectively.

We have already given an outline of the proposed schemes of the two first-named companies, but for convenience sake we will here briefly repeat them. In the first place, then, the Anglo-Indian Telegraph Company propose to use the existing lines as far as Susa, where the French lines end, and from thence to Modica in Sicily they will lay a cable for which an exclusive right has been granted to the company, by the Italian Government, for forty-one years. From Modica messages will be passed to Malta by a line belonging to the Mediterranean Extension Telegraph Company; from Malta to Alexandria, by the cable laid in 1860, which it is proposed to lease from the British Government for a term of forty-one years; between Alexandria and Suez, by an overland line belonging to the Telegraph to India Company, which it is proposed to lease for twenty-one years, with the option of purchase; and from Suez to Bombay by 3650 knots of new deep-sea cable. The promoters of the second scheme propose to lay a cable between the English and Prussian coasts across the Channel, joining which would be an overhead line passing through Prussia and Russia as far as the Black Sea. Across the Black Sea a new deep-sea cable would be laid, 280 miles in length, between the Crimea and the Circassian coast, which would ultimately join the existing lines through Persia, and along the Persian Gulf, to Kurrachee and Bombay. From Bombay both companies, it is believed, contemplate an extension of their lines to China and Australia; but, as this latter part of their programme is not proposed for immediate execution, its consideration may for the present be deferred. Indeed, this portion of each scheme, supposing that only one of the companies should succeed in raising its capital, must depend upon the commercial success of the line between this country and India, for if that did not pay there would evidently be extreme difficulty in raising capital for its extension; and if both companies succeed in starting into life, the same remarks would equally apply, but in this case, if the capital for an extension to Australia were raised, it would certainly be by that company which could pay, out of surplus receipts of its line to India, the largest dividends to its shareholders.

With regard to first cost, there can be no doubt that the route through Prussia and Russia would be the cheaper of the two, as it would consist almost exclusively of overhead lines, whilst almost all the new lines to be constructed by the Anglo-Indian Telegraph Company consist of deep-sea cables. On this point, therefore, the overland scheme should have the preference; and, as the amount of capital required for its completion would be the smaller of the two, it would, apart from other considerations, be the easier to raise. On the subject of maintenance, however, the case is quite reversed. Overhead lines, being exposed always to atmospheric influences, require frequently to be repaired, and new posts, new wires, and new insulators would be continually necessary, especially in winter, in Russia, where ice collects upon the wires and breaks them down; whereas deep-sea cables, when not subject to any direct mechanical injury, do not require this constant attention. When, however, an accident does occur in deep-sea cables, of course the delay and expense in repairing it become an important item which must not be lost sight of in weighing fairly the relative advantages of the two schemes. When an overhead line becomes injured, the injury is confined to a certain spot; a few yards of wire, a couple of labourers, and a day or two at most, are probably all that is necessary to put the line again in repair. But when a submarine line gets an injury, the whole cable becomes utterly useless for an uncertain period of time; it must be fished for, hauled up, underrun, cut, tested, rejoined, and resubmerged, all which is costly both in time and money. The success which attended the repairing of the Atlantic cable only a short time back is, however, a proof of the certainty with which such repairs may be effected, and all inconvenience from injury to a cable may clearly be, with tolerable certainty, avoided by having a second cable, as is now the case with the Atlantic Telegraph. This, however, entails considerable additional expenditure, and a large capital must be raised in the first instance if the submarine portions of the line are all constructed with second cables. The proposed overland line, *via* Russia and Persia, must therefore, in regard both to construction and maintenance, be admitted to possess advantages in point of cheapness over the alternative or Red Sea line.

With regard to the probable ultimate employment of the line, so far as through traffic between England and India is concerned, there appears no reason why both schemes should not be carried out, since the effect of competition would have the effect of stimulating both companies to offer the greatest possible convenience to the public, and it would tend besides to keep the rates down considerably below what they would likely to be under a monopoly; and, as the two lines would not, in any way, interfere with one another excepting for through messages, they would each enjoy the sole command of all short-distance messages over their respective routes. Thus the public are directly, as well as indirectly, interested in the establishment of both companies for the construction of telegraph lines to India. With regard to intermediate stations, the Anglo-Indian Telegraph Company's line would possess incalculable advantages over the rival route, as it will traverse those places touched by the Indian steamers, and by which the mails, passengers, troops, and overland merchandise, passing between England and India, are forwarded. This advantage is scarcely to be estimated, as it affords innumerable facilities for orders and communications under way; whilst the other line, passing through towns which are important enough, perhaps, in their way, but which have no direct communication with the halfway houses, would only be useful as a terminal line having a less direct bearing upon, and less applicable generally to, Indian traffic.

The value of the respective lines from a commercial point of view is so nearly associated with the foregoing question, viz., the probable ultimate employment of the line, that we have already to a great extent disposed of that part of the subject in the previous paragraph. The line which merchants would prefer to use must unquestionably be that which follows the route by which their correspondence, and, in some cases, their merchandise, is sent. The conveyance of troops by the overland route to India will of itself cause a considerable increase in our commercial relations with Egypt, when the necessity for a direct line of telegraphic communication will more than ever be felt. The facilities which this line also would afford to officers, on their way to or from India, for communicating with their friends may, not improbably, prove a source of considerable traffic, and which, coupled with the commercial advantages of the line, would fully justify a larger outlay on its construction than could, with any prospect of remunerativeness, be borne by the line *via* Prussia and Russia.

Politically there cannot be the slightest hesitation in determining between the relative advantages of the two routes to this country. According to all that can at present be foreseen, Russia is our only rival, or, rather, is the only nation likely to become a rival to the British supremacy in the East Indies; her armies are, even now, step by step advancing nearer and nearer to our northernmost outposts, and the voice of warning is constantly sounded, by means of the Indian press, to the fatal consequences that may arise from our persistent policy of inaction. To sound the alarm on this subject is commonly attributed to an attack of *Russophobia*; but, supposing the day were to arrive when the fears of so-called alarmists became realised, and the British armies in the East were called upon to contend with the mighty forces of Russia for the possession of our Indian empire, what would then be the probable advantage of a line of communication running through Russia? and if we were dependent upon that line alone for obtaining and conveying messages to and from India, messages, probably, of the greatest possible political or military importance, what might not be the disastrous result and consequences if the Russian Government, for its own purposes, deprived us of the use of it? On the other hand, by the co-operation of the India, China, and Colonial Telegraph Company's line from Falmouth to Gibraltar and Malta—which, if constructed, it might be found mutually advantageous to the two companies to unite with the lines of the Anglo-Indian Telegraph Company's wires at Malta—the Anglo-Indian line would render this Government entirely free from any such chance interruptions, and enable them to convey orders direct to the two important stations of Gibraltar and Malta, besides communicating with troops *en route* between England and India. That which tends to increase our commercial relations with any parts of the world also increases the importance of our political connexions in those parts, and it may therefore be assumed that that line of telegraph which would serve best the requirements of commerce will also prove the most desirable for political purposes; and, as we have already shown, for military purposes the same line

would, in this instance, also be of the greater importance. Under these circumstances it might, not unreasonably be expected that Government should give some direct support or encouragement to that line which so eminently excels the other in political and military importance, were they not indirectly pledged to support the opposite scheme, for the Persian and Persian Gulf lines are in Government hands, and they have already promised special privileges to the messages sent by the company over those lines.

The two projects must therefore rest entirely upon their respective merits; and each possesses advantages over the other which we have endeavoured clearly to point out, and which may thus be briefly summarised: The chief advantages of the Russian and Persian route are economy in first construction and facility for effecting repairs, whilst the other route has been shown to be less liable to derangement, and of the greater importance from a commercial, political, and military point of view. The political and military considerations affect chiefly the Governments of this country and of India, and for the sake of estimating the purely commercial value of the line as a speculative undertaking may, for the present, be discarded; and it therefore remains for the public to form their own opinions as to whether the probable traffic over this line is, from the reasons we have above stated, sufficiently in excess of what may be expected on the opposing line to make the one as good a speculative investment as the other, and they may naturally be expected each one to support the promoters of that line which appears to offer the greatest security and prospects of largest returns. As we have before stated, we shall be glad to see both lines successfully established, since, if properly constructed and carefully worked, we have no doubt there would be found sufficient traffic for the support of them both.

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. 2999, 10d.) Thomas Barnabas Daft, of Cleves Lodge, Church-street, Chelsea, patents constructing floating harbours of iron or steel plates and frames in such a manner that they can be built on shore and then launched. It is intended that these harbours should be moored in their required positions, and that they should be connected with the shore by swivel bridges, which would allow of their rising and falling with the tide. The harbours are to be constructed with hollow walls for receiving water or other ballast, and are to be without any floor in the open or water space where the vessels are received.

(No. 3016, 1s. 2d.) Julien Bolvin, of 31, Rue d'Enghien, Paris, patents a form of steam-engine in which a pair of pistons connected by a curved bar are made to reciprocate in an annular cylinder. The reciprocating rotary motion of the pistons is communicated, by an arm connected to their rod, to a central shaft, and this shaft carries another arm, from the extremity of which a connecting-rod is led to a crank on the fly-wheel shaft. An engine very similar to this has been proposed before. It possesses no advantages over the arrangements in ordinary use, and it would be much more difficult to keep in repair.

(No. 3018, 10d.) David Kircaldy, of Southwark, patents a measuring instrument intended for ascertaining minute differences in measurements or dimensions. It consists of a pair of parallel bars connected at one end by a cross-piece, one of these bars being divided out into main divisions—such as inches and tenths—and the other bar being screwed with a thread of a certain corresponding pitch, twenty threads to the inch, for instance. On the screwed bar is a long nut which turns in a socket, this socket having another hole in it through which the other bar slides. The nut has a collar on it which bears against the socket, and this collar is divided out around its circumference whilst the socket is marked with a zero line. Both the socket and the cross-piece, by which the bars are connected at one end, carry pointers; and the method of using the instrument is as follows: Supposing it is required to set the pointers at a distance apart of 5.02 in. The socket would first be set to the 5 in. division on the main bar, the zero mark on the circumference of the nut collar corresponding to the zero mark on the socket, and then, supposing the screw to be of the pitch above mentioned, by turning the nut two-fifths of a turn, the socket would be shifted the required 0.02 in. further on, making the distance between the pointers 5.02 in.

(No. 3024, 10d.) Jaques Hermann Auguste Gruson, of Buckau, Prussia, patents methods of casting railway wheels, tyres, and other articles requiring a hard surface combined with toughness. According to these plans the moulds are composed partly of iron and partly of sand, and are arranged so that the thinner portions of the casting come in contact with the sand, the object being to equalise the rate at which the cooling of the metal takes place. In some cases Mr. Gruson proposes to form a hollow space behind the iron ring of that part of the mould which forms the face of the tyre, and after the mould has been filled, to run hot metal into this space to keep the iron ring from cooling down the tyre too quickly. Mr. Gruson also patents making tyres of two concentric rings with a space between them, these rings being united by a zigzag feather or rib. The spaces left by the zigzag rib are intended to afford room for the suit of bolts by which the tyre may be secured to the wheel. Such tyres would, however, be very heavy in proportion to the amount of wearing material contained in them, even if there were no other objections to them.

(No. 3025, 10d.) William Edward Newton, of 66, Chancery-lane, patents as the agent of Claudius Edward Habicht, of New York, an arrangement of machinery for excavating mud, sand, loose stones, &c., under water, and for pulling up old piles, and performing similar submarine work. The arrangement consists of a friction hoisting apparatus combined with a kind of grasping bucket, which is raised, lowered, opened or closed by the friction gearing acting through chains or ropes. The details of the machinery could not be explained without reference to drawings.

(No. 3026, 6d.) Ellis Wesley Morton, of Boston, U.S., patents applying to carriage wheels tyres composed of a pair of metallic hoops with india-rubber or other elastic material between them. This is a very old idea.

(No. 3031, 8d.) Thomas Wardlaw, of Toughmill, Dunfermline, patents arrangements for working the side delivery rakes of reaping-machines, which could not be clearly described without reference to drawings.

(No. 3033, 8d.) Jaques Hermann Auguste Gruson, of Buckau, patents making armour plates of cast iron with chilled faces, the plates being cast in moulds formed in a similar manner to those in Mr. Gruson's patent, No. 3024 above noticed. We should have considerable doubts as to the resisting powers of such armour plates.

(No. 3034, 1s. 6d.) Thomas Greenwood, of Leeds, patents a form of lathe for boring and facing railway tyres, the arrangement being such that both sides of the tyre are accessible at the same time. We shall give an illustration and description of this useful tool next week.

(No. 3038, 1s. 2d.) Josiah Latimer Clark, of 5, Westminster-chambers, Victoria-street, patents improvements in the construction of telegraph posts, insulators, and telegraph instruments. This patent will be of considerable interest to electricians, but the points claimed in it would require more space to describe them than we can give to the subject here.

(No. 3050, 1s. 2d.) James Howard and Edward Tenney Bousfield, of Bedford, patent improvements in the construction of reaping and mowing machines. The patentees arrange the crank-shaft which drives the knives lower than usual, and they make the knives of about half the usual width, giving them at the same time an amount of travel equal to that now employed. This arrangement gives the knives double the length of cutting surface. The patent also includes arrangements for altering the pitch of the finger bar, and improvements in the construction of the reel, this latter having also a differential motion given to it, so that its speed of rotation is reduced at the time that the rake arm is passing over the table of the machine.

(No. 3051, 6d.) Jaques Hermann Auguste Gruson, of Buckau, patents a method of casting ordnance of a mixture of purified white and grey cast irons, which he denominates "Gruson's metal." The moulds are constructed partly of iron and partly of sand in a similar manner to those for casting railway wheels, &c., described in our notice of Mr. Gruson's previous patent, No. 3024.

(No. 3054, 8d.) George Haseltine, of 8, Southampton-buildings, patents, as the agents of John Freeland and Daniel Ward, of New York, a method of making double volute springs by coiling up strips of metal, which have been split longitudinally for the greater part of their length, and have then been opened out into a forked form.

(No. 3056, 8d.) William Clark, of 53, Chancery-lane, patents, as the agent of Laurent Chevalier, of 29, Boulevard St. Martin, Paris, a form of steam-boiler. In this boiler the cylindrical main barrel is enlarged at one

end to an oval section, this enlarged portion containing the firebox. From this firebox a larger flue is led through the barrel of the boiler, this flue being closed at the end and bent tubes being led from it back to the smokebox, which is fixed to the upper part of the front of the boiler. A boiler of this kind would be expensive to construct, and we have considerable doubts about its strength and durability.

(No. 3058, 10d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of John Oliver Reilly and Alexander Wiley, of Baltimore, U.S., an arrangement of spike and rivet making machinery which admits of the apparatus for bending over the spike head and pointing the spike being readily thrown into or out of action at pleasure, thus adapting the machine for making either pointed or unpointed articles. The details of the arrangement could not be described without reference to drawings.

(No. 3063, 2s.) Peter Gledhill, of Newcastle-on-Tyne, patents several arrangements of coal-cutting machinery. According to one plan, the coal is cut by a series of cutters carried by a pitch chain passing over a chain wheel at the end of a jib projecting from the side of the machines. The other machines included in the patent are pick-machines, several methods of working the picks being mentioned. The patent also includes mounting the machines on rails or guides carried by light frames or girders of considerable length, so as to avoid the necessity for laying a solid line of rails in the mine.

(No. 3065, 1s.) George Haseltine, of 8, Southampton-buildings, patents, as the agent of Charles Burrell, of Fitchburg, Massachusetts, U.S., an arrangement of rock-drilling machine. In this machine a rapid reciprocating and intermittent rotary motion is given to the cutter, as in Lowe's and Derring and Sach's machines, but the details of the mechanism are different.

(No. 3066, 4d.) Pierre René Marie Le Guen, of 30, Rue Voltaire, Brest, patents a method of combining tungsten with cast iron. M. Le Guen mixes the reduced wolfram with quicklime, in the proportions of about 10 to 1, and makes the mixture into a paste by pouring it into melted pitch or tar. This paste is divided into portions, which are submitted to pressure in order to form them into cakes, these cakes being used as follows: The weight of the cast iron to be melted being known, a number of cakes, containing the quantity of wolfram which it is required to add, are taken, and divided into as many lots as there are to be layers of cast iron in the charge of the furnace. Coke is then placed in the bottom of the furnace in the ordinary way, then one lot of the cakes, then a thin layer of coke, then a layer of iron, and so on. A small quantity of flux is also added, but less than usual, on account of the lime contained in the cakes. The metal when run off is received in ladles or receivers, and well stirred before it is run into the moulds.

(No. 3077, 1s. 4d.) Johnson Kitchen, William Kitchen, and Samuel Samuels, of Accrington, patent an arrangement of continuous railway brake. According to this plan, a piston working in a steam cylinder fixed on the tender is made by the aid of a rack and pinion to give rotary motion to a transverse shaft, and on this shaft is placed a bevel wheel, which gears into a pinion fixed on a longitudinal shaft extending through the hind buffer beam of the tender. Each carriage is also provided with a longitudinal shaft, and these shafts and that on the tender are coupled by a system of universal joints. Rotary motion can thus be given to all the shafts by the movement of the piston in the steam cylinder, and, by means of a screw on each shaft, the brake blocks can be applied to the wheels of each vehicle. An arrangement for driving the shafts by means of gearing connected to friction wheels, which can be applied to the wheels of the brake van is comprised in the patent. We doubt if this invention includes anything which is really novel.

(No. 3079, 1s. 4d.) William Henry Posthelwaite Gore, of Langham-street, and Robert Green, of Ladbroke-terrace, Bayswater, patent a machine for repairing roads. This machine consists of a kind of traction engine, carrying at the front end a pair of steam-hammers, or, as the patentees call them, "rammers." These "rammers," they say, should have faces about 3 ft. square, and should weigh about 5 tons each. They are shown in the specification drawings as being connected directly to pistons working in steam cylinders overhead, and it is stated that in some instances the force of the blow may be increased by admitting steam above the pistons. We should think that the movements which would be imparted to a traction-engine by the working of a pair of double-acting 5-ton steam-hammers attached to the front of it would be of

rather a lively character. Besides, we much doubt whether such "rammers," even if practicable, would perform their work any better than a heavy roller.

(No. 3088, 8d.) Frederick Robert Glover, of St. Peter's College, Cambridge, patents a form of hoist applicable to houses in which the staircases enclose only a narrow well, up and down which it is impossible to pass a platform in a straight line. In one form of this hoist a pillar or rod is carried from the top to the bottom of the house, and to this rod the platform is connected by a sliding socket fixed to one side of it. The platform is thus carried wholly on one side of the rod, and it is made to turn round the rod, and thus change from one side to the other, in order to clear the flights of stairs as it passes them, by means of curved guides, which are fixed to the platform, and come in contact with the balusters as the platform ascends or descends.

(No. 3095, 1s. 10d.) William Bass, of Little Broughton, Cumberland, patents a complete set of nail and spike making machinery, which it would be impossible to describe without referring to drawings.

DUVERGIER'S HORIZONTAL ENGINE.

We last week gave, on page 50, engravings showing a side elevation and plan of a horizontal engine, constructed by M. Alphonse Duvergier, of Lyons, which is now at work driving the machinery in classes 50 and 51 of the Paris Exhibition, and we now add on the next pages some further views representing some of the details. The cylinder, which is 19½ in. in diameter, with 3 ft. 3½ in. stroke, is, like that of the Allen engine, overhung, it being secured to the frame by the front end only, as shown in Fig. 1 (page 50). It is steam-jacketed both over the barrel and the covers, the jacket being in communication with the valve-chest. The distribution of the steam is effected by a valve which extends the whole length of the cylinder, and is fitted with an expansion valve on the back. The form and arrangement of these valves will be seen from Figs. 3, 4, and 5, which are respectively a transverse section through one of the cylinder ports, a longitudinal section of the cylinder and valves, and a transverse section through the exhaust passage. The passages leading to the ends of the cylinder are made as short as possible, and they are arranged so that they incline slightly downwards towards the valve, and thus allow any water which may collect in the cylinder to escape freely. The main valve not only fits at the ends against the cylinder faces, but its under side bears at the middle of its length upon a face surrounding the opening of the exhaust pipe, this pipe leading directly down from the underside of the valve-chest, as shown in Fig. 5. An opening in the bottom of the valve places the interior of the latter in constant communication with the exhaust. The expansion valve is merely a flat valve working at the back of the main valve.

The main slide-valve is driven directly from an eccentric in the usual way, and the expansion-valve, which is adjustable by the governor, is worked from the same eccentric by the aid of the arrangement shown by the centre lines in Fig. 11. This arrangement is as follows: In the eccentric driving the main valve is fixed a pin, which is coupled by a short link to the lower arm of a lever which vibrates on a fulcrum concentric with the crank-shaft. The upper arm of this lever—which, it will be seen, is not in a straight line with the lower arm—is coupled by another link to the upper arm of a second lever vibrating on a fixed fulcrum. The lower arm of this lever is slotted and curved to an arc struck with a radius equal the length of the rod which connects it to the spindle of the expansion-valve. The block carried by the end of this rod is raised or lowered in the curved slot by the action of the governor; an increase in the speed of the engine causing the block to be raised in the slot and the travel of the expansion-valve to be consequently reduced, and *vice versa*. If the block is raised so that its centre coincides with that of the fulcrum of the vibrating lever, no motion is communicated to the expansion-valve, and consequently the supply of steam is entirely shut off from the cylinder, and as the block is lowered the travel of the expansion-valve is more and more increased and the cut-off correspondingly delayed. The arrangement gives the power of varying the cut-off from 0 up to 75 per cent. of the stroke. From 0 to 45 per cent. of the stroke the cut-off is stated to be effected with perfect equality for both strokes of the piston, but with the later cut-offs there is a slight irregularity. Diagrams showing the working of this valve-gear are given in Figs. 12, 13, and 14.

The air-pump is placed below the floor level, and is worked from a crank-pin fixed in a plate at the end of the crank-shaft, as shown in Fig. 1. The condenser is situated immediately below the cylinder, and the exhaust pipe descends directly to it, as will be seen from the same figure. The crosshead guides are placed below the crosshead, the latter being shaped as shown in Figs. 8, 9, and 10. Figs. 6 and 7 show the form of the small end of the connecting-rod. M. Duvergier's engine in the Paris Exhibition is supplied with steam by two boilers, constructed by M. Chevalier, of Lyons, of which we gave engravings on page 42 of our last number.

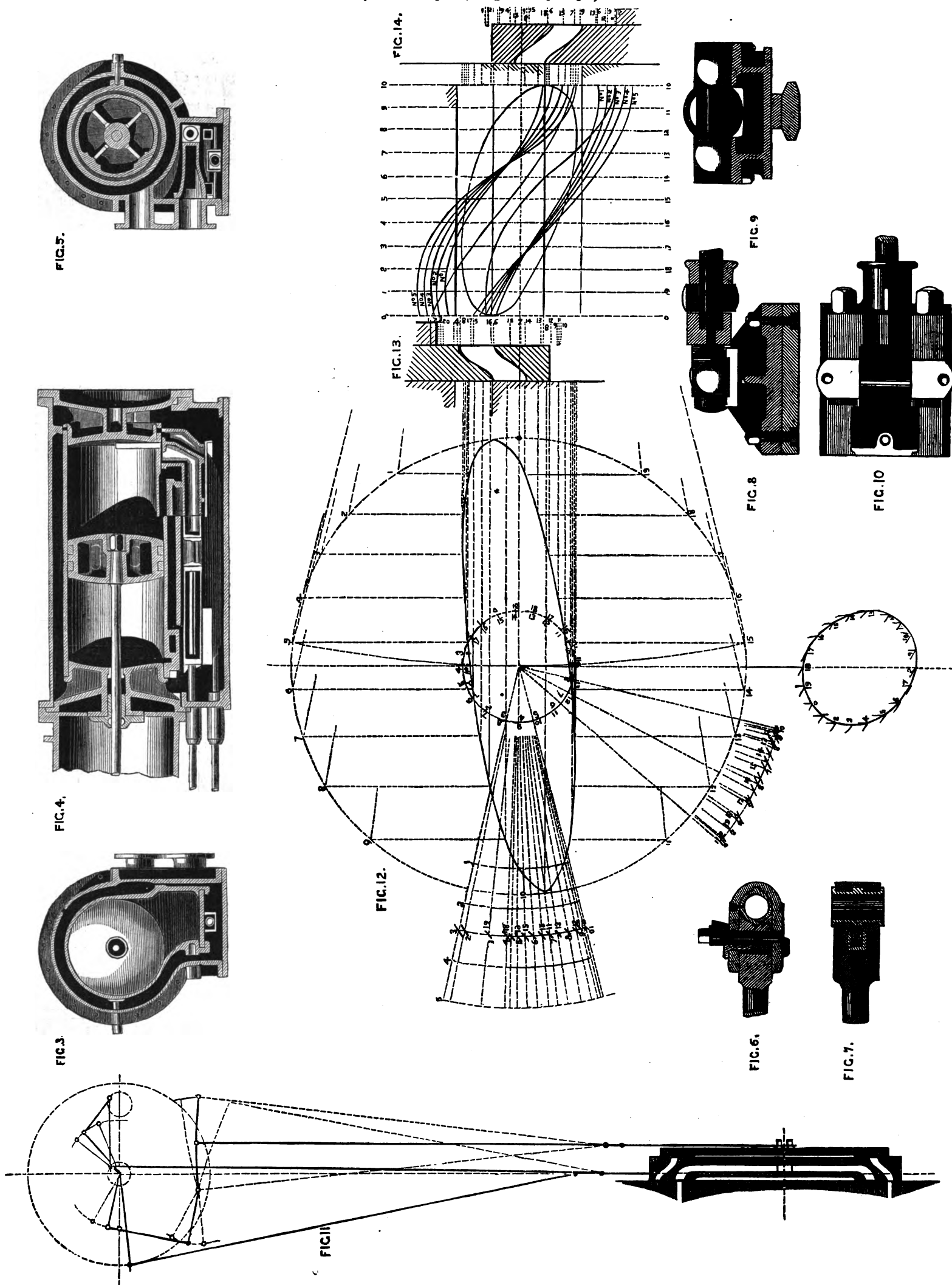
FOREIGN MECHANICAL INDUSTRY.—It is not perhaps generally known that the Franche-Comté Forges and Foundries Company supplied part of the wire used in the establishment of the Atlantic cable. A supplementary order for rails for Russia has been received by Belgian firms. A contract for 10,000 tons of iron rails supplied for the Belgian State railways is about to be let.

OSTEND.—Some rather important works are now on hand at Ostend. A new quay of masonry is being constructed for the accommodation of steamers frequenting the port; the works are already about half executed, and are expected to be completed by the close of October. A new basin for fishing vessels is also on hand, and is expected to be completed by September, 1868.

DETAILS OF HORIZONTAL ENGINE, AT THE PARIS EXHIBITION.

CONSTRUCTED BY M. ALPHONSE DUVERGIER, ENGINEER, LYONS.

(For Description, see preceding Page.)



LOCOMOTIVES FOR THE ST. JOHN'S WOOD RAILWAY.

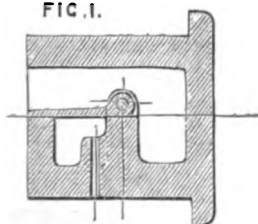
A FEW weeks ago (*vide* page 679 of the last volume of *ENGINEERING*) we gave some general particulars of the heavy locomotives which have been designed by Mr. Robert H. Burnett, the locomotive superintendent of the Metropolitan Railway, for working the traffic on the Metropolitan and St. John's Wood line; and we this week give a two-page engraving of one of these engines, of which five are now being built by the Worcester Engine Company. In the article above referred to we enumerated the various gradients on the St. John's Wood line; but it will be convenient for reference that we should repeat them here. The St. John's Wood Railway will leave the Metropolitan line proper at Baker-street, and, after proceeding on a level for a short distance, will rise by successive inclines of 1 in 90 and 1 in 44 to the Regent's Canal. From the canal the line will descend slightly, and then at three-quarters of a mile from Baker-street will commence an ascent of 1 in 60, three furlongs in length. This incline will be succeeded by about the same length of 1 in 150, and by about a quarter of a mile of line almost level, with the exception of a short length of 1 in 80. Then, at about $1\frac{1}{2}$ miles from Baker-street will commence the severe gradient of 1 in 27, three-quarters of a mile long, which forms the chief feature of the line, and which has necessitated the construction of engines of a peculiar class for working the traffic. Nearly halfway up the main gradient will be a station; but the incline will be flattened for a length of about 200 ft., where this station occurs, to 1 in 250. The line will be altogether $2\frac{1}{2}$ miles in length, and its total rise in this length will be 255 ft., of which height 98 ft. 6 in. will be gained between Baker-street and the foot of the incline of 1 in 27.

As will be seen by the engravings, the locomotives which have been designed by Mr. Burnett for working the traffic on this heavy line are six-coupled inside-cylinder engines, the cylinders being 20 in. in diameter with 2 ft. stroke, and the wheels being 4 ft. in diameter. The total weight of the engine will be about 45 tons, and the large amount of cylinder power with which they are provided has been given in order to enable them to take their load readily when the pressure of steam in the boiler falls to about 80 lb., as Mr. Burnett anticipates it may do at some parts of the road where the engines have to work in the tunnel with the exhaust steam turned into the tanks. The maximum pressure of the steam will be 180 lb.

Owing to the large diameter of the cylinders, there was no room for the steam-chest between them, and the valve faces have therefore been arranged horizontally on the top, as shown in the longitudinal section. The cylinders, which are placed at an inclination of 1 in 8 $\frac{1}{2}$, are well bolted to each other and to the frames by flanges both above and below, the whole forming a good strong job. The steam-ports are 14 in. by 1 $\frac{1}{2}$ in., and the exhaust-ports 14 in. by 3 $\frac{1}{2}$ in., the width of the bars being 1 $\frac{1}{2}$ in. The slide-valves are of brass; they have 1 in. lap, and $\frac{1}{2}$ in. lead, and $\frac{1}{4}$ in. travel in full gear. The valve gear is of the straight-link kind, and its principal dimensions are given on the longitudinal section. The eccentrics have 8 $\frac{1}{2}$ in. throw, or 6 $\frac{1}{2}$ in. travel, and the back gear eccentric rod is coupled to the top of the expansion link, the arrangement being such that the lead decreases slightly towards mid-gear. It will be seen that the motion is transmitted to the valves through a pair of rocking-shafts, these shafts being carried by brackets fixed to the frames, and by a central bracket bolted to the smokebox tubeplate. The bearings in these brackets are of good size, and the pair of bearings carried by the central bracket are independent of each other, so that the wear of that belonging to either shaft can be taken up as required.

The pistons are of cast iron, and each fitted with a pair of cast-iron rings sprung into their places. The piston rods are of steel, and are 2 $\frac{1}{2}$ in. in diameter. The guide-bars are also of steel; they are 3 $\frac{1}{2}$ in. wide; and the guide-blocks, which are of cast iron, are 12 in. long. The guide-blocks are each fitted with a neatly arranged oil-cup, as shown in the annexed section, Fig. 1.

FIG. 1.



The connecting-rods are 6 ft. 8 in. long between the end centres. The small ends are fitted with straps in the usual way, but the large ends are made as shown in Fig. 2, a form of connecting-rod end which has been adopted for all the Metropolitan Railway engines at present at work. It will be seen by the figure that the rod is made with a forked end, the brasses being secured in the fork by a filling piece through which and the jaws of the fork a bolt 1 $\frac{1}{2}$ in. in diameter is passed. The brasses are tightened by a cotter in the usual manner.

The barrel of the boiler, which is 4 ft. 3 in. in diameter inside and 11 ft. long, is made of $\frac{3}{4}$ in. plates butt-jointed and single rivetted, the rivets being $\frac{1}{2}$ in. in diameter, and placed at a pitch of 1 $\frac{1}{2}$ in. The longitudinal joints are provided with both inside and outside covering strips, these strips being $\frac{3}{4}$ in. thick. The plates of the firebox casing are all $\frac{1}{2}$ in. thick. The length of the casing outside is 7 ft. 1 in., and its depth below the centre line of the boiler is 3 ft. 4 in. at the hind and 4 ft. 10 in. at the front end. The top of the casing is flush with that of the barrel of the boiler. The inside firebox is formed of $\frac{1}{2}$ in. copper plates, with the exception of the tubeplate, which is $\frac{3}{4}$ in. thick at the upper part, but is thinned to $\frac{1}{2}$ in. thick below the tubes. The length of the firebox inside at the top is 6 ft. 4 in., and its height inside 3 ft. 11 in. at the hind and 5 ft. 5 in. at the front end. The width of the box inside is 3 ft. 5 in. at the bottom and 3 ft. 8 $\frac{1}{2}$ in. at the widest part; and the firebox heating surface amounts to about 115 square feet. The firegrate area is 22 $\frac{1}{2}$ square feet. The crown of the firebox is stayed by nine

longitudinal roof stays, these stays being well supported by numerous sling stays connecting them to angle-irons rivetted to the crown of the firebox casing. The back plate of the firebox casing is stiffened above the level of the crown of the firebox by a plate $\frac{1}{2}$ in. thick rivetted to it, as shown in the longitudinal section; and it and the smokebox tubeplate are tied together by eighteen longitudinal stays. The barrel of the boiler contains 172 tubes 2 in. in diameter outside and 11 ft. 3 $\frac{1}{2}$ in. long between tubeplates, these tubes giving a heating surface of 1017 square feet, making, with the 115 square feet of firebox surface, a total heating surface of 1132 square feet.

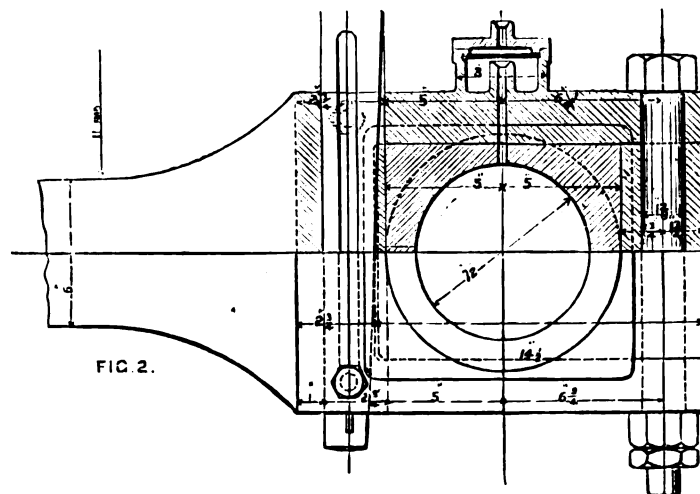
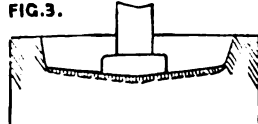


FIG. 2.

The boiler is provided with a dome 1 ft. 9 in. in diameter and 2 ft. 5 $\frac{1}{2}$ in. high, placed just in front of the firebox casing, as shown in the longitudinal section. In this dome is placed the regulator, which is a gridiron valve, with a small auxiliary valve placed on the back of it, the arrangement being such that when the lever is moved the smaller valve is first shifted, so that the small opening through the main valve is uncovered, and afterwards, by a further movement of the lever, motion is communicated to the main valve. This kind of regulator, which is now coming into use on many lines, is a very good one, and in the case of engines having very large cylinder power in proportion to their adhesion it is particularly useful, as it enables the steam admitted to be controlled with great nicety.

As will be seen by the plan, the engine has double frames. Both the inside and outside frame plates are 1 in. thick; and the outside frames have a minimum depth of 15 $\frac{1}{2}$ in., and the inside frames of 12 $\frac{1}{2}$ in. The distances apart of the frames and the arrangement of the cross-stays, &c., will be seen by reference to the engravings. The total wheel base is 14 ft., this distance being divided into spaces of 6 ft. 10 in. between the centres of the leading and driving wheels, and 7 ft. 2 in. between those of the driving and trailing wheels. The arrangement of the wheels will be seen from the engravings. In order to facilitate the passage of the engine round curves, the leading and trailing axles have a certain amount of lateral play allowed them, the side movement being governed by the ends of the spring pins which rest upon the axle-boxes being shaped to fit double inclines formed on the latter, as shown in Fig. 3. The wheel tyres and axles are of steel;

FIG. 3.



and the crank-axle has both inside and outside bearings whilst the leading and trailing axles have outside bearings only. The bearings are all of large size, as will be seen by the dimensions figured on the engravings. The axles are coupled by means of overhung cranks keyed on, and the axle-boxes are all of cast iron with brass bushes. As will be seen from our illustration, compensating beams have been provided between the leading and driving and the driving and trailing springs; but it is not yet certain whether these will be used, and provision has been made for removing them without altering the arrangement of springs in case it should be found that the engines run more steadily without the beams than with them.

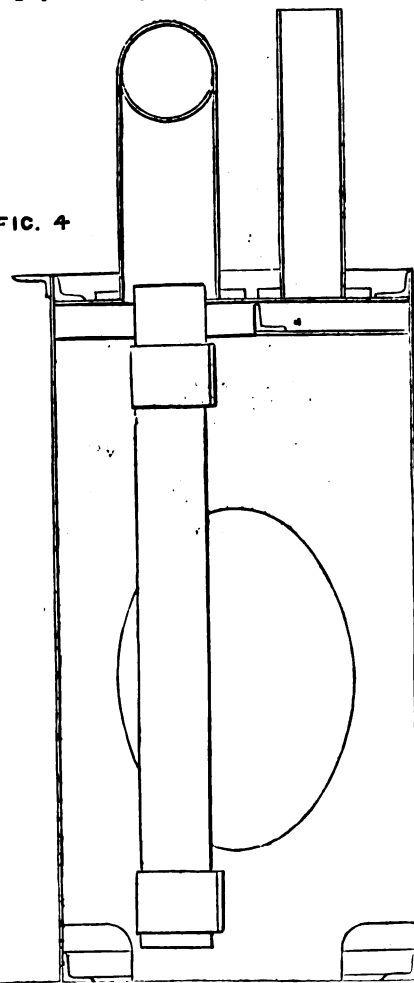
The feed-water is carried in side tanks, and the coal in a bunker arranged at the trailing end of the footplate. This coal bunker is of a peculiar shape in plan, the length from back to front being reduced at the middle of its length so as to give more room on the footplate for firing, &c. The condensing arrangement with which the engine is fitted is similar to that applied to the locomotives at present in use on the Metropolitan line. The exhaust steam is directed either into the blast nozzle or into the pipes leading to the tanks by means of a sliding valve, arranged as shown in the longitudinal section, the valve being capable of being worked from the footplate. The bottom of the chimney is fitted with a damper formed of a pair of flap-plate valves, which are opened or closed simultaneously by the system of levers shown in the section. Fig. 4 is a section of one of the tanks, showing the arrangement employed for ensuring the perfect condensation of the exhaust steam, this arrangement being, as we have said, the same as that used on the Metropolitan engines now running.

In the case of the first engines used on the Metropolitan line, the exhaust steam was merely led into the tank by a pipe communicating with the top of the latter, there being no arrangement for ensuring the circulation of the water. Under these circumstances, it was found that the water in the tank became highly heated for a few inches below the surface, the temperature of the remainder being but slightly raised; and that

after this heating had taken place, the condensation of the steam was imperfectly performed. The exhaust pipes were then continued down through the tops of the tanks so as to dip into the water, but this plan was not found satisfactory, and finally Mr. Burnett designed the arrangement shown in Fig. 4. This arrangement, which has been found to answer its purpose perfectly, is a very simple one, and consists merely in leading a pipe, open at both ends, and of a slightly smaller diameter than the exhaust pipe, from the mouth of the latter to the bottom of the tank. In the St. John's Wood engines the exhaust pipes, which terminate at the top of the tanks, are 6 in., and the inner

pipes 4 $\frac{1}{2}$ in. in diameter. The greater part of the steam entering the tanks from the exhaust pipes is at once distributed over the surface of the water and condensed; but a certain amount enters the inner pipes, causing the water to fall in them, and keeping up a sort of pulsatory motion which ensures the

FIG. 4.



circulation of the water in the tanks, and keeps the surface from becoming more highly heated than the other portions. Any steam not condensed escapes from the tanks by small exhaust pipes, arranged as shown in Fig. 4, the entrance to each escape pipe being guarded by a shield plate 4 ft. long placed beneath it at a distance of 2 in. from the top of the tank.

The filling holes of the tanks are fitted with covers, made as shown in Fig. 5. The covers, which are of cast iron, are hinged to a cross-bar, which is jointed to a bracket at one end, and held down by a stirrup and tightening screw at the other. The joint is made by a lip on the casting at the top of the tank, fitting against an india-rubber ring let into a dovetailed groove formed in the cover, as shown in the cut. The two tanks are connected by pipes leading to a cast-iron box placed beneath the footplate, this box being fitted with a large conical valve, by opening which the hot water can be quickly discharged from the tanks at the end of a trip. The arrangement of this valve is shown in the