

HIGHLAND AND AGRICULTURAL SOCIETY'S SHOW AT GLASGOW.

THE Highland and Agricultural Society of Scotland has long been one of the most popular institutions north of the Tweed, and, indeed, it may be regarded as the parent of all the Agricultural Societies in the kingdom, having been instituted so far back as the year 1784. It was in Scotland that the now really *Reverend* Mr. Bell invented the reaping machine, a mechanical appliance which, in some form or other, is used in untold numbers wherever high or scientific farming is prosecuted, and which, in America alone, last year yielded to McCormick nearly 40,000*l.*, while poor Mr. Bell still remains poor, and is likely to remain so for the rest of his life, which cannot be of long duration now. It was in Scotland that Smith, of Deanston, lived and moved, and incited his countrymen to apply the most approved scientific means in the mechanical treatment of the soil to be cultivated; and it is in Scotland likewise that the Lothians are situated, together with the Carse of Gowrie, Carse of Stirling and Strathern—districts in which scientific tillage has reached such a high state of excellence—we don't say perfection yet—as has never been surpassed elsewhere.* Then why should not the society in question be eminently popular? Its annual show of stock, dairy produce, implements, machines, &c., has this year been held in Glasgow—the great commercial capital of the west of Scotland; and during the three days—Tuesday, Wednesday, and Thursday of last week—that it was open, something like 80,000 people were admitted to the spacious show-yard, and nearly 3000*l.* taken for admission, besides 185*l.* for catalogues sold, and the stall-rents paid by implement makers and others. From Bury St. Edmunds a very different story is heard—one of official shortcomings, sins both of omission and commission, the grumbings at which have been so loud and prolonged as to have become distinctly audible in the far north. The show recently held in that ancient town, even with all the prestige of a *Royal Agricultural Society*, could only bring into the treasury 4180*l.*, and yet it extended over a longer time than the Glasgow show, and had the additional excitement of a competition of agricultural machines in the open field.

The show that has just been held in Glasgow brought out the greatest display of agricultural appliances in the shape of machines, implements, &c., known in the history of the society. Including some few things which should not have been admitted to the show-ground, there were 1344 entries, the highest number previously being 1101, at the Kelso meeting in 1863. Never until the year just mentioned had more than three figures been required to indicate the number of such entries. Even at the last Glasgow meeting, held in 1857, there were only 610, and the average has been from 350 to 500. Since then, however, invention has proceeded with amazing rapidity, and labour-saving appliances in the art of husbandry have come into such request and use that the production of food may almost be regarded as a manufacturing art; for, as a rule, providing the season is ordinarily favourable, it is almost axiomatic that, so many pounds of coal being used, or so much steam generated, or so many horse power developed, so will be the bushels of corn, tons of hay, or pecks of potatoes. And amongst the said 1344 objects entered for show and now scattered abroad, there were not a few that were deserving of, and received, very special and marked consideration from thousands of farmers and others during the time they were on view. Not all, but many of the most eminent makers of agricultural implements in England, as well as in Scotland, brought or sent their most recent inventions, including those which had been singled out at Bury St. Edmunds for prizes or special commendation, and duplicates of others which have had a similar fate or similar luck at the hands of the Paris Exhibition juries.

It is impossible for us to give any very detailed account of the numerous exhibits with which the implement show-yard almost teemed. Indeed, our allotted space in these columns would not suffice for a mere enumeration of them; and all that we can even hope to do, therefore, is to give a running comment on some of the more striking and more useful objects that caught the eye while making several peregrinations from stall to stall during the three days of the show.

Not the least prominent objects amongst the implements were the reaping and mowing machines. In this section there were no fewer than twenty-two exhibitors, English and Scotch, and including several who are nothing but exhibitors, that is, they are not manufacturers. Since the year 1828, when Bell's invention was practically given to the agricultural world, and even since 1851, when McCormick's American reaper was first exhibited in this country, reaping machines have taken on many modifications and improvements, varying with the notions of the various makers, who are now not few. There was abundant variety among those exhibited on Glasgow Green last week, and almost every machine found some practical agriculturists ready to praise. The Beverley Iron and Wagon Company (Limited) put in a modest appearance with two of their improved patent reaping machines, with double self-acting swathe delivery, one for three horses and the other for two, and cutting, respectively, widths of 7 ft. 6 in. and 5 ft. 2 in. These Beverley machines are peculiar, in the fact that the horses follow the cutting instrument, and the driver follows

all; and thus a farmer only requires to open the gate of his corn-field, and the reaper may enter and plunge forthwith into the corn. The 3-horse reaper will easily cut from 20 to 30 acres per day. The fact that some 1600 of the Beverley machines have been sold in four years affords some indication that they have gained a good character. But the Beverley Company did not begin yesterday to make these machines, nor even four years ago; for we overheard a "canny" Perthshire farmer say that he had used one of them for fourteen years, and dearly he seemed to cherish it, and talked of getting the recent improvements effected on it, some of which are as recent as last harvest. The eminent firm of Lillie, Goodlet, Elder, and Company, of Berwick-on-Tweed, tread close on the heels of the Beverley Company with their buckeye reaper and mower, and combined reaper and mower, in which the double action is obtained by a different arrangement of the mechanism. They also have late improvements to speak of. Other well-known firms, such as Brigham and Bickerton, of Berwick-on-Tweed, Samuelson and Company, Hornsby and Sons, Grantham, Walter A. Wood and Bisset and Sons, of Blairgowrie, showed their latest and best forms of reaping and mowing machines. With so much room for choice, and so much excellence both in workmanship and mechanical arrangement of the parts, we think the intending buyer would be severely taxed to make a selection of the instrument which could truly be said to be the most perfect.

In ploughs, the display was perhaps not less complete. The exhibits in this section were almost entirely by Scotch makers, and in many instances the implements were so substantial, well-constructed, and their parts so skilfully disposed, that makers south of the Tweed may equal, but we question if they can excel them. The ploughs exhibited were almost endless in variety, and adapted to all kinds of work that one can conceive capable of execution by means of ploughs. Some were light and handy, and workable by one horse, whereas others would require two, three, or four horses to work them. Not content to have a plough to do a plough's work and nothing more, some inventors and makers engraft a potato-raiser upon, and give us some recent improvements in these adaptations. We have no desire to be invidious, but we cannot refrain from mentioning the firm of John Gray and Company, of Uddingston, near Glasgow, on account of the great and varied display of ploughs, upwards of twenty, observed at their stall.

The display of steam-engines in motion was not great, but those that were exhibited and at work were minutely inspected, even to the extent, in one case of which an engineer friend informed us, of taking the dimensions by a foot rule. Three Lincoln firms put in appearance, well knowing, or doubtless feeling, that Scotch engineers cannot yet compete with them successfully in agricultural steam-engines. Robey and Company exhibited their single-cylinder traction engine of 8 horse power, a portable engine of 6 horse power, and two thrashing machines; Ruston, Proctor, and Company had only one steam-engine and one thrashing-machine; and in this respect they were kept in countenance by their townsmen, Messrs. William Foster and Company. Such of these engines as were seen at work were greatly admired, as well they might be, for it is not every day that pieces of mechanism combining the strength, durability, workmanlike, and even, beautiful finish and sweet, steady motion of the Lincoln engines are seen by northern agriculturists. The thrashing-machines of Robey and Company seemed to be as durable as they are simple in design, and doubtless they can separate and clean the grain to perfection; and we should not feel much indisposed to expect the same of the one shown by Ruston, Proctor, and Company. Foster and Company claim improvements on behalf of their combined finishing corn thrashing-machine, but we did not learn what they were. As regards the Glasgow and Uddingston firms, who exhibited engines for steam cultivation, we think they could not do otherwise than admit that their professional brethren in the south had out-distanced them in this specialty.

Messrs. Williamson Brothers, the well-known Kendal engineers, exhibited a 6 horse power portable steam-engine, and a 4 horse power portable thrashing, shaking, and winnowing machine; but besides these they had their No. 5 whirlpool centrifugal pump, their No. 5 whirlpool blowing-fan, and a vortex turbine-wheel of 60 horse power on 45 ft. fall, each and all of which seemed nearly to "take the breath" from the curious and inquisitive operative engineers who got loose from their workshops on the third day of the show, when the charge for admission was reduced to a moderate sum. They learned that it was only necessary to go south to Westmoreland—no very great distance, truly—in order to find something not "common or unclear" in the engineering line. Very few of the country people, however, could make either head or tail of the Kendal exhibits under notice. By means of Williamson's whirlpool centrifugal pump, a modification of Appold's invention, water can be continuously raised from a cistern, into which it falls again with all the force of a natural cataract.

There was a very plentiful crop of chaff-cutters on the show-ground, in only one case, however, is there set up any claim as to improvements, and that is by Messrs. Richmond and Chandler, of Salford. The judges in the machine and implement department have recommended that this machine be put on trial; their recommendation extends to many other exhibits, such as the three machines shown by

Williamson Brothers and others which we have already mentioned. Speaking of chaff-cutting machines, is there not something *mal à propos* in the name? Chaff needs no cutting, no matter what purpose it is applied to. We would suggest a name more in accord with the work executed by these machines, which is cutting straw or hay into quarter or half inch or other lengths, for use along with other food in the byre or stable. E. H. Bentall, of Maldon, appeared in strong force with his chaff-cutters, encouraged, doubtless, by his success at Bury, where he was awarded prizes both for horse or steam and hand power machines. We are informed that about 6000 of these machines are sold annually, which is quite credible, considering that they will cut up from 1 ton 7 cwt. to 2 tons 5 cwt. per hour into lengths of three-quarters of an inch!

In the department of fanners, A. B. Childs, of London, was far and away ahead of all competitors. His machines, however, are designated patent aspirator seed-cleaners, the price of which varies from 15*l.* to 25*l.* Some of them are made to work by hand, and others to work by steam or water power. One of them which we saw in operation claims to have improvements recently effected on it; there is no doubt that it executed its work in a most effectual manner, and without the loss of a single grain of any size. An improved winnowing machine was also exhibited by James Elder, of Corstorphine. In both these cases the machines were recommended for trial by the judges.

Cake-breakers, malt-crushers, oat and bean bruisers, root-pulpers, turnip-cutters, and other machines of a similar character were exhibited in great variety, and of various degrees in quality as regards workmanship and work performed. Bentall, Richmond and Chandler, Brigham and Bickerton, Pickles, Sims and Company, and several Scottish firms, all made very commendable displays in this department.

Mrs. Thomas Sherriff, of West Barns, Dunbar, had displayed at stand No. 96 a number of machines that might almost be designated specialties. These were chiefly corn-drills and sewing-machines, hand and broadcast. Two of the machines are quite new inventions, and have been specially singled out for recommendation. One of them is a 16-row lever corn-drill, with back steering, land-measuring index, and grass-seed sower, so that it is adapted for sowing grain and grass seeds at the same time. This was certainly one of the greatest novelties displayed on the show-ground. The other is a 3-row guano-distributor, to suit bean, potato, and turnip drills, with drill-lever to prevent the guano and farm-yard manure from mixing. Verily, if the earth does not yield and bring forth her increase, it is not the fault of the agricultural implement makers.

Drill-grubbers, drill-ploughs, drill-harrows, and harrows generally, were exhibited by Scotch firms exclusively; but in the department of horse-rakes several English competitors entered the lists, or English makers had their machines exhibited by Scotch agents. This was the case with the Bedford horse-rake, the makers of which (Messrs. Howard) seemed to think Glasgow too far away from their famous works, for they did not exhibit in a single department, and the same is true of Ransomes and Sims.

Besides the machines and implements more or less directly employed in the cultivation of the land, or in gathering in the crops, there were exhibited many that are more especially intended for use in the kitchen or dairy. Among these there were bread-making machines, butter-making machines, churns, and other dairy utensils, and washing, wringing, and mangling machines, the principal exhibitors being Bradford and Company, Kent; Canadian Washing Machine Company; Pringle, Haughton, and Thompson; Hornsby and Sons; Pickles, Sims and Company; Richmond and Chandler; Main and Company; John Gray; McCutcheon and Sons; Fleming, and Duffield. In most of them there were displayed nice mechanical arrangements for economising human labour.

Not exclusively for agricultural purposes were the weighing-machines that were exposed to view, and in these Glasgow makers greatly predominated. Various features of excellence were noticeable, especially in those made by Smith Brothers and Company, A. and W. Smith and Company, and Herriot and Company. The last-named firm showed three or four novelties of construction or adaptation which attracted our attention. As weighing-machines form the specialty of this firm, excellence of workmanship and constructive ingenuity should be looked for at their hands. These points we found, but as we may, by and by, give illustrations of these machines, we forbear at present to give any simply verbal description of them.

The only other things we can find space even to mention in passing are the extensive and excellent display of wire and strand cable and other forms of strained fencing, and the accompanying gates, together with models of various sorts of buildings erected by the exhibitors, Morton and Company, of Liverpool, in galvanised iron; W. B. Dick and Company's fire-extinguisher, which was seen daily in practical operation on most highly inflammable materials; the great collections of domestic "nicknackeries" or mechanical utilities exhibited by Arthur Lyon and George Kent, of London; and the fire-clay goods of Messrs. Howie, of Hurlford, Kilmarnock.

The 1600*l.* given this year by the Highland and Agricultural Society, in the shape of prizes, was given exclusively to the stock, poultry, dairy produce, &c.; the machines, implements, &c., have ceased to receive that notoriety which results from prize-giving, and the makers

* It is an Englishman, not a Scotchman, who writes.

depend entirely, therefore, upon the sales they can make in the show-yard, and the orders which they can book, together with the publicity which the act of exhibiting brings to them and their respective businesses.

Such exhibition as the one held last week makes known to us the fact that the manufacture of agricultural machines and implements is largely carried on in many places throughout the country, that it is almost, if not altogether, one of our staple industries, and that it is carried on in small out-of-the-way places that were not suspected of any connexion with it, such as Maybole, Corstorphine, Jedburgh, Banbury, Dunkeld, Blairgowrie, Tranent, Dunbar, Dalkeith, &c. It has also shown that townspeople can be got to take an interest in such things as give delight to the purely agricultural mind, and that they will attend the exhibition and gain instruction from the same. Thanks to the good weather and the excellent arrangements made by Mr. Menzies, the new secretary, the whole show was a great success, perhaps the greatest success the society has yet had.

We should not omit to mention that Professor W. J. M. Rankine was one of the most active judges on the implement committee.

THE OHIO SUSPENSION BRIDGE.

TO THE EDITOR OF ENGINEERING.

SIR,—The interesting report of Mr. Roebing on the noble structure which he has so successfully carried out at Cincinnati, will have been read by all English engineers with a feeling of admiration, both for the boldness of the conception and for the ingenuity displayed in working out the various novel and difficult points of detail. Under these circumstances it will appear ungracious to be critical; but as Mr. Roebing, in his report, distinctly challenges the opinion of his professional brethren, a little discussion cannot be taken amiss by any one, and may serve to clear up some rather obscure statements in the report.

In the first place, we think the inferred prejudice against the adoption of the suspension system, about which Mr. Roebing rails so bitterly, exists chiefly in his own imagination, and that it does not at all fairly represent the present state of professional opinion on the subject. On the contrary, we think if a problem similar to that of the Ohio bridge presented itself to an English engineer, it would be solved in a very similar manner. As such an instance, however, has not occurred in recent times, there is, of course, no positive evidence one way or another, and any attempt to base an argument upon what has been done under different circumstances could only lead to false conclusions. A hand-box may afford ample protection for some descriptions of traffic, whereas a strong packing-case should prudentially be insisted upon for some other; in this country we are, figuratively speaking, compelled, both by public opinion and by law, to give up handboxes when the safety of the subject is concerned in the slightest degree.

The available strength of the Ohio bridge is, upon Mr. Roebing's own data, as near as possible similar to that of a railway station roof of the average construction adopted in this country, the maximum load per super foot, exclusive of the weight of the structure itself, being in both instances reckoned at 30 lb. Again, the cross-girders transmitting the load to the main cables of the Ohio bridge weigh but 20 lb. per foot lineal, whereas, by the Board of Trade regulations, we should be compelled, in a railway bridge of similar width, to appropriate from seven to eight times that quantity of metal in the same portions. A comparison of weight for span with any existing or proposed bridge in this country must necessarily, therefore, be perfectly useless.

Owing, probably, to the limited space to which Mr. Roebing considered it advisable to confine himself in his report, and the consequent want of full detail, it is difficult to reconcile some of the statements advanced. Thus, in advocating the efficiency of the stays, Mr. Roebing says: "suppose the cables removed, or their connexion with the floor relaxed, the latter, in connexion with the stays, would support itself." This theorem requires no demonstration, if the floor of the bridge may be replied upon as forming a practically unchangeable base to the triangular brackets composed of the stays, piers, and floor. But we are told that, "to allow for contraction and expansion, slip-joints are employed in the splices" of all longitudinal girders in the floor, and that "one good result of this is that the straight line of the floor is always maintained, and the fastenings of the planking are never affected." Now it is obvious that if the slip-joints operate as designed, the whole of the strain on the stays, estimated by Mr. Roebing at an ultimate amount of about 8000 tons, must be transmitted through the fastenings of the planking, and be taken up by the woodwork of the platform alone, unassisted by the ironwork, consequently it can hardly be maintained that "the fastenings of the planking are never affected." The omission of any explanation of this apparent anomaly is the more noticeable since attention is called to the fact of the pier being of a different material to the stays. Granting, for the present, the sufficiency of the floor for its imposed duties, we now find ourselves in another dilemma. We have two distinct systems, the stays and girders, and the cables, each adequate to the support of a certain load, and the degree of accuracy with which the gross load will be divided between the two in the required proportions will be governed by the adjustment of the several portions of the compound structure. We do not see how the compensating action of the centre portion of the cables, free from stays, will operate in the manner suggested in the report in every instance. Thus, we might obviously slack out any stay till the strain on it vanished, or we might tighten it up till it ruptured. The proper time to cease tightening would of course be when the unit strains on cable and stay were similar; at least this condition is assumed in the calculation of the ultimate strength of the bridge, and we should like to know how it has been obtained in practice.

There is another apparent discrepancy between Mr. Roebing's theory and practice in the matter of the stays worthy of notice. With reference to the cables, it is remarked that "the old saying 'united, we stand, but, divided, we fall,' applies literally. A group of small cables is subject to the danger of variableness

"in their individual motions, and perfectly uniform resistance is rendered impossible. One cable may break after the other, because they cannot be expected to act in perfect unison." Now, if a divided system of cables is not to be depended upon even when their contiguity affords every facility for the adjustment necessary to secure uniformity of strain, surely a liberal margin is absolutely imperative in estimating the combined strength of a number of cables, widely separated, at different inclinations, and requiring separate adjustments, all of which conditions obtain in the stays of the Ohio bridge. What guarantee have we, or what chance even is there, that they will not break successively, as insisted upon when the main cables are concerned? And yet the estimated strength of the Ohio bridge is based upon the hypothesis of the simultaneous rupturing of 76 stays and 2 cables when the stays are considered to offer a resistance similar, within a fraction, to that of the cables.

One of the advantages claimed for the solid cables is "the stiffness and rigidity thereby obtained, and their powerful horizontal action in bracing the centre of the span." Now it requires no calculations to make it evident that, if transverse strength be required at any point of the structure, the duty cannot be adequately sustained by a solid shaft about 1 ft. diameter, such as the cable, even if it were not ruinous to the tensional strength of that member, as it would in fact be. It may be demonstrated that the radius of deflection of a beam, within the elastic limit, will be $R = \frac{Md}{2t}$; consequently, taking

the modulus $M = 10,000$ tons, the elastic strain $t = 15$ tons per square inch, and the diameter of the cable, $d = 1.04$ ft., we have, by substitution, the radius of the deflection curve $= 350$ ft., or, in other words, the 1100 ft. of cable forming the centre span might be bent into a semicircle without affecting its elasticity. Again, the force required to bend it will, in pounds per square foot longitudinal section of cable, be given by the equation $\frac{1760d^2}{64}$ per square foot $= \frac{1760 \times 1.04^2}{64}$; whence, by substitution, we find a

force of 3½ lb. per square foot alone would be required. It is obvious, therefore, that a force of merely a few ounces per square foot could not be effectually resisted by the transverse strength proper of the cable as a whole.

But, on the other hand, great rigidity of cable would but intensify the difficulty of adjusting the stays to that portion of the structure. Thus, taking a length of six bays of suspenders, or 30 ft., the normal curvature of the cable in that length would be $\frac{80^2 \times 89}{1050^2} = \frac{1}{2}$ in.; and, since the mean radius of curva-

tion is about 1600 ft., whilst, as we have already shown, a radius of 350 ft. corresponds to a strain of 15 tons, it follows that an error of adjustment amounting to $\frac{1}{2}$ in. in 30 ft., or a straightening of the cable for that length, which is quite possible under unequal distributions of load, since the stays and cables rest on separate saddles, would impose an additional strain of $\frac{15 \times 350}{1600} = 3\frac{1}{4}$ tons per square inch on the cables.

When all the complicating conditions of unequal loadings are duly considered, we think the majority of our professional brethren will agree with us that it is quite impossible to state definitely the precise strain on any member of the Ohio bridge, governed as it must be by the comparative elastic action of the cables, stays, and girders. At any rate, we think the assertion can hardly be maintained that "no engineer is as safe in his works as he who is competent to plan and execute a suspension-bridge; there is no guess-work, no blind judging, but absolute certainty for him, provided he understands what he is about."

Mr. Roebing is enthusiastic, and indulges in a little speculation concerning engineering of the future, addressing himself to "the next generation of engineers, and not the present." Certainly, if he wishes his arguments to have weight in the present matter-of-fact age he must curb his poetical imagination, and not base them upon nature's doings. It is true most animal and vegetable substances may be roughly considered as made up of bundles of tubes, but so also may a locomotive boiler. For what possible reason, however, a vegetable, any more than a boiler, should (since they both have varied functions) be considered a correct type for an arched rib we leave Mr. Roebing to explain. We know from experiment that the crushing resistance per unit of area would be unaffected by the form of cross section, and theoretical consideration informs us that one half of the transverse strength of the arched rib would be forfeited by the substitution of a bundle of tubes for one large one of the same diameter over all.

Although I have thus freely criticised the report on the Ohio bridge, and pointed out the various inconsistencies contained therein, it must be observed the arguments chiefly point to the probability of an excess in the estimated strength of some 25 or 30 per cent., whilst no objection has been raised to the conduct of the design. On the contrary, no one could more fully appreciate the value of the results accruing to the profession from Mr. Roebing's talent and perseverance than

Your obedient Servant,
AN ENGLISH ENGINEER.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF ENGINEERING.

SIR,—In your last publication, Mr. Liernur calls my attention to the fact, that when faecal matter and remnants of kitchen stuff have been withdrawn from sewer fluids, the remainder cannot be very difficult to deal with. Where these constituents have been entirely abstracted from sewage, there will doubtless be little of an offensive nature left, at all events in our manufacturing towns. But how is this entire abstraction to be accomplished? Such substances as rags, bones, and vegetable debris may be kept from the sewers by a strainer, but the great bulk of noxious matter in combination with the liquid that has been used for cooking and other domestic purposes can never be separated by such means. The only use of a strainer is to prevent the obstruction of house drains, and a sluggish flow where water for flushing is not abundant. Faecal matter may possibly be withdrawn separately, by never allowing it to enter the drains, but how is it possible to collect the entire amount of urinous fluids, mixed as these are with the washings from streets, stable-yards, and in combination with the waste water of domestic use?

Ten shillings per head of population can never be realised from human excreta, unless the entire amount be obtained, and by some persons 8s. 6d. has been considered the full value.

The profit realised by the irrigation meadows at Beddington cannot, I believe, be fairly judged by the rent, at all events not till the tenant's first lease has expired. The Croydon Board of Health were under an injunction for polluting the Wandle when first they commenced to irrigate, and were obliged, in consequence, to take land and let it under disadvantageous circumstances. The commissioners appointed to inquire into the utilisation of sewage (according to a paper by Mr. Latham) estimated the profit realised by the sewage (after deducting 6d. per acre as the value of the land) at 4s. to 1d. per ton; this, at 5000 tons per acre per annum, amounts to 15s. to 20s. The value of the constituents of sewage has been estimated at from 4d. to 2d. per ton, varying according to circumstances. As to the efficiency of the irrigation system to purify sewage, any person who chooses to visit the Beddington or Norwood meadows may see that it flows off clear, pellucid, and quite free from any noxious effluvia; if Professor Voelcher's analysis has discovered some impurities, in order fairly to compare one system with the other, it would be necessary to have an analysis of the sewage from the military depot at Warley, after it has been passed through a bed of Spence's magnetic carbide. I do not suppose, however, that the discharge from the Beddington or Norwood meadows would be a desirable water for domestic use, at all events not for drinking; but land drainage, or water from the surface of a meadow, seldom is. There is a vast difference between a good potable water and a stream or river that is simply inoffensive, and does not vitiate the atmosphere, and again between the latter and town sewage. For a water supply, such portion as is required for drinking or cooking should be of unquestionable quality, that has neither been subject to contamination with sewage, however thoroughly purified, nor with drainage from meadows, or land in a high state of cultivation.

At Bury St. Edmunds the authorities, after trying various schemes for purifying the sewage of their town (which, I have been informed, contains but little sewage proper, as cesspools and middens are extensively in use), have this year pumped it up to a height of about 50 ft. for the purpose of irrigation. A marked difference was apparent in the growth of the grass a few weeks after the irrigating commenced, but whether the increased produce will cover the expense of pumping, rent of land, and other items, I am not at present able to say.

I am, Sir, your obedient Servant,
CHARLES F. GOWER.
Nova Scotia House, Ipswich, August 6, 1867.

THE ENGINE TRIALS AT BURY.

TO THE EDITOR OF ENGINEERING.

SIR,—The ridicule you heap upon the engines tried at Bury, which consumed more than 6 lb. of coal per horse power per hour, ought not to pass unnoticed by those delinquents who may have extenuating circumstances to urge.

Your comparison of the trials with the "Derby" race could only hold good if every engine and driver went through a long and severe course of training. Few of us can afford so expensive a process; but the rules of the society do not give us the option as exhibitors of declining the trials.

You "confound the commercial engines;" but, with all the experience of our great makers and prize-takers, how is it that you never see a "racing" engine in the hands of an agriculturist? Single slide-valves, un-jacketed cylinders, absence of feed-water heaters is the rule. It was not always so; but experience has proved that simplicity is the great desideratum of an engine which is constantly knocking about the country, working in dust and dirt, fed with the muddiest water, and in charge of a common agricultural labourer.

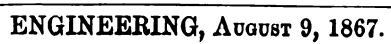
The engine of ours put on trial was run at home over the brake with 14 lb. of coal per horse power, when we succeeded in getting 2½ hours' work out of her, with which, having no pretensions to a "racer," we were satisfied. We did not do so well at Bury. We were called on for trial at a late hour, and when our personal attention was otherwise engaged. Our driver was inexperienced and nervous; but with the feedwater unheated, a single slide-valve, and with an ample firegrate uncontracted by firebricks (as is the custom with the racers when on trial), the consumption of coal (7.6 lb. per horse power per hour) was not so immoderate; and we venture to say that not one of the leading makers would guarantee their ordinary engines for a less average consumption.

We declined the second trial, as we should have done the first had the choice rested with us. To have had our engine on trial in the middle of the show week would have caused us immense inconvenience.

Yours faithfully,
St. Peter's Ironworks, Ipswich, E. R. AND F. TURNER.
7th August, 1867.

[When the Royal Agricultural Society offer prizes for the best steam-engines, as tested according to their own absurd mode of trial, and twenty or more makers enter their engines for the race, one would suppose that the competitors would take care to so construct and work their engines as to come off somewhere near the winning-post. The leading makers do this; but the gentlemen who are "nowhere," and who apparently do not wish to be anywhere—so stubborn is their resistance to the ordinary principles of competition and to the teachings of the commonest business experience—come whimpering with their "Please, sir, 'mine was a commercial engine, and I only entered it as such.' Messrs. Turner's 'commercial' engine swallowed 7½ lb. of coal per horse power per hour at the brake at Bury. It requires a racing engine to work down to 2½ lb. or 3 lb., but it needs no conjuring to keep under 6 lb. Messrs. Brown and May's double-cylinder engine was the best of the ordinary "commercial" engines tried at the late show, and they burnt but 4.15 lb. of coal for the same work. This had steam-jacketed cylinders, although we inadvertently said, three weeks ago, that they were not jacketed, but otherwise it had no complication, and, indeed, no striking peculiarity. In fact, it was simplicity itself. We are certain that half-a-dozen makers, if not a dozen, would guarantee, not only a better result than our correspondents attained at Bury, but a better than they got from the same engine at their own works, viz., $\frac{14 \text{ lb.}}{24 \text{ hours}} = 5.6 \text{ lb. of coal per horse power per hour.}—\text{ED. E.]$

MR. JOHN FOWLER AND MR. WILLI
(For Description, &c)



see Page 102.)



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. 3176, 10d.) August Hermann and Henry Brethauer, of New Haven, Connecticut, U.S., patent a method of discharging bilge water from vessels. The apparatus they propose to use for this purpose consists of a kind of centrifugal pump placed in a casing constructed over an opening in the bottom of the vessel. A sluice is provided for admitting the bilge water into this casing and thence into the centre of the pump, which latter revolves horizontally. The pump consists of a hollow cylinder, having three or more projecting chambers fitted with valves opening outwards. The water will be discharged through these valves when the pump is rotated; but from the nature of the arrangement we should think that but a small percentage of the power applied to drive the pump would be utilised.

(No. 3178, 1s. 2d.) William Horatio Harfield, of 2, Royal Exchange-buildings, patents a form of chain-cable holder, and also an arrangement of driving-gear for capstans. In this latter the capstan is driven by a pair of horizontal engines fixed to the underside of the deck on which the capstan is placed, the object of using "overhead" engines in this way being to leave the deck space clear.

(No. 3186, 1s. 6d.) George Haseltine, of 8, Southampton-buildings, patents as the agent of John Gould Perry, of South Kingston, Rhode Island, U.S., numerous improvements in the details of reaping and mowing machines, which could not be described without reference to drawings.

(No. 3187, 8d.) Ferdinand Kohn patents, as a communication from Frederick James Vivian Minchin, of Aska, an arrangement of machine for cutting sugar cane into thin slices preparatory to the saccharine matter being extracted from it by Roberts's diffusion process—a process which has been already described in **ENGINEERING**.

(No. 3189, 8d.) William Haden Richardson, of Glasgow, patents the employment in the puddling process of a tubular "rabble," through which air or gas is forced into the metal under treatment. The use of a tubular rabble in this way is obviously an infringement of Mr. Bessemer's patents. Our readers will find some further remarks on Mr. Richardson's plan on another page of the present number.

(No. 3197, 1s.) Thomas Bridges and Joshua Bigwood, of Wolverhampton, patent the application to a boiler furnace of a kind of box-shaped fire-door, the back and front plates of this door being perforated, and the corresponding perforations of the two plates being connected by perforated tubes. The passage of air through these tubes is regulated by a sliding plate placed over their inner ends, and it is intended that the air entering them should pass out through the perforations in them, and should become heated by circulating in the hollow fire-door before entering the furnace through the holes provided for the purpose. We fear that the amount of heat thus imparted to the air would be exceedingly slight. An arrangement for admitting air through hollow castings placed at the bridge of the furnace is also included in the patent. This is not new.

(No. 3200, 8d.) John Toward, of St. Ann's-row, Newcastle-on-Tyne, patents a form a brick-making machine, in which the clay is fed into a series of moulds formed round the circumference of a wheel, which revolves vertically round a hollow axis. The bottoms of the moulds are formed by the ends of a series of radial arms, which turn round an axis eccentric to that of the wheel, the positions of the two axes being such that the clay is thrust out of each mould in turn as it arrives at the lowest point of its rotation.

(No. 3203, 2s.) Thomas Jonas Chubb, of Brooklyn, U.S., patents a method of manufacturing steel or steely iron direct from the ore, and also some forms of furnace for carrying out the process. According to this plan, iron sand or iron ore, pulverised and artificially purified, is taken and mixed with carbonaceous and glutinous substances, and then formed into balls or lumps; or the ore and carbonaceous substances are placed loose into the furnace. The furnace in which the conversion and melting down of the metal is carried on consists of a long tubular chamber divided into two compartments, the upper one being termed the carbonising and the lower one the melting chamber. The whole of the long tubular chamber is inclined, so that the materials may readily be shifted down from the top to the bottom.

The patent also includes some special forms of gas furnace and other details for carrying out the process.

(No. 3206, 4d.) James Barwick and Samuel Tindall, of Silvertown, patent forming packing for piston-rods, &c., of hard india-rubber or ebonite, reduced to dust or shavings and mixed with oil or grease. The mixture is applied to the rod to be packed between layers of spun yarn or other fibrous material, or it is filled into tubes of coarse linen, these tubes being coiled into the stuffing-boxes and compressed by the gland in the ordinary way.

(No. 3207, 8d.) William Clark, of 53, Chancery-lane, patents, as the agent of Auguste Gerin, of 29, Boulevard St. Martin, Paris, an extraordinary form of rotary engine. This consists of a number of cylinders projecting tangentially from a casting fixed on a central axis. Each cylinder is furnished with a piston, the rod of which carries a weight at its outer end. The pistons of each pair of diametrically opposite cylinders are connected by a metallic cord, and it is intended that the motive power shall be obtained by admitting steam into each cylinder in succession, and thus successively forcing the pistons outwards, so as to obtain a preponderance of weight on one side of the axis. Each piston, on being projected outwards, would draw in the piston of the cylinder opposite to it. We fear that there will not be many engines constructed on this plan.

(No. 3210, 10d.) Robert Duncan, of Port Glasgow, patents arrangements for applying auxiliary power to sailing vessels. Mr. Duncan proposes to fit up one or more of the ship's boats with screw engines, these engines being supplied with steam from boilers situated on board the ship itself. The boats are to be secured alongside, and are to be used for towing the vessel when she is becalmed.

(No. 3212, 8d.) Paul Emile de Wissocq, of 11, Rue Richempanse, and Count Louis Kraswiski, of 22, Rue de Penthière, Paris, patent methods of treating the ores of metals, of which the sulphates are soluble in water, with a view of obtaining the metals in the state of oxides. According to these processes, the metals under treatment are first brought into the state of sulphates by roasting, and the sulphate is then dissolved out and converted into hydrochlorate by mixing it with hydrochlorate of soda, and exposing the mixture to a temperature of 7° or 8° below zero Centigrade, or by mixing it with hydrochlorate of lime. The oxide of the metal is obtained from the hydrochlorate by the admixture of lime, which replaces the oxide, the latter being deposited in a minute state of subdivision. Some forms of furnace for roasting the ore are included in the patent.

THE NEW LIME-STREET STATION, LIVERPOOL.

THE London and North-Western Railway Company have for the past three years been engaged in carrying out some of the most important works which have ever been undertaken in the history of the company. Among these, next to the immense viaduct over the Mersey, at Runcorn, the progress of which we have chronicled from time to time, is the construction of a entirely new terminus and hotel at Liverpool. The present station was erected in 1836 by the Liverpool and Manchester and Grand Junction Railway Companies on the site of the old cattle-market in Lime-street. The front is ornamented by thirty-six three-quarter columns of the Corinthian order, and has four large entrances. The offices recede under a portico, approached from Lord Nelson-street, which is sustained by a long colonnade of Doric pillars, and above which is an extensive balcony. The present roof of the station is arched, and is formed of iron, and spaced with windows. The girders terminate at the east end in seven perforated and elaborately traced iron circles which spring from the buildings on the north side, and are supported at the opposite extremity on strong cast-iron pillars. For many years the station was found to be most admirably adapted to the purpose for which it was designed. But of late years the number of trains requiring to be marshalled and despatched was found to be too great for the capacity of the old terminus. The trains now arrive and start every few minutes, the aggregate of the departures averaging nearly 2000 daily. Now all the old arrangements are to be altered, by the heavy work of extending the superficial area of the station, and erecting on the foundation of the old one of the most costly and capacious termini of modern times. It is intended that a vast hotel, similar to the Westminster Palace and other first-class hotels in London, shall stand on the frontage now occupied by the booking and other offices. But it is not considered advisable to proceed with this part of the work until the station works have been first com-

pleted. A large number of men have been employed in pulling down the houses in the streets adjoining the station, and others in doing the necessary excavations, and this part of the work is now almost completed. Indeed, considering the magnitude of the works, everything is in a very forward state. At the south side a new line of rails has laid down, and a new platform constructed, together with a temporary roof thrown over. One of the streets which the company had some difficulty in obtaining possession of was Hotham-street. It has now been closed against carriage traffic, and, as agreed upon with the Liverpool Corporation, the Company are putting up a foot-bridge, which is intended to be a continuous lattice girder with a column dividing it in the centre into two spaces. The booking-offices will occupy the space of the old refreshment-rooms, and will open out upon a platform of 50 ft. in width, extending from the departure to the arrival side, the proposed hotel being on the right, and underneath it the new refreshment-rooms. Four of the principal platforms will branch to the left in the same way as those at the Cannon-street station. These platforms are in course of formation, and they will shortly be completed. One of them has been already opened. Formerly the trains were all drawn into the Edge-hill tunnel by horses. At present this is done by a locomotive engine stationed at Lime-street, and when the enlargement of the station is finally completed, it is intended, with the view of facilitating the arrival and departure of trains, that all trains shall be despatched up the tunnel to Edge-hill by engines of great power. The new station will have six distinct lines of rails running the entire length for the despatching and receiving of trains, and the platforms to them will be broad and commodious.

The roof of the enlarged station will be an important engineering work. It has been designed by Mr. Baker, chief engineer to the London and North-Western Railway Company, and it will be constructed of iron and glass in one clear span, and will be one of the largest in the world. Mr. Baker has not failed to make it remarkable for boldness of conception and gracefulness of outline. It will be a work of no slight character to throw such a roof over a station where the despatch and arrival of trains is almost continuous. The Darlestone Iron Bridge and Roofing Company (Limited) have, we understand, been entrusted with the erection of the first half of this colossal wrought-iron roof.

THE SOCIETY OF ENGINEERS.

TO THE EDITOR OF **ENGINEERING**.

SIR,—Having seen the reply to Mr. Thomas Hughes, M.P., upon his inquiry regarding the granting of a royal charter to the Society of Engineers, I regret to see that the Government should bear out the Board of Trade in their only objection to grant our society a royal charter, as the name is "so closely resembling that of the Institution of Civil Engineers." This seems to me to be an assertion which is quite incomprehensible to ordinary minds, for how can two names of two associations of engineers be more dissimilar, unless we entirely leave out the name of engineers, which suggestion was certainly made by the Duke of Richmond when we waited upon his Grace, the other day, regarding the charter.

But although it is the general wish of our members to obtain a royal charter, I am sure that no one would consent to change the name of our society by replacing the word "engineers" by something else; in fact, we might as well be asked to change our profession. That the two names, the "Institution of Civil Engineers" and the "Society of Engineers," are very dissimilar is so plain, that I shall not attempt to give further explanation upon this point; but it is perhaps not so well known that papers read and discussed in the "Institution" are almost exclusively confined to civil engineering, whereas the majority of subjects brought before the "Society" are more particularly confined to mechanical engineering, although now and then papers on civil engineering are also read and discussed.

It seems, therefore, unfair that the two associations of engineers, representing the two main branches of engineering here in London, should not be entitled to enjoy the same privileges; and if the only objection brought against the "Society" holds good, it would seem to indicate that hereafter members of the Society of Engineers are hardly entitled to call themselves engineers, or use the name at all, a monopoly which I am sure the members of the Institution of Civil Engineers would not wish to claim, nor could it ever be maintained if they did.

I am, Sir, your obedient servant,
LEWIS OLDRICK, M.I.M.E.

27, Leadenhall-street, August 8, 1867.

[Our correspondent is not justified in saying that "the Government has borne out the Board of Trade," since no refusal of the charter has been communicated. Mr. Cave, the Vice-President of the Board of Trade, spoke only for his own department.—ED. E.]

METALLURGY IN PRUSSIA.—In 1837, the quantity of pig iron made in Prussia was 82,137 tons. In 1846 the total had grown to 96,766 tons; in 1856, to 330,740 tons; and in 1865, to 740,222 tons. There has been a corresponding increase in the production of rolled iron and rails in Prussia. In 1837, this production attained a total of 58,721 tons; in 1846, it had grown to 129,665 tons; in 1856, to 274,411 tons; and in 1865, it stood at 404,294 tons.

PUBLISHER'S ANNOUNCEMENT.

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ENGINEERING.

FRIDAY, AUGUST 9, 1867.

PNEUMATIC PUDDLING.

SOME experiments have been made in Glasgow in puddling iron with the aid of a movable blast-pipe called a "tubular rabble," not that it is used to bring successive portions of the melted pig up to the surface, to be acted upon by the open air, but it resembles a rabble in appearance, and its end is dipped into and moved about in the metal so as to introduce the compressed air in streams at all parts of the charge. This use of a movable blast-pipe is described at some length in the *Practical Mechanics' Journal* as "The Richardson Process." It is covered, however, by Mr. Bessemer's patent of December, 1855, which was for "improvements in the manufacture of iron" (not of steel), and from the specification of which we make the following extracts:

"I use a reverberatory or puddling furnace similar to those in general use, making the hearth, however, a little deeper; and on the sides thereof, at any convenient distance apart, I place hollow fire lumps having a hole or holes therein below the level of the metal; or, in lieu thereof, I use one or more pipes which have their lower ends inserted in the fluid metal, for the purpose of conducting streams of air into it. The charge of iron, having been put in and piled up, as is usual in puddling furnaces, is allowed to melt slowly and run down on to the hearth; the air from the blowing-machine is then turned into branch pipes leading into the hollow fire lumps before referred to, or into the pipes which dip direct into the iron, meanwhile the workmen should rake the metal about with an implement in the manner generally practised, until the iron is in such a condition as will allow the balling operation to be carried on, after which the squeezing, shingling, or other processes common to the manufacture of bar-iron, may be proceeded with."

Again:

"When the workman (who moves the iron about with a tool as usual) judges that the iron is sufficiently freed from its impurities, he may form it into balls in the manner now commonly practised. Should it be preferred to force air into and below the surface of the fluid iron by means of pipes, I make openings in the side walls of the furnace, through which I insert LOOSELY the fireclay pipes, which may be made and connected to the blast pipe in the manner hereinbefore described, and represented at Fig. 6, sheet A of the annexed drawings, so that the pipes may be put into or taken out of the furnace as required."

"In the methods hereinbefore described, of carrying out my improvements in the manufacture of iron, I have sought to adapt them to the other processes of the manufacture as at present generally practised in Great Britain, and whereby the said improvements may the more readily be brought into operation; but I wish it to be understood that, except in such cases as the aforesaid adaptation may be found expedient, I carry out the refinement of pig or crude iron by a single process, and cast the same into ingots suitable for rolling at once into bars or rods."

Mr. Bessemer having mentioned, in his specification, that steam as well as air may be employed, finishes

with the following disclaimer: "I am also aware that steam has been forced into fluid cast iron when undergoing the puddling process, by a workman using a hollow or tubular rabble. And I am also aware that it has before been proposed to employ a series of sliding-tubes through the upper part of a puddling furnace, for the purpose of blowing streams of steam in contact with the fluid metal in such furnaces; and I mention these facts in order to state that I make no claim to the introduction of streams of steam into a puddling furnace where iron is undergoing the process of puddling; but what I do claim is, forcing air into or below the surface of fluid crude or cast iron in a puddling furnace, through passages, pipes, or tuyeres, the orifices of which are situated below the surface of the fluid metal."

In all Mr. Bessemer's early experiments in making malleable iron, an iron pipe having a piece of burned fireclay at one end, and a flexible pipe at the other, was used to convey the air into the molten iron; the elastic pipe allowed the blast-pipe to be put down into the iron or withdrawn at pleasure.

Why does Richardson use a rabble to convey the air into the iron, or, rather, why does he call the blast-pipe a rabble at all, since it is not used as such; for he says, "As soon as the blast is withdrawn, the charge is stirred about in the ordinary way by a common rabble until the iron has separated from the cinders in lumps, after which it is collected and balled up in the ordinary manner?"

Indeed, if the hollow rabble were used to stir the metal after the blast is turned off, the orifices in it would be immediately filled up. So Mr. Bessemer used a movable pipe, or pipes, which were withdrawn when the blowing was not required any longer, and used an ordinary rabble to puddle with.

Mr. Richardson has used a blast of 5 lb. or 6 lb. per square inch, keeping this on about 6½ minutes and then puddling with a common rabble for half an hour longer. The average time of his heats, with 4 cwt. charges, and including melting, was 1 hour 11 minutes.

THE CORLISS ENGINE.

It will be interesting at this time to know what has been done in the way of introducing the Corliss engine into this country. The first engine of this description set up in the kingdom was by Mr. Corliss himself, at Pirie's paper-mills, Aberdeen. Since then Mr. Robert Douglas, of Kirkcaldy, has made and has in hand the following Corliss engines: six with 24 in. cylinders each, four of 18 in. cylinders, four of 16 in., one of 26 in., one of 25 in., and one of 20 in.—seventeen in all.

Next to Mr. Douglas, Messrs. Hick, Hargreaves and Co., of Bolton, have been the leading makers of Corliss engines. They have made a single-cylinder condensing engine of 40 in. cylinder and 5 ft. stroke, for Malcolm, Ogilvy and Co., of Dundee; a condensing engine with a single cylinder, 30 in. by 5 ft. stroke, for Wallis and Pollock, of Cork; a condensing engine with a single 20 in. cylinder and 4 ft. stroke, for Whiteley and Sons, of Halifax; a non-condensing engine, with a 16 in. cylinder, 3 ft. stroke, for Mr. Mackarel, of Bolton; a non-condensing engine, with a 24 in. cylinder and 3 ft. stroke, for the maker's own works; a condensing engine (second order), of 24 in. cylinder and 4 ft. stroke, for Messrs. A. Pirie and Son, of Aberdeen; a surface-condensing engine, of 24 in. cylinder and 4 ft. stroke, for Woolwich Arsenal; and two more of the same size, for the same establishment, being a second order; a condensing engine of 20 in. cylinder and 4 ft. stroke, for a spinning-mill in Ireland; a non-condensing engine with a 24 in. cylinder and 3 ft. stroke, for Messrs. Platt Brothers, of Oldham; a condensing engine of 36 in. cylinder and 5 ft. stroke, for James Combe and Co., of Belfast; two surface-condensing engines of 20 in. cylinders and 4 ft. stroke, being a second order from Dugdale Brothers and Co., of Blackburn; a condensing engine, of 15 in. cylinder and 3 ft. stroke, for Dickinson and Co.; another, of 18 in. cylinder and 4 ft. stroke, for Turner and Co.; another, a beam condensing engine, of 34 in. cylinder and 7 ft. stroke, for Mr. Briggs, of Bolton; a non-condensing 24 in. cylinder, 4 ft. stroke, for Mr. Windley, of Nottingham; and one, a non-condensing engine, of 18 in. cylinder and 4 ft. stroke, for Wrigley and Sons, the great paper-makers at Bury.

Besides these, Messrs. Losh, Wilson, and Bell, of Gateshead, Newcastle-on-Tyne, have made a pair of surface-condensing Corliss engines, of 38 in. cylinders and 5 ft. stroke, for Messrs. Illingworth and Sons, of Bradford, a condensing engine, of 22 in. cylinder and 3 ft. stroke, for Titus Salt, Sons and Co., of Saltaire; a pair of surface-condensing engines, of 32 in. cylinders and 5 ft. stroke, for Dugdale Brothers and

Co., of Blackburn; a condensing engine with 18 in. cylinder and 4 ft. stroke, for the Forfar Flour Mills; and a condensing engine with 30 in. cylinder and 5 ft. stroke, for John Shaw and Sons, of Halifax.

Besides these, Messrs. Carmichaels, of Dundee, have in hand five Corliss engines for factories in their town; and Manlove, Alliott, and Co., of Nottingham, and the Reading Ironworks Company—the latter a non-dividend-paying concern, however—have each made one, both non-condensing, the former 16 in. cylinder, 3 ft. stroke, the latter 11½ in. cylinder and 2 ft. stroke.

WOOD-WORKING MACHINERY AT THE PARIS EXHIBITION.

THE reports of the English jurors at the Paris Exhibition, as we announced, some weeks before their appearance, that they would be, are being printed in the *Illustrated London News*, and we quite agree that, considering all classes of exhibits, no better medium could have been selected by the Government. Last week, however, we find the report of Colonel Anderson, of Woolwich Arsenal, upon iron and wood working tools. Colonel Anderson, without intention, we are sure, has committed a grave injustice to the principal exhibitors of wood-working machinery, the only exhibitors who gained even a silver medal—the highest medal granted to exhibits in this class. These makers are the first and leading English constructors of wood-working machinery, Messrs. Samuel Worssam and Co., of 304, King's-road, Chelsea, London, S.W. Colonel Anderson does not even mention them, but awards his chief praise to a rising and very deserving provincial firm, and afterwards picks out a couple of London copyists of Worssam and Co., firms whose names are so little known that we are justified in forgetting them. We know Colonel Anderson too well to believe that his report had any intentional leaning towards any firm, but we are not the less compelled to point out that the very first house in the trade, the only house that received the silver medal at Paris (the highest medal given for wood-working machinery), is wholly omitted from his report, and that certain new and comparatively unknown London firms, who have done nothing but copy them, are awarded a prominence wholly undeserved, and which the jury did not in any way recognise.

LORD H. LENNOX AND "THE ENGINEER."

THE Secretary of the Admiralty has been well laughed at, this week, for having mentioned, although he did not quote, that laughing-stock of our profession, *The Engineer*, in the House of Commons. It was true that he mentioned it only to condemn it, but he might as well have fired his broadside at the *Bumblepuppy Gazette*. Most of the leading members of our profession, as we are in a position to know, never see the paper, and the younger members make it the cruel sport of egregious hoaxes, which it swallows with an avidity almost incredible, until these are identified by chapter and verse. The only explanation of the fact that its name is ever heard at all is afforded by its astonishing blunders, and by the circumstance that it is living upon a past reputation for accuracy long since forfeited. How could Lord H. Lennox even say that "*The Engineer* drew a very vivacious, but not very complimentary, picture of the statements he 'had made'?" As if it mattered what that shallow vehicle of incompetency, Irish bulls, and atrocious blunders might "draw." *The Engineer* is the paper which invented the ridiculous report, last year, that Mr. Fowler, the president of the Institution of Civil Engineers, and the engineer in chief of the Metropolitan District Railway, bound hand and foot by Act of Parliament, was nevertheless about to make his railway in open cutting along the Thames Embankment! The editor of the paper had, he said, actually seen the drawings of the proposed cutting, and this when none existed, and when, indeed, he had no admittance to the engineer's office. The same paper invented the still more ridiculous report that the six streets converging in the Place de l'Europe, at Paris, had, for many years, crossed the Western Railway on a level, and devoted a whole column to the imaginary horrors of such a state of things. The same journal also brought out that famous hoax, "the Rumble engine," with full-page engravings, as actually designed "for one of our great English lines," and, although it was ridiculous to the locomotive engineer, pronounced it, in almost so many words, a monument of knowledge and skill. This was no ordinary slip—and, Heaven knows, there are slips enough, every week, in this extraordinary publication—but it was elaborated with all the editorial and typographic

energy of which a paper in its second childhood was capable. Then came a thundering leading article, at the beginning of the year, nine columns long, which sat not many, it is true (for but few saw it), in a roar, for its enormous ignorance and defiance of all grammar and rhetoric. Later, it printed a private and confidential paper, not obtained by any address or energy, but circulated freely among a few supposed friends, a paper marked "private and confidential" as plain as pen and ink could mark it, and, if we are not misinformed, the journal in question is already in the hands of the lawyers for a disgraceful libel which it afterwards published in connexion with this document. More lately it has covered itself with laughter for the wretched reports which it has given of the Paris Exhibition, in which so many articles are incorrectly described, and in many cases English manufactures are grossly disparaged, through either sheer ignorance or the most unpatriotic intention. Last of all came its report of the Royal Agricultural Show at Bury, a report which could only have been written by a lunatic or a drunken man—a report which abounded in the most egregious blunders, beyond even the belief of any engineer, unless he read them for himself, and which has at last overthrown, in the minds of the faithful public, nearly all the confidence which a past reputation had won. *The Engineer* is to-day the laughing-stock of the pupils in three-fourths of the offices in the kingdom; and yet this is the paper which Lord H. Lennox, no doubt confounding *The Engineer* of 1867 with that of 1862, actually mentioned in the House of Commons as defending that abortion, the Henwood scheme. This scheme was, intrinsically, too unsound to receive any intelligent support, and it has been accordingly shelved at the Admiralty, although the real reasons do not appear so plainly in Lord H. Lennox's reply to Mr. Hanbury Tracy. It is not because Henwood did not know how to calculate rightly his draughts and displacements that the Admiralty rejected him, although these might appear good reasons for sending him about his business; but that his whole notion of making a first-class iron-clad fleet out of half a hundred half-rotted timber ships of the line, all of them slow ships on the mile, was too obviously ridiculous for any serious consideration.

THE WILSON FURNACE.

THE Wilson furnace—in other words, the downward-draught puddling furnace—has been stamped with the broad seal of success. At the Bolton Iron and Steel Company's Works this furnace is puddling 20 cwt. of blooms from 21½ cwt. of pigs, and this with but one ton of coal, and this again without smoke. Nothing like this has ever been known before in puddling. Mr. Wilson has stood by his furnace from first to last, and is now making the reasons of its singular success understood. It is simply by the aid of the downward draught that he properly mixes the gas from slack coal with air. We have written searching letters to Hick, Hargreaves and Co., of Bolton, and to others interested in supporting, and to others still interested in opposing, this new claimant to favour, and we are bound to admit that the replies are such as convince us that it is at last achieving wonderful results. It is giving a ton of puddled blooms to a ton of coal, and that without smoke, and with but a minimum of waste of metal, say 21½ cwt. of pigs per ton of blooms.

The Wilson furnace is the most extraordinary invention of its class yet brought out, saving nearly, if not quite, half the fuel commonly employed for the same purposes. We write after having corresponding closely with Hicks, Hargreaves and Co., the Bolton Steel and Iron Company, and other large firms in a position to know all the facts.

NOTES FROM INDIA.

It is stated to be the intention of the Messageries Impériales to establish a new line of steamers between Suez and Bombay, and another line from Suez to Point de Galle, Saigon, Hong-Kong, and Yokohama.

A vein of silver has been discovered in the Sir Khunee Hills, in the native state of Rewa. The Maharajah has given orders for the commencement of mining works.

Lieut.-Colonel T. G. Glover, R.E., officiating Director-General of Telegraphs in India, has obtained sick leave to England. Major Murray, Deputy Director-General of Telegraphs, will officiate for him during his absence.

Major Smith, R.E., acting-director of the Persian branch of the Indo-European Telegraph, has reported that the double line has now been completed through Persia, and the Persian route is now open by day and night, and is in good working order. As the charges by messages by this route are considerably less than *via* Turkey, the public may now make more extensive use of it.

The Peninsula and Oriental Steam Navigation Com-

pany's new dock at Bombay was opened on June 17, but the channel leading to the entrance has yet to be considerably deepened.

The site for another new light-house at the entrance to Bombay harbour has now been settled. It is to be erected about 1½ miles S.W. by S. of the existing Colaba light.

The Government of India has published the fact that it considers the general results of the employment of British soldiers on the Murree and Abbottabad road, during the season of 1866, to be highly satisfactory, and is of opinion that their re-employment on similar duty during the ensuing season is very desirable.

The Secretary of State has ruled, in a recent despatch, that an uncovenanted servant of the Government is not entitled in all cases to the full amount of the pension proportioned to his length of service. Such a reward must be held out to "approved service" only. This decision is one which will scarcely give satisfaction to the uncovenanted service, to which the engineers sent out from this country all belong; for, so far as we are aware, no definition of "approved service" has ever been made. The pension of an uncovenanted officer will, therefore (says the *Englishman*), for the future depend upon the favour of his departmental superior for the time being.

The Exhibition of the Bengal Photographic Society, next December, is to be open for photographs taken within the previous two years, and a smaller number of pictures will be required to gain the prizes. The viceroy has offered a gold medal for the best single photograph, whether portrait or landscape, by whomsoever taken. Mr. Grey, the lieutenant-governor, will give a gold medal for the best series of six landscapes taken in or out of India by a member of the society. The society's prizes are offered only to its own members. The secretary will present a silver medal for a series of six good transparencies suitable for the stereoscope or magic lantern, taken either in or out of India, open to all photographers.

A bill of great importance to the coffee-producing districts of Wynaad has been brought before the legislative council. Hitherto, one of the greatest drawbacks to the prosperity of the Wynaad has been the want of suitable roads to the ports of shipment, and many and loud have been the complaints of the planters in consequence. Of late, however, Government has actively helped them, and soon it is hoped that the main roads now in course of construction will be finished. The present bill is intended to induce the planters themselves to complete the system of communication, by empowering them to levy tolls on cross-roads constructed by them, from their estates, so as to reimburse themselves, in a measure, for the outlay in construction, and to provide funds for their maintenance. The measure is considered, by those most interested in it, to be a very desirable one, and one that has every prospect of proving both practical and useful.

Mr. A. J. Stuart, acting head assistant-collector, Kistna district, reports that he has visited the villages in the neighbourhood of Juggiapettah, in which it is hoped that coal may be found, but could not learn that anything was known on the subject to the natives. He offered a reward of twenty rupees for any information, but hitherto without success. He also made a collection of specimens from all the rocks in the neighbourhood, and an index referring to the places where they were found, as well as a geological map of the country, so far as he was able to name the specimens found. Mr. Stuart also dug in several places, as indicated by Major Applegarth, but was soon obliged to stop by coming to water. He nowhere found anything to lead him to hope for success. He found a considerable quantity of a soft white rock, which would be suitable for the manufacture of porcelain, and he proposes to send specimens of this to Dr. Hunter, for trial at the School of Arts.

THE SOCIETY OF ENGINEERS.

THE following is a copy of a petition, lodged by the council of the Institution of Civil Engineers, against the petition of the Society of Engineers for a royal charter, empowering them to sue and be sued as a corporate body, and to hold property of the annual value of 1000*l.* yearly, privileges which can, of course, be taken at will under the Companies Act of 1862:

To the Queen's Most Excellent Majesty in Council.

The humble petition of the Institution of Civil Engineers humbly sheweth,—That the Institution of Civil Engineers was originally established in the year 1818, and by a charter granted by his late Majesty King George the Fourth, and dated the 3rd day of June, in the ninth year of his reign (being the year of our Lord 1828), after reciting, among other things, that Thomas Telford, Esq., a Fellow of the Royal Societies of London and Edinburgh, and others, had formed themselves into a society for the general advancement of mechanical science, and more particularly for promoting the acquisition of that species of knowledge which constitutes the profession of a civil engineer, being the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states, both for external and internal commerce, as applied in the construction of roads, bridges, aqueducts, canals, river-navigation, and docks for internal intercourse and exchange, and in the construction of ports, harbours, moles, breakwaters, and lighthouses, and in the art of navigation by artificial power for the purposes of commerce, and in the construction and adaptation of machinery, and in the drainage of cities and towns, his said Majesty did will, grant, and declare that the said

Thomas Telford and such others as had formed themselves into and were then members of the said society, or should at any time thereafter become members thereof according to such regulations or by-laws as should thereafter be framed or enacted, should by virtue thereof be the members of and form one body politic and corporate for the purposes aforesaid, by the name of "The Institution of Civil Engineers," by which name they should have perpetual succession and a common seal, and by the same name to sue and be sued, implead and be impleaded, answer and be answered unto in every court of his said Majesty, his heirs and successors.

That the Institution of Civil Engineers has been recognised ever since its first establishment, and more particularly since the granting of the said charter, by the British Government, and by the Houses of Parliament, and also by foreign powers, as the representative body of the engineering profession in the United Kingdom.

That your petitioners have been informed and believe that a petition has been presented to your Majesty, praying that a charter of incorporation may be granted to a society calling itself "Society of Engineers."

That your petitioners have also been informed and believe that such new society was first established in the month of May, 1854.

That according to the original constitution of this new society, it was not necessary that the members of it should be engineers, or connected with engineering pursuits; and according to its rules and by-laws published so lately as the year 1866, it was established for the discussion of scientific and other subjects of general interest; but in the year 1867 the professed object has been altered, and is now stated to be established for the advancement of engineering science and practice.

That the said society holds its meetings at the Lower Hall, Exeter Hall, Strand.

That your petitioners feel convinced that the title of "Society of Engineers" adopted by this society has already had the effect of misleading the public, and has led to the supposition that the Institution of Civil Engineers and the "Society of Engineers" were one and the same body, and has given to this new society the appearance of being connected with your petitioners' Institution, and has also given it a footing and standing with the scientific world which it would not otherwise possess; and should a charter be granted to it, these evil consequences to your petitioners would be augmented to a very great extent, and would be of a very serious character.

That should a royal charter be granted by your Majesty to this new society by the name of "Society of Engineers," great mistakes and confusion would undoubtedly arise in many respects in consequence of the similarity of the name of your petitioners, of "the Institution of Civil Engineers," and the name proposed to be adopted by this new society, of "Society of Engineers," in the following among other instances: references contained in Acts of Parliament, in parliamentary and other agreements, contracts, references from foreign Governments, and with reference to legacies, which may be intended to be left to your petitioners' Institution.

Your petitioners humbly submit that it is not usual and not expedient to grant charters of incorporation to two different bodies having the same or similar names, or intended, or apparently intended, for the same or similar objects and purposes, and more particularly when such two bodies have their places of meeting, and may be said to exist, in the same city or town.

That your petitioners humbly submit that no other charter of incorporation should be granted by your Majesty to any body or society professing to be a Society of Engineers, or proposing to take as part of its name or title any reference to engineers or engineering, or having a title or name similar to the title or name of your petitioners.

Wherefore, your petitioners humbly pray that your Majesty will be graciously pleased not to grant a charter of incorporation to the said society called "Society of Engineers." Or that if your Majesty shall be graciously pleased to grant the said society a charter of incorporation, then that the corporate name of the said society shall not contain the word "Engineers," or any word having reference to engineers or engineering.

And your petitioners, as in duty bound, will ever pray.

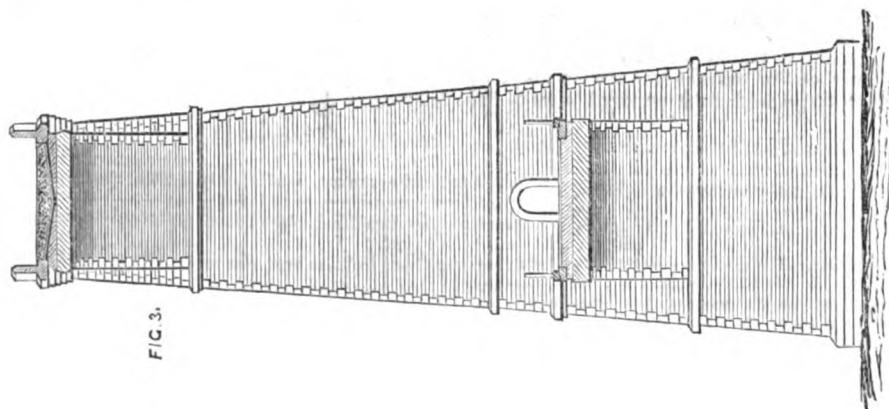
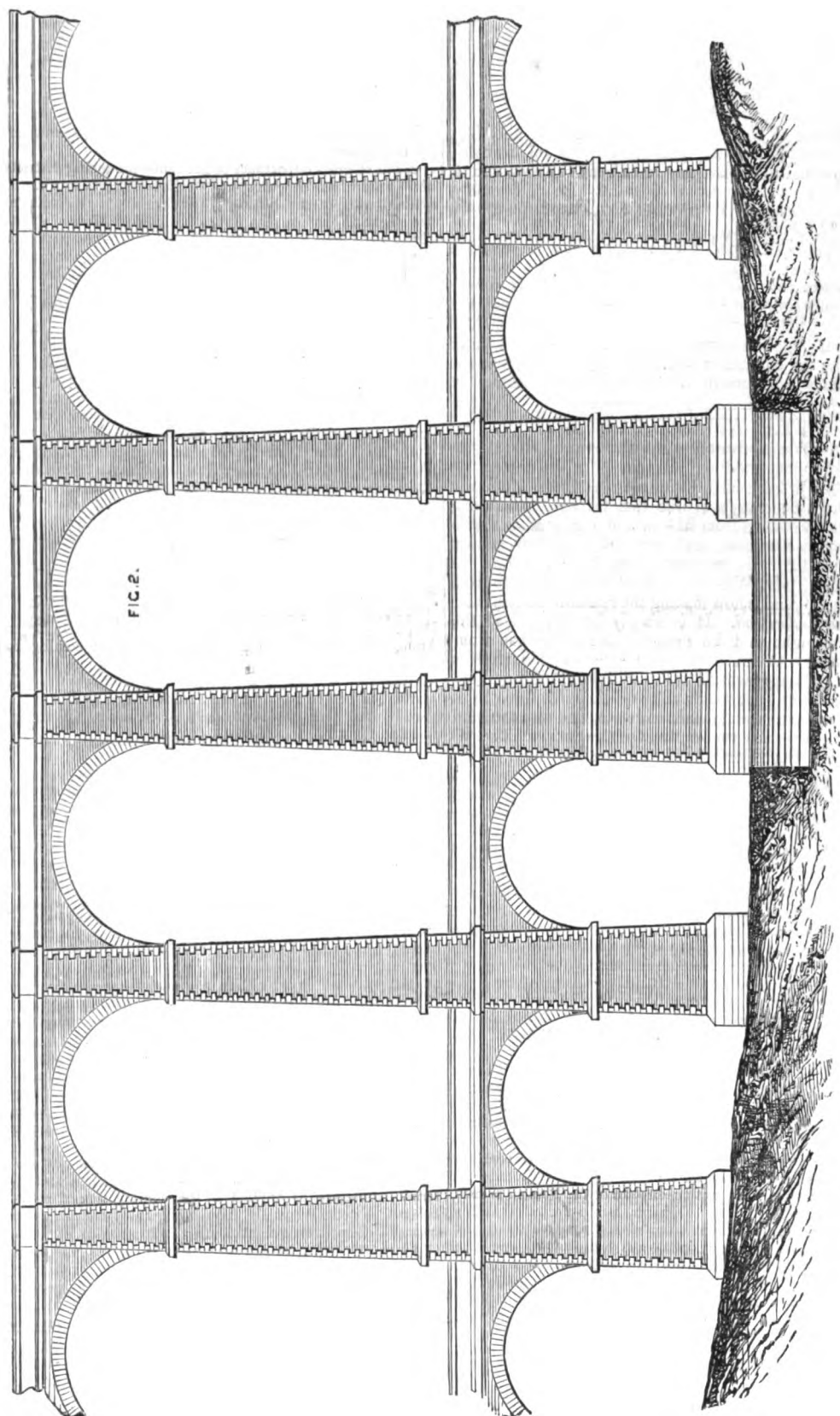
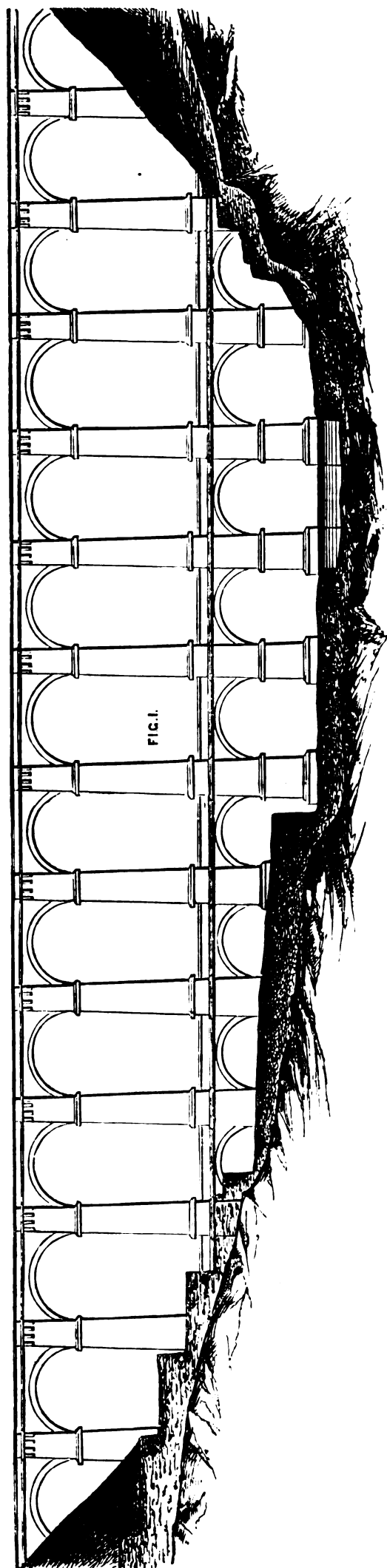
HALF A YEAR'S RAIN.—The variation in the quantity of rain in different parts of the kingdom is shown in the returns just published by the Registrar-General. In the first half of the year 1867 20.5 inches of rain fell at Bristol, 20.1 at Glasgow, 18.2 at Sheffield, 15.3 at Birmingham, 15.4 at Salford, 14.1 at Manchester, 14 at Edinburgh, 13.1 at Dublin, 13 at Leeds, 12.6 at London, 10.1 at Liverpool, and only 8 at New castle.

RAILWAY LOANS.—The contract with the Secretary of State for India in Council, securing to the Indian Branch Railway Company a 5 per cent. guarantee of interest on a capital of 4,000,000*l.* for lines of railway in Oude and Rohilkund, was duly executed on the 2nd inst. The facility with which these 5 per cent. guarantees can be obtained for the service of India from a Government department is a daily subject of comment in contrast with the disinclination of Parliament to recognise a single obligation to attempt to arrest the disastrous confusion that has fallen upon 400 millions of property in home railways, created and administered under their guidance and control, and with regard to which, at the time of their inception, it was declared to have been "proved" that they were each required for the good of the nation.

THE MORLAIX VIADUCT; RENNES AND BREST RAILWAY.

M. PLANCHAT, ENGINEER.

(For Description, see next Page.)



THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with interest the correspondence in *ENGINEERING* respecting the Corliss engine, but I don't think it is at all possible to settle by discussion alone the question whether this engine is better or worse than engines on the ordinary plan. We want statements of facts from those who can give them. Arguments or assertions from parties who know little or nothing about the engine can be of no value, and why should your correspondents attacking this engine do so anonymously? In my own business I frequently receive anonymous letters, but, of course, I never give any attention whatever to such communications; and in a scientific matter, which can be settled only by facts founded on experience and careful experiments, I do not, nor do I suppose do any of your readers, give any consideration to the opinions or the arguments based on the opinions of anonymous letter-writers. It is within my own knowledge that many Corliss engines are giving excellent results, and there must be now a large number of these engines at work in England. It would be a matter of some interest to have reports collected from the owners respecting their working compared with engines on the ordinary plan. The alteration of our large beam engines to the Corliss principle of valve gear will give me an opportunity of testing this point very fairly. I will have careful trials made with the object of obtaining accurate results, so that a fair comparison can be made. When they are completed, I will communicate the results to you for publication. The trials of the engines, with the old and new cylinders, will extend over one month in each case respectively; the steam will be supplied from the same boilers, and indicator diagrams will be taken every hour, so that in each trial there will be upwards of 1000 diagrams taken, from which to compare the power developed, every pound of coal used for the engines will be carefully weighed. Our engines work 20 lb. initial steam pressure on pistons, but as they are regulated by the throttle valve, 30 lb. is carried in the boilers to maintain uniform speed. When the Corliss valve cylinders are fitted, we will get practically the boiler pressure on the pistons. I intend then to reduce the pressure in the boilers, so that the initial steam pressure may remain as it is now.

Your correspondent, "Economy," suggests that I should have trials made with the Corliss engine I recently started, to ascertain the comparative advantage of working with and without a condenser. If he will write to me and give his name, I will see if his suggestion can be carried out. I have no doubt it would be of much interest to have this experiment made.

GEORGE SALT.

Saltaire, Bradford, August 6, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—I do not doubt that most of your mechanical readers are as competent as I am to draw just conclusions from the controversy about the Corliss engine that has been going on in your pages. Nevertheless you may perhaps think it worth while to enable me to state the conclusions which, on a review of the arguments upon both sides, appear to me unavoidable. I agree with you in thinking that no great amount of ability has been shown by the vindicators of the Corliss system in the correspondence you have published. But this remark is not applicable to your leading article of last week, which recapitulates with much ability the professed advantages of the Corliss system, and plausibly repels the objections which have been brought against it. Both sides therefore having been now fairly heard, your readers are in a position to draw their own conclusions, and these conclusions, I venture to say, will not be very widely different from those at which I have arrived.

You state that, whatever individual engines may do, the bulk of ordinary engines work wastefully from various causes, that the Corliss engines do not work wastefully, and that Mr. Corliss, when he first brought out his engine, was content to be paid for it out of the saving of fuel he effected. You also state that the Corliss is favourably distinguished from the common valve gear by opening the ports quickly and wide, whereby full boiler pressure is obtainable on the piston, by the absence of friction on the moving parts, and by the fact of the cutting-off being regulated by the governor—conditions all favourable, you say, to economy. You further state that, although there are a great number of joints in this gear, yet that a multitude of joints is not necessarily an objection; that a watch-chain has many joints, and is yet used; and that this gear is cheap of construction, and gives no trouble. You add that the Corliss engine is not an experiment; that it has made its way against every phase of unbelief; that the objections raised against it are mere declamation; and that only the members of the old school of engineers would characterise the valve gear with its springs, vacuum cylinders, and multitudinous joints as a "rattletrap," as it is those persons alone who would think of using such a phrase.

Now no one, I think, will have difficulty in believing that if the bulk of ordinary engines work wastefully, and if Mr. Corliss in some cases substituted one of his economical engines for one of these wasteful ones, the saving in fuel might be so great as amply to remunerate him for the exchange.

This, however, I submit, is not the question. Of course, if a bad or leaky engine is replaced by a well made and tight one of any construction, a visible economy will be the result. But the question to be determined is whether a better result would be attained by substituting a tight and well-made Corliss engine than by substituting a tight and well-made common engine, working with the same pressure of steam and at the same rate of expansion. Granting that the Corliss gear is cheap and durable, though neither has been proved, is it more cheap and more durable than the gear of common engines? Then is any one so ignorant as not to know that any desired rapidity in opening the ports, and letting in the steam, may be obtained in common gear by making the ports wide and the travel of the valve great? In common engines, fitted with expansion valves, there is no more compression than in the Corliss engine, if the eccentrics are properly set, since there is no need of lap when there is an expansion valve, and it is the use of lap that involves compression. Nor is there more friction in a balanced common valve than in the Corliss valve, however well it may be made and kept. With regard to the statement that the multitude of joints

in the Corliss gear is not necessarily an objection, since there are hundreds of joints in a watch-chain, which will nevertheless work for years, it is sufficient to say that, *ceteris paribus*, a multiplication of joints is unquestionably an objection, but not necessarily so if any compensation is obtained by the peculiarity which will outweigh the mischiefs of the complication. But in the Corliss engine no such compensation has been shown to exist; and if the Corliss system is not an untried experiment, but a system which has been matured and established during eighteen years, surely some evidence of a superior performance over that of common engines would be producible, if such superiority existed. Has there been no time or opportunity for this? Why then is the evidence of a superior performance withheld, if it exists? and if it does not exist, of what value are the other assurances of the system, amounting as they do only to immodest and unsupported assertions? The pins in the Corliss gear differ from those in a watch-chain in this respect, that whereas in the watch-chain there is a slow and steady pull, in the valve-gear there is a rapid and violent reciprocation; and the smallest amount of play in the joints will consequently produce a shock. If there be any new school of engineers which seeks to commend itself to public favour by the introduction of clockwork expedients into heavy steam machinery, it is not difficult to foretell what their fate must be, for rattletraps will be recognised as rattletraps spite of all partisan reclamations, and will be rejected as ineligible by sound mechanics. In the case of the Great Britain, no doubt sixteen pitched chains were originally employed to communicate the motion from the engines to the screw-shaft, and the innovation was sought to be justified by some such arguments as those which you have employed. But although there, as in a watch-chain, the strain was always in one direction, the joints were found to wear, and, spite of all efforts to the contrary, the plan was finally abandoned. While, therefore, I admit that complication is not necessarily an objection, since, in some cases, its effect may be to produce benefits which outweigh its essential evils, it is of itself, and without such compensation, a manifest and undeniable evil, which only those who like to tell the clock by algebra will admire. The complications of the Corliss system find no justification in an economy not otherwise attainable, since no such unique or unprecedented economy is realised; but, on the contrary, this vaunted improvement is excelled in efficiency by many common engines. I see no reason to doubt that an engine on the Corliss system may be made to work well through considerable periods of time. But is such negative praise warrant for the introduction of complications costing more money, involving more wear, and requiring more frequent adjustment, when the same ends are equally attainable by common engines of simpler, cheaper, and more reliable construction? It signifies nothing to the public in England whether Mr. Corliss has a large factory in America or not, or whether there and here he has set to work many engines. The only natural question is, whether his engines can do more than common engines, with less expense, and though the trial has been continued during eighteen years, nobody undertakes to say that they can.

I am, &c.,

A CIVIL ENGINEER.

[It is but just to our readers to know that of the several anonymous correspondents who have written against the Corliss engine, but one, "Observer," is known to us. Few journalists would print the letters of correspondents who will not give their real names in confidence. Yet we have done so, merely because of the appearance of reason contained in the anonymous letters of "A Civil Engineer," "W. H. N.," &c. We find it difficult to resist the suspicion, however, that all these letters are written by the same, "Observer's" hand. The above letter is from M.S., obviously a copy by a schoolboy, the words "suasuries" and "immodest" being clearly foreign to the original. The circumstance may be a trifling one, but they are all posted in the same postal district, the "N.W.," one not inhabited by many engineers; and they are all in much the same tone and style, and all contain the same term, long since banished from engineering discussions until resuscitated by "Observer," the meaningless word to the modern engineer, "rattletraps." We think it but fair, therefore, unless the letters of "A Civil Engineer" and "W. H. N." are acknowledged by gentlemen who are not intimately connected with "Observer" by social or other ties, that they should be considered as proceeding from the same pen, and, so far, they must fail to produce the effect which the weight of numbers, on one side of an argument, and those numbers having no common interest, would obviously carry. All these letters show an ignorance of the history of the Corliss engine, and the writer is (or writers are), therefore, under a disadvantage in dealing with the subject.—Ed. E.]

TO THE EDITOR OF ENGINEERING.

SIR,—I have felt much interested in the discussions that have been going on in your pages on the merits of the Corliss engine, and beg to be allowed to say a few words in its favour.

I gather from the letters of your correspondents that the principal objection urged against it is the unnecessary complication of the valve-gear, and its liability to undue wear and tear. It is not denied that first-rate results have been obtained from it as to power, economy, and regularity of motion; but the question is, is it not possible to obtain the same by the adoption of simpler means; or to put it in another form, as the burden of proof undoubtedly rests with those who propose an innovation, does the duty and saving realised by this engine over and above that by the ordinary engine, and the greater durability of its parts, so far as it has yet been tried, justify its construction with such an apparently complex valve gear? That it will be found superior in these respects I myself have not much doubt; but I should like to see a few more recorded results and facts brought forward in regard to its performance both on land and sea. Such a testimony, together with the opinions and arguments of men whose experience qualifies them to judge correctly of its merits, would I think, notwithstanding the sweeping condemnation passed upon it by "Observer," show that it is fully able to hold its own against any ordinary engine with which it may be compared.

With regard to the valve-gear itself, having had a good deal to do with setting it out, and being well acquainted with its action, I consider the complication more apparent than real, and it by no means follows that because there are many joints and

pins employed in it, that therefore it must speedily get out of order. The makers and users of the engine will for the most part testify to the durability of the working parts, and it must be obvious that were so small an amount of power as is required to work the valves is distributed over so many surfaces the wear upon each will be reduced to a minimum.

"Observer" mentions that he has compared diagrams of this and the ordinary slide-valve engine, and found them equally good.

This is quite possible, but if the Corliss valves are properly set, I will defy "Observer," or any one else, to produce diagrams from an ordinary engine that can possibly compare with those from the Corliss in all grades of expansion.

I believe that the Corliss engine will gain much by the publicity thus given to it, and if some more of its designers and manufacturers will come forward, as I have suggested, to prove its efficiency by facts and figures, it will become more generally known and understood, and, as a consequence, will, I feel sure, rise proportionately higher in the estimation of the profession and of the public at large.

I am, Sir, yours obediently,

S. J. C.

London, July 31, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—As some of your correspondents on this subject have an opinion that good indicator diagrams cannot be obtained from engines with slide valves, we enclose some taken from old horizontal engines which have lately had their slide valves somewhat modified, thereby effecting a considerable saving of fuel, and at the same time steadier turning. The slide valve, wrought by an eccentric in the usual manner, is constructed with a cut-off plate at the back, the exhaust port being made open through to the back of the valve, increasing the pressure on the back plate, and thereby causing it to travel along with the valve. The cut-off ports are double, and are so arranged that by stopping the

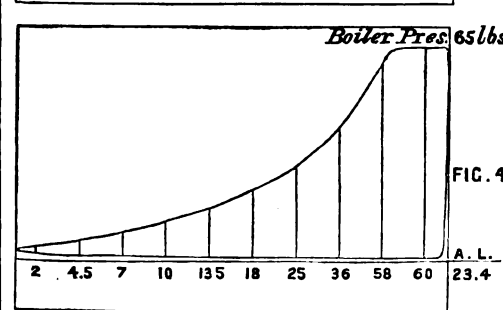
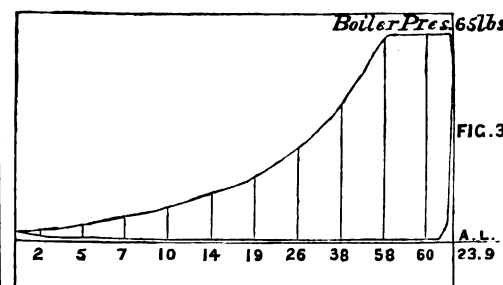
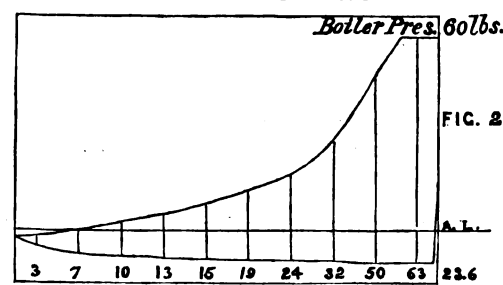
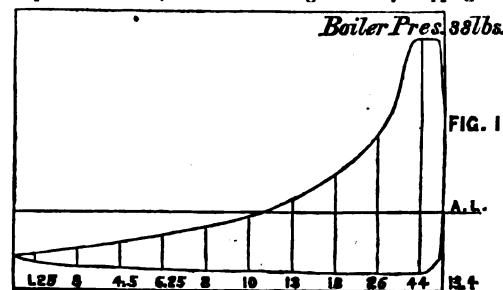


plate before the valve has arrived at the end of its traverse, the steam is cut off from each end of the cylinder alternately. The variable stopping of the plate is effected in the following manner: A brass spindle, passing through a stuffing-box on the steam chest cover, is connected to the cut-off plate by a crank arm; on the other end of this spindle is a disc fitted with two studs projecting on the flat face, and on which are two swivel blocks; between these blocks is an opening through which a tapered bar is wrought by the governor, by this means regulating the traverse of the cut-off plate according to the varying load on the engine; its action is noiseless. We shall be glad to give you any further information, and remain,

Yours respectfully,

SHEPHERD, MULLINER, AND GARSTANG.

Blackburn, July 30, 1867.

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—After all the correspondence which has appeared in your pages on the above subject, there are very few letters written by the opponents of the Corliss engine which prove anything but a desire on the part of their writers to prevent its general introduction, by raising an outcry against it. In your issue of July 19th, a letter appeared, signed "A Civil Engineer," which seems to contain all the "facts" which have been adduced to prove the Corliss inferior to the "common engine." A "Civil Engineer," like most of your correspondents, says that the valve-gear is a "rattletrap," both "noisy" and "complex." It is a great pity that he did not specify what part of the gear constituted the rattletrap. If we are to judge by where the most noise comes from, the dash-pot, air-valves, and the air escaping from them, form the rattletrap (in Mr. Inglis's engines). I beg "W. H. N.'s" pardon for "asserting a fact coming within the sphere of my knowledge" after his letter of the 12th ult., and hope that he will not believe me. Another of the drawbacks attending the use of the Corliss valve-gear enumerated by your correspondent is want of durability at high speeds, caused by its "complexity" and "working with noise and concussion." I have already pointed out that most of the noise is caused by air escaping from the dash-pot; and the concussion is against the air in the dash-pot. It is not, therefore, very clear what part is to be injured by the "noise and concussion," even at a quick speed. As to the complexity of the gear preventing a high speed, the Corliss gear is as simple as that of the Allen engine. That that gear does not prevent a high speed, I think, is proved by the following quotation from a letter from Mr. H. H. Grierson published in your issue of September 7th, 1866:

"Our experience of the Allen valve-gear is that it is admirably adapted for the high speed, which Mr. Porter has advocated; but that such speed is, although practicable, commercially a complete failure." To produce a uniform motion, a "Civil Engineer" thinks a "sensitive governor," a "heavy fly-wheel," and a "swift piston" preferable to any complexity in the valve-gear, even if it (the complexity) possesses other advantages. We have, above, Mr. Grierson's opinion of the advantages of a swift piston. A "Civil Engineer" next compares the economy of Corliss engines (most of which are of small size) with some compound and single cylinder (beam, I suppose) engines at the New River works. Taking his comparison to be correct, I hardly think it would deter a manufacturer from purchasing an engine that would only require 2½ lb. of coal per horse power per hour in preference to a "common engine," which would probably require 4 or 5 lb. per horse power per hour. It is certainly rather amusing to read a "Civil Engineer's" remark, after comparing the Corliss engine with compound beam (?) engines. If it is more complex than the old system, on what conceivable ground can it be recommended? It seems that there are some people who, from "ignorance or obstinacy," will throw impediments in the way of all improvements.

I am, Sir, your obedient Servant,
L.

Does a "Civil Engineer" object to the complexity of the parallel motion, or does he approve of it, because it is an old fashion?

NALDER'S PORTABLE ENGINE.

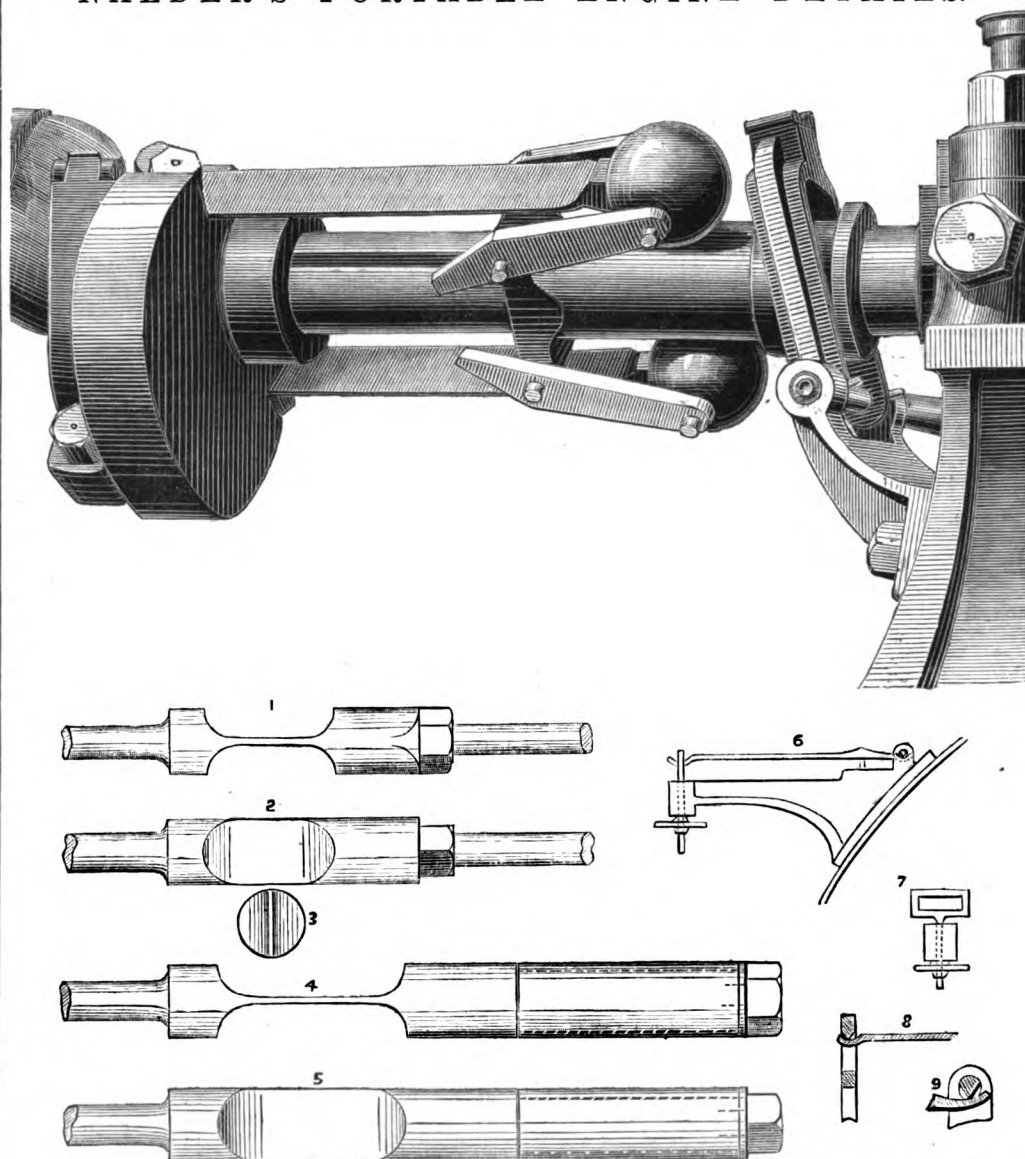
In the course of our report of the recent trials of portable engines at Bury St. Edmunds, and in an article on "High-Speed Portable Engines" in our last number but one, we alluded to the peculiarities of the engines made by Messrs. Nalder and Nalder, of the Chillow Works, Wantage, and we now give in the accompanying engravings figures showing some of these peculiarities. One of the constructive features of Messrs. Nalder's engines is the substitution of springs for the ordinary pin-joints in cases where a small degree of deflection only is required. Thus the connexion of the eccentric rod and valve-spindle is effected as shown in Figs. 1, 2, and 3, the end of the eccentric rod being flattened down for a length of about 2½ in. into a blade or spring, 1½ in. wide, and rather less than ¼ in. thick. These dimensions and those given hereafter are those of the details of Messrs. Nalder's 7-horse engine, as exhibited at Bury. The valve-spindle, which is ¼ in. in diameter, is screwed into the end of the eccentric rod, and secured by a lock nut, as shown in the sketch, so that a rigid connexion is formed, the angular movement of the eccentric rod being accommodated by the deflection of the spring.

The pump-rod and plunger are formed in one piece, as shown in Figs. 4 and 5, that portion which actually forms the plunger being surrounded by a brass bush secured by a screw and washer, as shown. The flattened portion of the pump-rod, which gives it the necessary elasticity, is 1½ in. wide and about 4 in. long.

Instead of using a spring balance applied to an ordinary safety-valve lever, Messrs. Nalder make the lever itself the spring. The lever is 13½ in. long between end centres, and it is 2½ in. wide, its thickness being gradually reduced, as shown in Fig. 6, to ⅞ in. at the outer end. The lever bears against a knife-edge fulcrum, and the stirrup at the outer end is also formed to a knife-edge where it bears upon the lever. These details are shown in Figs. 6, 7, 8, and 9. The use of a spring lever in this way is open to the objection that it allows a very limited amount of lift to the valve.

Another special detail of Messrs. Nalder's engines is the governor, of which we give a perspective view above. From this it will be seen that the governor balls are secured to two springs, which are fixed to a casting keyed on the crank-shaft, and that the balls are also connected by links

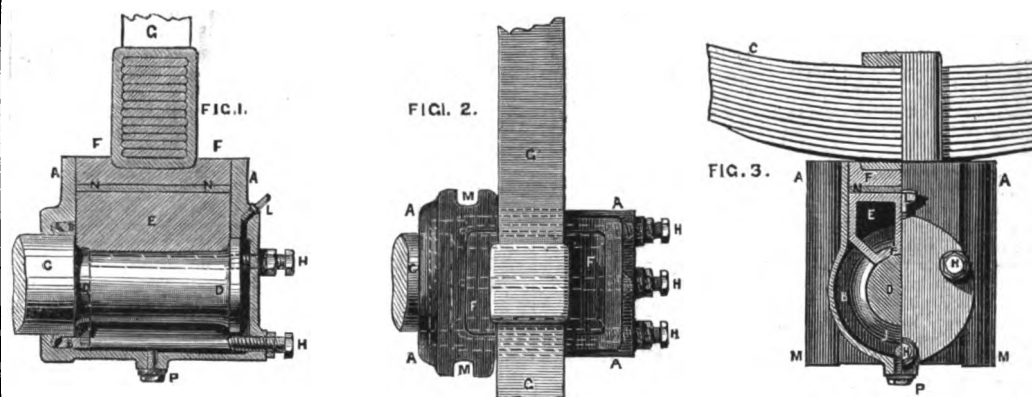
NALDER'S PORTABLE ENGINE DETAILS.



with a collar sliding on the shaft. These links being much shorter than the springs, it follows that when the balls diverge the sliding collar is shifted longitudinally on the shaft, and this movement is communicated to the throttle-

valve by means of a connecting spindle and the arrangement shown on the right-hand side of the engravings. The whole arrangement of the governor is very simple and compact, and we believe it answers well.

COOKE'S RAILWAY AXLE-BOX.



We give, above, an engraving of a form of railway axle-box designed by Mr. Joseph Green Cooke, of Vera Cruz, this axle-box being so arranged that the weight of the vehicle to which it is applied, instead of being transmitted to the journal through the axle-box in the usual way, rests directly on the top of the brass, the latter being free to move vertically in the axle-box. In the illustrations, Fig. 1 is a longitudinal section; Fig. 2, a plan; and Fig. 3, a part end elevation and part transverse section of the axle-box; and the details of its construction are as follows: Around the neck or inside shoulder, C, of the axle is placed a metal ring, B, turned to fit into a circular recess formed in the axle-box, A, to receive it. Between this ring, B, and the neck or shoulder of the axle, C, is fitted a packing, J, of india-rubber or other suitable material, which prevents the oil escaping at that part; screws, H, H, which pass from the front of the axle-box to the ring, B, pressing the latter against the packing, J. The screws, H, H, are secured by check-nuts, as shown, so as to prevent the oil from leaking out at the points where the screws pass through.

The axle-box, A, is cast open at the top to allow the brass, E, which bears upon the journal, D, to be dropped in; and above the brass is placed a layer or packing, N, of india-rubber or other suitable yielding material, on which a cast-iron plate, F rests. The weight of the wagon or carriage is borne by the plate, F, and the packing, N, which latter in transmitting it to the brass, E, and axle, D, equalises the pressure upon the whole top surface of the brass. The packing, N, at the same time prevents the escape of any oil which may be pumped up by the jolting of the wagon. The outer end or shoulder of the axle has a slight bearing upon the box at K to keep the box straight and take the sag of the stuffing-box. By removing the wagon-spring, G, the brass, E, as well as the packing, N, and the plate, F, above it can be taken out and examined, and at the same time the oil in the box can be seen, and its level ascertained. The bottom of the axle-box is formed with an aperture kept closed by a plug, P, for drawing off the oil. The oil may be supplied to the axle-box before the brass is put in place, or it may be admitted by an inlet provided with a screw plug, L.

APPARATUS FOR MEASURING THE DISCHARGE OF WATER.

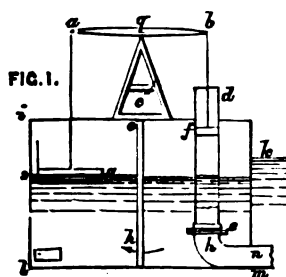
THE following memorandum on the subject of apparatus for measuring the discharge of water has been drawn up by an officer of great experience in the construction of works of irrigation in India. This paper has kindly been placed at our disposal for publication, and we shall be glad to see the subject further discussed in the columns of *ENGINEERING*. The importance of obtaining the best possible apparatus for measuring water discharge is very great, especially in a country where irrigation is carried out to so large an extent as it is in India; and as this paper has a large circulation in that country, such a discussion as we have suggested would doubtless prove of great value.

A great number of suggestions for the construction of a sluice to deliver water by measure have been the subject of calculation and experiment, and it may be hoped that, amongst those which will be noticed in this memorandum, some may be found practically useful for the purposes of the company.

It may be well to mention, in the first place, that the objects to be obtained are—1st, the greatest possible simplicity and economy in the construction and working of the apparatus; 2nd, the delivery of the water with as little loss of level as possible; 3rd, security against fraudulent attempts at alteration; 4th, freedom from obstruction by the action of silt.

In England a method has been long in use, and is found to answer the purpose perfectly, founded on the principle of admitting water, from the canal or stream, into a separate tank in an enclosed building in which it is maintained, by a balance apparatus acting as a ball-cock, at an uniform level, and whence, by means of an aperture of a size suited to its depth below the surface of the water in the tank, delivery is made.

The annexed sketch (Fig. 1) will explain the principle of this contrivance. By proper adjustment the apparatus is arranged so



a g b, a balance having knife edges at the three points, and supported by the stand, c; g, a float made of stone supported by the rod, a g; a g, an iron pipe with mouth turned up communicating with the canal; d e, a cast-iron pipe open at both ends, of inner diameter equal to mouth, A, the height of d being above the level of the water in the canal. It is supported by the rod, b f, and weighted so as to counterpoise the stone float; o p, a wall with openings below to allow the passage of the water and prevent any agitation of it near the float.

that the float, g, rests at any desired level, and the area of the opening at l is suited thereto, in order that the required quantity of water may be discharged. If, owing to a rise of water in the canal, too much should enter the cistern at A, and raise the float, this would immediately depress the bottom of the pipe, e d which, if it were lowered sufficiently, would rest on the flat rim, of the mouth, A, and effectually stop further admission of water till the float sank again and raised it.

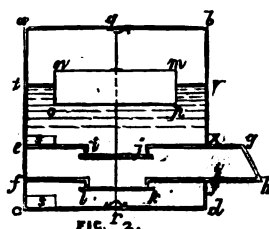
The only objections to this method, for Indian use, are the expense and delicacy of the apparatus. The former amounts, as I have been informed, to about 70*l* or 80*l*, besides the cost of the building; but it is obvious that the apparatus might be constructed in a simpler and cheaper manner by the use of a wooden beam and other modification. But in whatever way constructed, it is probable that the whole expense would not be far short of 400 or 500 rupees.

It must be remarked that by adding to the depth, s l, of water maintained in the tank, the precision with which the required discharge is regulated for different depths in the canal is increased, but the range of depths through which the instrument will act is diminished, because, as a certain head, k t, in the canal above the surface of water in the tank is requisite, according to the size of the entrance pipe, to force in the supply, it is evident that the apparatus will cease to be efficient as soon as the water sinks below the level of that head. Thus a sluice furnished with entrance and counterpoise pipes of 12 in. diameter, if 1 ft. depth of water be retained in the tank, is calculated to discharge a cubic foot of water per second at all depths of the canal down to nearly 6 in. above the tank level, with an error towards the last not exceeding 4½ per cent., but if 2 ft. of water were retained, the error would amount to only 2½ per cent. In the former case the canal would have been drained to within 18 in. of its bed, in the latter to within 30 in. only. With pipes of the same size as above mentioned, double the volume of water might be passed with an error of 9.8 per cent. in the former case and 4.8 per cent. in the latter. If the pipes were increased in diameter in due proportion to the required discharge, the errors would be the same as those first mentioned.

No information has been obtained of the successful employment of this meter where the water passed through is heavily charged with silt, but there is no reason for apprehending that if the entrance pipe were protected by a grating or wire-work screen there would be much difficulty from that cause.

Cylinder Sluice.—The same general principle as the above, though a very different form of application of it, may be adopted, so as to be more generally useful in India. The annexed sketch (Fig. 2) shows, in section, the simplest construction, and explains the action: a b c d represents a square or circular cistern, communicating with the canal by a rectangular wooden or iron pipe, e f g h, closed on all sides within the cistern, except at two openings, i j and k l. The float is represented by m n o p. It swims in the water contained in the cistern, and is kept by guides immediately over the two openings, through the middle of which an axis, q r, passes, carrying two valves (acting on the principle of a double-beat steam valve), which are a little larger than the openings, and so arranged that when the float rises to a certain height (which is regulated by its position on the axis, and secured by nuts above and below it) they both accurately fit the ledges or combings fitted beneath the edges of the openings,

and all further entrance of water into the cistern is stopped. By this means the level of the water is kept regularly at a given height, t v, and the aperture of discharge, s, is made of a size suited to the depth, t s.



It is not absolutely necessary that s be at the bottom of the cistern, but it is desirable for many reasons, amongst others, the greater the depth the more exact the measurement will be. If from the surface, at t, to the middle of s (which ought to be 8 in. or 4 in. high) the depth be 9 in., then the variations in the discharge will not exceed 4 or 5 per cent. in a well proportioned apparatus; and if s y h be the level of the bed of the canal, the water of it would be measured out correctly till it was drained to 12 in. depth (when the measurement would begin to be inaccurate), and the delivery would be on a level with the bed. But if the situation were such that the loss of 12 in. level were of no consequence, then either the drainage of the canal might be carried to a lower depth with the same degree of exactness of measurement by lowering the apparatus 12 in., when the canal would be emptied to within 8 in. or 4 in. of its bed, or the exactness of the measurement might be increased by increasing the distance between t and s, from 9 in. to 21 in., in which case the variations would not exceed 2½ per cent.

This method has been tried in a model and found to answer perfectly, the errors in measurement not exceeding 5 per cent. when the variations in the level of the water ranged from 12 to 1, and the important result has been established that a compact and portable apparatus for the measurement of one or two hundred cubic yards per hour may be made at an expense probably not exceeding 5*l* to 10*l*, and sent from England in large numbers, so as to be ready for application at once, with no other labour in establishing them than their being fixed on the top of the conduit leading the water away to the fields.

Some further experiments are required to ascertain the best proportions of the different parts of such instruments, and it is deserving of inquiry also whether they could not be made of earthenware, such as is used for drain-pipes, in which case the cost would be reduced probably to from 3*l* to 6*l*, according to the size.

In the above figure, g h represents a close grating placed in front of the end of the tube leading from the canal, as the chief risk of disappointment arises from the chance of any solid matter choking the action of the valves. It is to be remarked, however, that their action may be as free as that of the pipe represented in Fig. 1, which has been found to work perfectly in practice; and it may be added that if the valves were partially obstructed, this would not alter the accuracy of the measurement, but only lead to their opening a little wider; besides which, as the water is taken from the bottom of the canal, no floating materials or rubbish are likely to be intercepted.

In the portable sluice an iron bar or wire grating would be fitted outside the cylinder, or even a rattan casing, weighted by a stone on the top of it, would be sufficient; unless, in order to prevent any possibility of injury or interference, it were preferred to enclose it in a dry brick or rubble masonry well, with a door at the top secured by a lock.

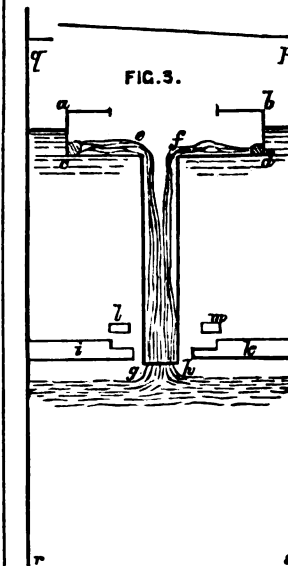
When the apparatus is built of masonry and placed in the bank, the space, a t v b, communicates freely with the air, and no special arrangement is required; but in the employment of a portable cylinder, of 2 ft. or 3 ft. diameter, and the same height, and which would be altogether submerged, free communication with the air must be provided, by making the axis, q r (Fig. 2), hollow, communicating with the culvert into which the water is discharged through an orifice in the bottom of the cylinder. In the portable form also, there is no separate tube, x y g h, but the whole space, e f x y, is open and filled by the water, with the exception of three or four pipes communicating between the upper and lower parts of the cylinder.

It will be understood from a study of the action of this and the foregoing apparatus, that when the canal is very full, and the depth of water great, the float in the cylinder rises till the valves are so far closed as only to admit the necessary quantity to maintain the level and keep up the discharge, at the increased velocity of influx; and when, on the other hand, the canal is nearly empty and the depth small, the float sinks, and the valves open sufficiently wide to keep up the supply with the diminished pressure and velocity. This rise and fall in the float leads to a slight variation in the level, t v, and consequently to a certain slight variation in t s, and error in the measurement, which is that above referred to, when it is calculated at 5 and 2½ per cent. But a very simple compensation for this slight error is easily made, so that the measurement becomes perfectly accurate throughout the entire range of the instrument's action.

Suspended Opening.—Some contrivances for the measurement of water are founded on the principle of suspending an opening or openings of a regulated size (connected with a discharge pipe) at a uniform depth below the surface of the water by means of a float; the lower end of the pipe communicating with the outside in different ways. One method is sketched in Fig. 3. In this the hollow float and its tube swim in a well constructed in the bank of the canal. The well is closed at top by a cover capable of being locked up, and water is admitted to the well by a conduit which may be closed by a shutter at pleasure. The float carries one long vertical tube open at both ends, into the upper part of which are led the streams admitted by two or more small openings, with or without tubes, passing through or under the hollow float, and with their mouths set at equal distances below its upper edge, and consequently equally below the surface of the water. The exact distance may be regulated by attaching weights to the tube or float.

The well is double the depth of the canal, and has a platform

or floor halfway down, and corresponding with the level of the bed of the canal. In its centre a circular hole is cut just sufficiently large to allow the vertical tube to pass through easily. A circular channel is cut out at the edge of this hole in order to be filled with loose cotton or coir pressed down by a ring of stone to act as a kind of rough stuffing box, and prevent leakage and the introduction of pebbles into the opening. The

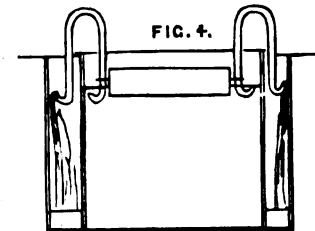


p q r s, the well; i k, the platform; a b c d, float; e f g h, vertical tube; c d, two small openings.

water which passes into the vertical tube is delivered into the lower chamber of the well, and rises in it till it attains the level of an opening underneath the floor, whence it issues to the fields. This method has been tried experimentally on a small scale, and answers very well, when the capacity of the vertical tube is not less than double the aggregate areas of the small openings.

On the large scale this apparatus would not be expensive, and the chief objection to it, besides that arising from the action of silt, which is common to most on this principle, and will be referred to hereafter, is that there would be a loss of level, as the water could not be delivered higher than about one foot below the bed of the canal.

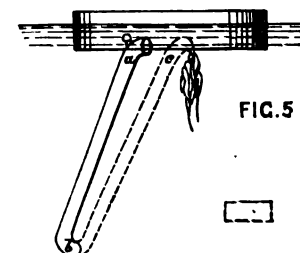
Syphon Sluice.—Another method on the same general principle is that wherein one or more syphons are attached to the side of a float swimming in a circular cistern enclosed in a building close to



the canal. The mouths of the syphons are kept at an uniform distance beneath the surface of the water by means of the float, while the pipes forming them rise vertically above and descend outside the circular wall of the cistern, where they discharge their contents into a circular trough outside of it, and connected with a conduit leading to the fields.

This plan is accurate in principle, but for practical purposes less likely to be useful than the one next to be described (it will, therefore, not be examined in detail), as it would be expensive to construct, and difficult to manage compared with many others; besides being liable to the risk of the action of the syphons being stopped by the accumulation of air.

Inverted Syphon.—The inverted syphon is one of the most promising of this class; it will therefore be more particularly inquired into. The sketch given below, Fig. 5, shows the



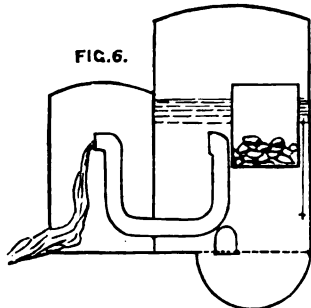
principle of its action. A bent tube, a b c, shaped as an inverted syphon, with legs of equal length, has the upper end, a, of one leg attached to the side of a float swimming in a cistern divided longitudinally into two parts, one of which communicates with the canal. At the lower end of this tube, the neck of the syphon at b passes through the wall separating the two parts of the cistern, into the second or empty section, of which the other leg rises till its mouth, c, precisely level with and opposite to the one attached to the float. The water in the first or full section passes through the syphon into the second or empty one, whence it issues to the fields.

As the mouth of that leg of the syphon which is attached to the float is intended to be kept by it permanently at a given depth below the surface of the water (which depth may be adjusted by putting a little ballast into the interior of the float), whether the depth of the canal is uniform or not, and as the orifice terminating the other leg of the syphon is always in a

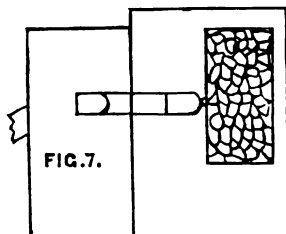
position precisely opposite and at the same level, it follows that the "head" or pressure, and consequently the discharge, ought always to be uniform at whatever height the water in the cistern or canal may be standing.

The two cisterns form one building, which is locked up to prevent intrusion or interference.

The annexed Figs. 6 and 7 represent the practical form given to the apparatus as applied to a depth of water of 4 ft.,



and it has been said to work excellently; nevertheless it is probable that when longer experience of its action has been attained one part of the present arrangement, viz., that whereby the pipe is attached to the side of the float, will be found capable of improvement; because any variation in the effective weight



of the pipes would disturb the equilibrium of the float and produce a much greater effect in depressing the mouth of the pipe below its normal depth than if it were suspended beneath its centre.

It has been proposed that a head of 4 in. be adopted in all cases, but it would be better to increase this, for the following reasons: first, because so small a head involves the use of syphon pipes of a larger size than would probably be convenient in practice; and secondly, because, from being so small, any trifling irregularity in the immersion of the float would have a marked effect on the accuracy of the measurement, the variation of an inch producing a difference of 13 per cent. As above remarked, there is a risk of this irregularity, not to mention that which would be caused were any obstruction to prevent the free action of the arm guiding the opposite end of the float to that carrying the syphon. Hence it is important that the effect should be reduced to a minimum. If, instead of 4 in., 12 in. head be allowed, the sectional area of the syphon pipes would be reduced in the proportion of 4 to 7, and the irregularity caused by the difference of an inch in the immersion of the mouth of the pipe would be reduced to less than 4 per cent. The only objection to the alteration would be that it would reduce the scope of action of the instrument, which would touch the ground, and cease to be regular, in 15½ in. depth, instead of 7½ in.

(To be continued.)

INDIAN ENGINEER EXAMINATION.

At page 36 of the present volume we stated the number of candidates who this year presented themselves as competitors for appointments in the Public Works Department in India, and we are now enabled to give some particulars regarding the examination, and the nature of the papers given at it. The following is a list of the successful candidates in the order in which they passed, together with the aggregate number of marks obtained by each: 1. P. Maitland, 783; 2. T. Higham, 779; 3. H. Joll, 745; 4. E. W. Oates, 740; 5. J. F. Mackenzie, 739; 6. W. B. Bromley, 733; 7. J. Stewart, 723; 8. T. E. Ivens, 718; 9. J. S. Beresford, 714; 10. A. Grant, 693; 11. T. Beatty, 683; 12. J. Heinig, 679; 13. E. G. Davies, 669; 14. W. G. Strype, 661; 15. F. W. Stevens, 660; 16. A. W. de Crettes, 658; 17. D. Wallace, 645; 18. R. Ring, 640; 19. D. Noyes, 639; 20. H. B. Parry, 629; 21. R. W. Norris, 626; 22. G. D. Wybrow, 625; 23. C. J. Peters, 610; 24. D. Rutherford, 600; 25. J. Tate, 600. These will all receive appointments in the Indian Public Works Department. Although the full number of twenty-five qualified candidates has been obtained—which cannot fail to be a source of much gratification to the Indian Government—there can be no doubt but that the exigencies of the service could have found room for even a greater number of engineers, had more than the above specified number come up to the required standard of qualification. There can be no doubt that additional engineers will immediately be required for India, and in fact another examination is already announced, in addition to the regular annual examination, which, we presume, will be, as heretofore, held in the first week of next July. Of course it must be some little time later still before the examination papers are printed by Parliament, and

a review of them here may not, therefore, be unacceptable; but as they will, in all probability, be published in due course in the usual manner, we have not thought it desirable to transfer the questions, *in extenso*, to our columns.

Considering the nature of these appointments, it appears to us that too much prominence is given to the subject of mathematics in these examinations. In saying this, we would not have it for one moment supposed that we in the least degree undervalue the importance of mathematics as applied to engineering science; but where one thousand marks only can be obtained, it appears to us that four hundred is too great a maximum to be allotted to mathematics, as there thus remain but six hundred marks for engineering and surveying. If, then, the maximum number of marks were raised from 1000 to 1200, the number given to mathematics might be retained as at present, whilst a higher maximum would then be obtainable in the more practical part of the examination; this would tend to give the really practical candidates some better chance against those who adopt the cramming system of education in order to prepare for these examinations; for by reference to the results of previous examinations it will be seen that many more, as a rule, pass in engineering and surveying than in mathematics; so that mathematics is, *de facto*, the real test of qualification for appointment, few, if any, who have obtained the minimum number of marks in that branch failing to pass in the other two.

It is not necessary here to make any special comments on the questions given by Mr. Cape in mathematics, excepting that we should like to see them having a rather more direct bearing on the object of the examination, instead of branching out into other subjects (especially in algebra) which, though well enough for a school examination, certainly appear rather out of place in an examination of civil engineers.

The examination in surveying, levelling, and plan-drawing consisted of an extremely practical set of questions by Lieutenant-Colonel C. D. Newmarch, R.E., well calculated to test the efficiency of the candidate in this important branch of the profession of a civil engineer. The papers commence with questions regarding the Gunter's chain, its length, &c.; scales on which surveys are executed; the mode of using a plane table; the use of a triangulation, and the manner of carrying it out; and the process of taking a round of horizontal angles with the theodolite, followed by a set of examples to be worked out. In surveying, two plans were given, one comprising a traverse survey of a plot of ground near Shooter's Hill, and the other a survey of the Lakes of Killarney, with portions of the counties of Kerry and Cork. From the data given in the former, a field-book was to be compiled, and the latter was to be surveyed with reference to the selection of the proposed new line of railway to Kenmare. In the paper on levelling and practical surveying there appear some questions relating to the means of ascertaining the longitude by the occultation of Jupiter's satellites, or by a lunar observation, and for finding the latitude by observing a star's zenith distance on the meridian, and its declination. These, and such like matters, though not generally required in practice in this country, are of the utmost importance in India, and we cannot do better than to draw attention to these questions with a view to impressing upon future candidates the necessity of devoting a portion of their study to the subject. Colonel Newmarch's papers conclude with a lithographed field-book, comprising the details of the traverse survey of a road in the vicinity of the Great Northern Railway, which the candidates were required to plot on a scale of 2 chains to an inch. Whilst these papers were going on, candidates were also examined one by one in the practical use and adjustment of instruments.

This year Mr. G. P. White, the examiner in civil, mechanical, and mining engineering, has directed attention principally to the following subjects, viz.: On water supply, reservoirs, dams; on pumping engines; on harbours, docks, groins; and on lighthouses and piers; besides which, there were also a few questions given on miscellaneous subjects. It is, of course, impossible to compress within the limits of a two days' examination questions embracing every branch of the engineering profession, and we think, therefore, that Mr. White has done wisely to vary from year to year the subjects in which he gives most questions at these examinations, as, by this means, not only is the system of cramming frustrated, but attention is very properly directed in turn to each branch of the profession, and, in some cases, the character of the questions points out in what manner it is important to the class of works required in India, in doing which

Mr. White's personal experiences whilst in the service of the Government in India render his remarks doubly important and authoritative. We cannot, however, avoid the remark that Mr. White's papers are, this year, rather too exclusively confined to hydraulic engineering works. On the subject of water supply, the questions, though only nine in number are fully sufficient to test proficiency in this branch of the profession. Commencing with the different means employed to supply towns with water, the candidate is led on to the comparative advantages of the gravitation and pumping systems, and he is requested to describe briefly what are impounding, compensating, depositing, storage and service reservoirs, residuum lodges, and collecting grounds, as well as to describe what are the best water-bearing strata. Next comes the subject of constructing dams for impounding water, and of filter-beds, the principal conditions which should determine as to the mode of supply, and the probable amount required for supplying a town with water; and the paper concludes with questions relating to cast-iron water pipes, the mode of casting them, and the different means used for jointing pipes. The next paper, "On Pumping Engines, &c.," after going into the questions of testing pipes, the use of different apparatus used in water supply, such as bib-cocks, crutch-key cocks, reducing-pipes, air-vessels, hydrants, sluice-valves, &c., the flow of water through pipes, and the different kinds of pumps and other contrivances for raising water, requires a description of the mode of ascertaining the power of pumping engines in any given case, with a practical application of the same, followed by questions on the head due to friction, the net horse power required, the diameter of cylinder necessary under certain conditions of steam and expansion, the diameter of pump barrel for a certain delivery, and particulars of steam supply and boilers. On the subject of harbours, docks, and groins, the candidates were furnished with a map of Bantry Bay, and required to lay down on it such works as appeared necessary to render it suitable for a naval station and harbour of refuge; and perhaps no better method could have been adopted with a view of testing the knowledge of candidates on these subjects. Questions, also, were given bearing on the treatment of silt brought down by rivers flowing into the harbour; the construction of breakwaters; hydraulic lines; removal of rocks; laying down moorings, and the construction of docks, quays, landing-stages, &c. The last paper treats on the subject of screw-pile lighthouses and piers; different forms of wrought-iron girders; modes of scarfing timber; the different kinds of stone employed in building; the means adapted in the main sewers for the drainage of London to provide for storm water; weirs employed at Manchester Waterworks to separate the storm and turbid water from that suited for the town supply; railway points, sidings, &c.; and it winds up with directing attention to the use of photography as most valuable for engineering purposes, especially in India.

A note at the conclusion of Mr. White's papers contains an extract from the recent address of the President of the Institution of Civil Engineers, wherein he referred to the duties of the dock and harbour engineer, prefacing the quotation with the following remark:

"On the present occasion I have specially directed attention to the subject of water supply and harbour engineering, two of the most important, but at the same time difficult, branches of the profession, and which are yearly becoming more necessary in India, only a few of the principal cities being at present supplied with water. Much, therefore, remains to be done in this way; whilst as regards harbour engineering, a wide field presents itself in India, considering her extensive seaboard is very deficient in natural harbours. I would, therefore, suggest these subjects as being deserving of especial attention."

RAILWAY-CARRIAGE VENTILATORS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your impression of the 26th ultimo you notice and illustrate the design of a ventilator for railway carriages alleged to be the production of Mr. W. G. Creamer.

I am instructed by my client, Mr. A. A. Durant, of Wilson-street, Finsbury, who is the sole lessee of the patent obtained by Mr. George Bohn, of Twickenham, to inform you that Mr. Creamer's design appears to be precisely similar to such patent. I will not take up your space by reference to the details of Mr. Bohn's ventilator, as they are fully specified in your advertising columns. I will only add that the patent is dated 15th February, 1864, No. 389.

I am, Sir, your obedient servant,
FRANCIS K. MURTON,
Solicitor for A. A. Durant.

Rugby-chambers, 19, Great James-street,
Bedford-row, W.C., August 7, 1867.

TECHNICAL EDUCATION.

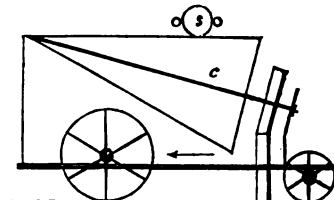
If any one of the first-class Continental engineering schools was to be suddenly transplanted into this country, and if the school were opened gratis to every young man between fifteen and eighteen years of age, provided that he could pass the preliminary examination which is required abroad before a student is admitted to the lectures, we doubt that the number of suitable pupils that could be mustered without preparation would be exceedingly small. This seems a very bold assertion to make; still it is only necessary to inquire what preparatory knowledge the professors of mechanics or civil engineering in France and in Germany make a *conditio sine qua non* for admitting a pupil into their classes, and the conviction will soon replace every doubt. It is a well-known fact that most of the young gentlemen from this country who are sent to Germany for finishing their education there must go to private institutions or small second-rate schools, simply because they are utterly unfit by their preliminary knowledge to follow the teachings of the regular public colleges. There are also in some towns preparatory courses established for the benefit of young ignorants from this country and from other less civilised corners of the world, which enable the novice, after a year or two, to enter the college proper upon a par with the native students. If we look to the causes of this most striking circumstance, we find that the absence of sound schooling in England goes much further than the mere question of high science. The common school of arts, the school which teaches the elements of the natural sciences, or what is called on the Continent the "middle school," is not even known in this country. This is very different in France and Germany. Taking the latter country as our example (for education there, particularly that given by the middle schools, stands upon a higher level than anywhere else), we find the middle school, under the name of *Realschule* or *Realgymnasium*, to consist of no less than a six years' course. It takes its pupils from the country school, or *Volkschule*, where education is limited to about the same quantity of knowledge which is the standard in our own elementary or primary schools. The age of these pupils is from nine to eleven years. The six years' course is divided into two distinct parts of three years each. The first set of three years, if successfully passed through, will make a well-educated workman, foreman, or shopkeeper of the pupil. The courses give the elements of every natural science, including chemistry, mechanics, natural philosophy; they teach arithmetics, book-keeping, geometry, and drawing. At the close of these courses, very strict examinations are passed through by the pupils, which effectively prevent those who are less talented or less assiduous to pass to the higher courses, and in this manner the contingents are mustered out for the different stages of practical employment according to the capabilities of each individual, and without injustice to any one. The nation is a great gainer by this arrangement. The schools at the outset being open to every comer, all the growing talent of the nation is carefully collected there, and only very little is wasted and lost from want of suitable education. Wherever peculiar talent shows itself, it is without difficulty directed into its proper channel, and the natural course of the education passed through, degree by degree, musters out those who are best suited for each respective branch. The second set of three years in the middle school is devoted to a further instruction in all the branches, the elements of which have been taught before. They give an education far superior to that required in the ordinary pursuit of trade, but they give all the knowledge which is requisite for starting in any one distinct branch of science or in any technical profession. They give, in fact, a thoroughly scientific general education. Those persons who intend to devote themselves to any technical profession receive a sufficient knowledge of all the other branches of science, which they are expected to be familiar with, without following them up as a specialty. From this course the pupils are mustered out according to talent and inclination into the schools for civil engineering, mechanical or mining schools, or they pass into an academy of architecture, a school for chemistry, or a military school. It is these middle schools that this country wants more than anything else. We have very good, although expensive, means for teaching any distinct speciality of knowledge in this country; but we have no "Polytechnic" schools, no institutions for acquiring that generality of technical knowledge which alone will make a well-educated modern engineer. Without these preparatory schools the engineering universities, such as exist abroad, even if imitated in this country, would

prove useless, or rather unfit for use. Education is a thing difficult to replace if once neglected, and this holds good for a nation as well as for an individual. The moment we admit that we have neglected education, and allowed other nations to surpass us in this respect, we must be prepared to pay for the neglect by the acknowledged inferiority of a whole generation of professional beginners. It will never do to start one school, or one institute, or one museum. We must have a whole system of schooling, we must have education thrown broadcast upon the whole surface of the country, accessible, readily accessible, and, indeed, gratuitously accessible to all who want to learn. By these means, and only by such arrangements, we can arrive at the desired end with patience and perseverance, but only after a considerable lapse of time. Let it be hoped that the difficult task will be speedily commenced, that the necessity once seen, and almost unanimously acknowledged by our great scientific authorities, will be provided for with vigour and determination, and with that amplitude and munificence which have always been characteristic of the British nation.

DYNAMOMETERS AT THE PARIS EXHIBITION.

The friction brake is a very rude instrument for the refinement of modern engineering and machine-making. It is a very useful and simple contrivance, and it is adapted to tell approximately how many horse power a water-wheel or a windmill gives out in its action, or how much power is consumed by a millstone or other uniformly rotating mechanism. But when it comes to the investigation of more complex and irregular movements, when such a question arises as what precise point or portion of a curved cam suffers the greatest strain during its revolution, and what proportion this strain bears to that which cams of other shapes or curves will have to undergo if substituted for the first, when it comes to watch and compare the relative consumption of power between different spinning and weaving machines, or between different headstocks of a mule, or between differently constructed parts of a single mule headstock—then the friction brake of course is no longer applicable, and a delicate, scientific, yet simply constructed instrument becomes a generally acknowledged desideratum. Such an instrument is what engineers now call a rotation-dynamometer, and a perfect instrument of this kind is yet to be designed. The name rotation-dynamometer is given to distinguish it from those instruments which measure and register linear exertions of power, or forces exerted in a straight line, such as the pull of a locomotive engine or of a tug-boat. Dynamometers of that kind present no difficulty in their construction, and there exist a considerable number of such instruments all practically perfect, or nearly so, in their action and performance. Most of these instruments are based upon the production of a diagram, one element of which is represented by the tractive force or linear strain exerted, while the other element represents the time or space of movement through which that exertion has taken place. The area of that diagram representing the product of the tractive effort multiplied by the time or space through which it has been exerted gives the precise amount of the work performed. The form and outline of the diagram itself in those instruments which produce a visible diagram of that kind indicates at the same time the precise fluctuations, changes, and other characteristic features connected with the exertion of power, and thereby gives one of the finest, most trustworthy, and useful records of the performances of machinery which we have in practical mechanics. The steam-engine indicator is in reality nothing but a linear dynamometer registering the exertions of the steam pressure as connected with the space travelled through by the piston, and it is certainly one of the finest, most suitably contrived, and most perfect instruments at present at the command of mechanical engineers. For a rotation-dynamometer, the problem consists in producing the same register of power and space with regard to rotatory movements as the indicator gives for a straight-lined exertion of power. We require a diagram showing the amount and variation of power exerted upon a pulley by the belt running over it during the time that any given machine which is driven by that pulley performs its operation. The dynamometers hitherto made for this purpose suffer from several defects. Most of them are complicated and costly instruments, difficult to keep in order, and unreliable in their indications. Others of a simpler nature are interfered with in their indications by alteration of friction and other elements, such as the centrifugal force, which, varying in amount

with the speed of rotation and interferes with the indications of the dynamometer, which are then correct only at one given speed, and more or less far removed from the true mark as the speed differs from the normal velocity. The Exhibition contains two rotation-dynamometers; they are the best of their kind ever made, and both invented in France. Still our general remarks apply to both of them, and they leave plenty of room yet for any really simple and practical instrument of their kind. The two dynamometers we speak of are those of M. Taurines, in Paris, and of M. Engen Bourdon, the well-known engineer of the same town. The dynamometer of M. Taurines is a very complete instrument. It was invented some five years ago, and used in a series of experiments made for determining the power consumed by different engineers' tools at the workshops at Indret, apparently with much success. It consists of a pair of pulleys mounted upon a solid shaft and upon a surrounding hollow shaft respectively, and connected together by a pair of segment springs. The transmission of power from one pulley to the other, through the action of these springs, causes the latter to alter their shape, and thereby a tension is exerted parallel with the axis of the two shafts which carry the pulleys. In this direction a small carriage, moving on four wheels and upon a pair of straight horizontal rails, is attached to the springs by a connecting-rod, and this carriage is traversed forward and backward upon the rails, according to the action of the measuring springs connected to the two main shafts. The position of the carriage on the rails is therefore equivalent to the strain exerted through the pulleys, and corresponds to the position of the pencil-point in the steam-engine indicator. The second element, or the space travelled through, corresponds to the number of revolutions made by the pulleys, and this is transmitted to the indicator in the following way: The carriage previously referred to carries upon its frame a long nicely finished cone, which revolves round its own axis in two bearings, mounted so that the upper line of the cone remains always horizontal. This cone is geared by a pair of bevel-wheels, so as to revolve with the two driving-pulleys and to make the same number of revolutions. At the top of this cone, and in frictional contact with it, is a sphere guided between rollers which are also in frictional contact with



the sphere. The contact between the cone and the sphere, theoretically, is a mathematical point, and this point corresponds to the pencil-point of the other indicators. Now, as the cone revolves, the sphere follows the movement of the point of contact, and receives an amount of motion which is due to the circle described by the point of contact upon the surface of the cone during the revolution of the latter. The position of the carriage and cone upon the rail is therefore the element which determines the size of the circle of contact between the cone and the sphere. The annexed diagram shows the relative position of these elements, and it will be seen from it that the movement of the carriage in the direction of the arrow brings the broader part of the cone, C, in contact with the sphere, S, and that for one revolution of the cone the sphere will make a greater number of turns in proportion to the increased diameter of the circle of contact. The number of revolutions made by the sphere, and counted by a common engine counter moved from one of the small friction guides, is a fraction of the product of power and distance travelled through, or an equivalent to the work performed. It is necessary only to read off the figures of a suitably arranged counting apparatus to arrive immediately at the power indicated by this instrument, and, so far, its use is very convenient; but, on the other hand, it cannot be denied that the apparatus is very complex, and that its elements are liable to derangements and inaccuracy on account of slip, particularly when exposed to sudden changes of power. M. Bourdon's dynamometer consists of a pair of pulleys, each on a separate shaft, and the two shafts are geared together by means of a pair of spur-wheels with inclined teeth. The inclined gearing exerts a longitudinal pressure proportionate to the strain transmitted through it, and due to the angle of the teeth. There is therefore an end thrust caused by this gearing, and this is taken up by one of the shafts which is free, endways, in its bearings, and

REIFERT'S RAILWAY CARRIAGES.

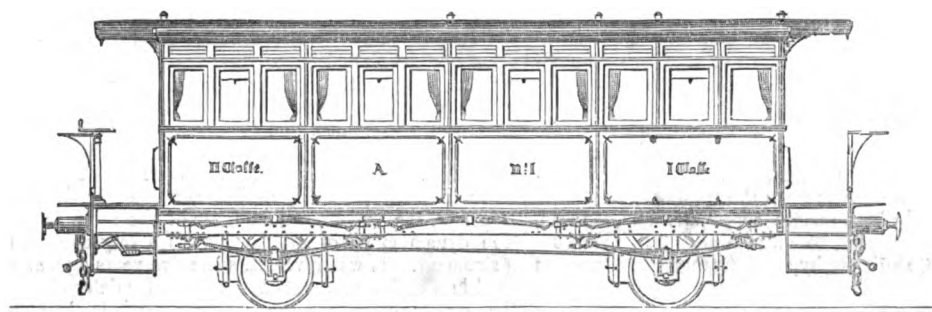


FIG. 1.

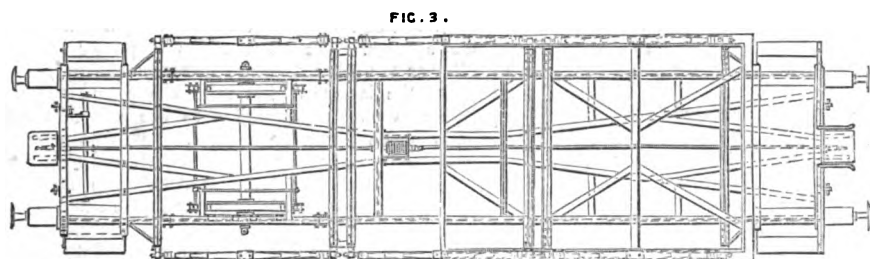


FIG. 3.

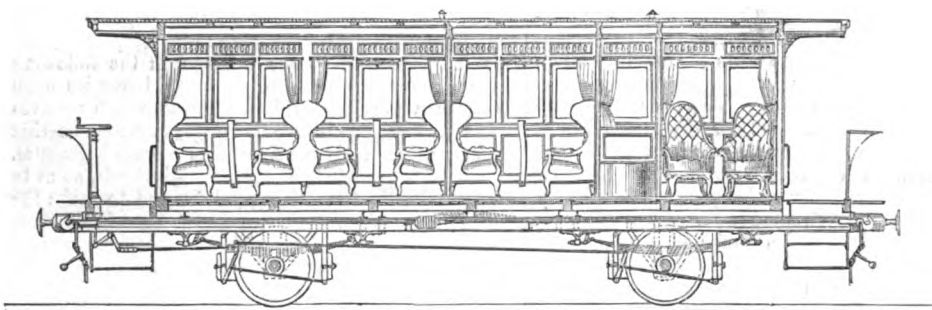


FIG. 4.

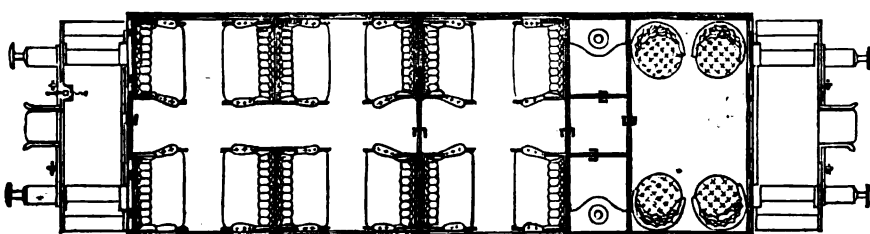


FIG. 5.

presses endways against a spring. The spring transmits its movement to a pointer, and in this manner the amount of strain transmitted is registered upon a scale. This instrument, although simpler than the first, is liable to be interfered with in its indications by the changing influence of friction, and so we find ourselves compelled, in the face of those two best indicators yet made, to declare that an absolutely perfect instrument of the kind remains yet to be invented.

YANKEE ROWING.

THE *Army and Navy Journal* of New York gives the time made on a three-mile race by six-oared crews of Harvard University (at Cambridge, Massachusetts), and Yale University (at New Haven, Connecticut). The race took place on Lake Quinsigamond, near Worcester, Massachusetts. The "Freshman's crews" made the three miles, Yale in 19 min. 38½ sec., and Harvard in 20 min. 6 sec. The "University crews" afterwards made the course, viz., Harvard in 18 min. 12½ sec., and Yale in 19 min. 25½ sec. The average weight of the Harvard men was 11 stone 1½ lb., and of the Yale 10 stone 12 lb. The sizes and weights of boats are not given. It may be interesting to compare with this performance the time made by the Oxford eight on the last race from Putney to Mortlake, viz., on April 13th last. The distance is given as 4½ miles, and it was rowed in 22 min. 39 sec. In the race of 1858, and again in 1865, the same course was rowed in 21 min. 23 sec. Although the American boats were worked with but three-fourths the power of our own, their performance was less in proportion. Had the Harvard University boat gone 4½ miles at the same rate of rowing, it would have required 25 min. 48 sec., although whether they could have borne

the strain for 7½ minutes longer for the extra mile and a quarter is another matter. And although our boats carry two more oars, they weigh 350 lb., with their cushions, gear, &c., and have the additional displacement of the two extra men, say 22 stone, the boat itself having 8 ft. additional length, and consequently more skin friction, for the two extra seats.

The power required to work the boat must be increased as the cube of the speed, the resistance at any moment increasing as the square. The Oxford rate, last April, was 11.26 statute miles an hour for 22 min. 39 sec., while the Harvard rate was 9.883 miles per hour for only 18 min. 12½ sec., and that with one-fourth less power, and probably not far from one-fourth less displacement and one-sixth less wetted surface, although neither of these are given. Now the cubes of these speeds, 11.26³ and 9.883³ (respectively 1427.63 and 977), at once preclude any notion that two additional Harvard oars, involving, of course, additional displacement and skin friction, could have carried the boat nearly 1½ miles an hour faster, for a space of time nearly 4½ min. greater. The Yankees want either the *physique* or the skill of our beef-eating English boys.

A drawing and full particulars of the boat of the Oxford eight appeared at page 168 of our second volume. It is 56 ft. long, 2 ft. beam, and its greatest depth is 12½ in. Its weight is 850 lb. We have sent the engraved block of the boat to the *Army and Navy Journal* for publication for the good of American oarsmen.

THE CLEVELAND IRON TRADE.—The number of furnaces in blast in the Cleveland district is 81, and there are 36 out of blast. The quantity of pig iron made in Cleveland in the first six months of the current year was 562,499 tons, so that the make of the district now exceeds 1,000,000 tons per annum.

FIG. 2.

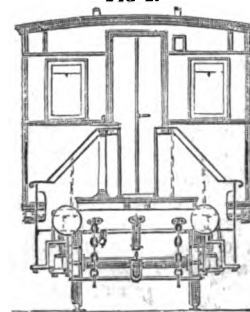
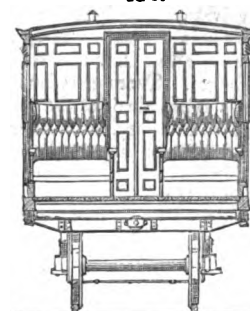


FIG. 5.



REIFERT'S RAILWAY CARRIAGES.

We give, above, engravings of a composite carriage constructed on Mr. Reifert's system, a system which has to some extent been adopted by several German lines, viz., the Wurtemberg, Nassau, and Bergish-Märkisch railways. As will be seen by the engravings, the carriage has one first and three second class compartments, (besides a smaller compartment, which divides the two classes, and is fitted up with water-closets, &c. The carriage is entered from end platforms, and there is a central passage right through it, the first and second class compartments being, however, shut off from each other by doors, as shown in the plan. The handrails of the end platforms have each an opening in the centre, and the platforms are provided with flaps, which turn down over the couplings and afford the means of passing from one carriage of the train to the next.

The underframe of the carriage is of iron, and its parts are arranged as shown in the engravings. Across it extend six transverse bearers, which project laterally to the width of the body, and which are connected at their ends to six springs, placed three on each side of the carriage, as shown in the elevation and plan. On these springs the body of the carriage directly rests, and it is carried by them completely clear of the underframe, the latter being also provided with springs arranged in the usual way between it and the axle-boxes. The arrangement of springs between the body and underframe above noticed is very similar to that employed on the state and sleeping carriages of the imperial train of the Paris and Orleans Railway Company, a train of which we give a full and illustrated description on pages 293 and 294 of the first volume of *ENGINEERING*. Springs arranged in this way no doubt cause the carriages to which they are applied to ride very easily, but the extra expense entailed by their use would, we fear, prevent them from being generally adopted on most railways. If the main springs of the carriage are properly proportioned, we believe that india-rubber pads placed between the body and underframes, as is now done on many English and Continental lines, will be found to be very nearly as effective as the auxiliary steel springs, and certainly much cheaper. We may, perhaps, at some future time lay before our readers the results of some experiments which have been made with some carriages constructed on Mr. Reifert's system. Our engravings have been prepared from drawings for which we are indebted to Herr E. Heusinger von Waldegg, of Hanover.

THE VISTULA.—The Vistula has overflowed its banks to an extent such as has not been remarked for the last twenty-two years. A great number of streets in Warsaw have been inundated.

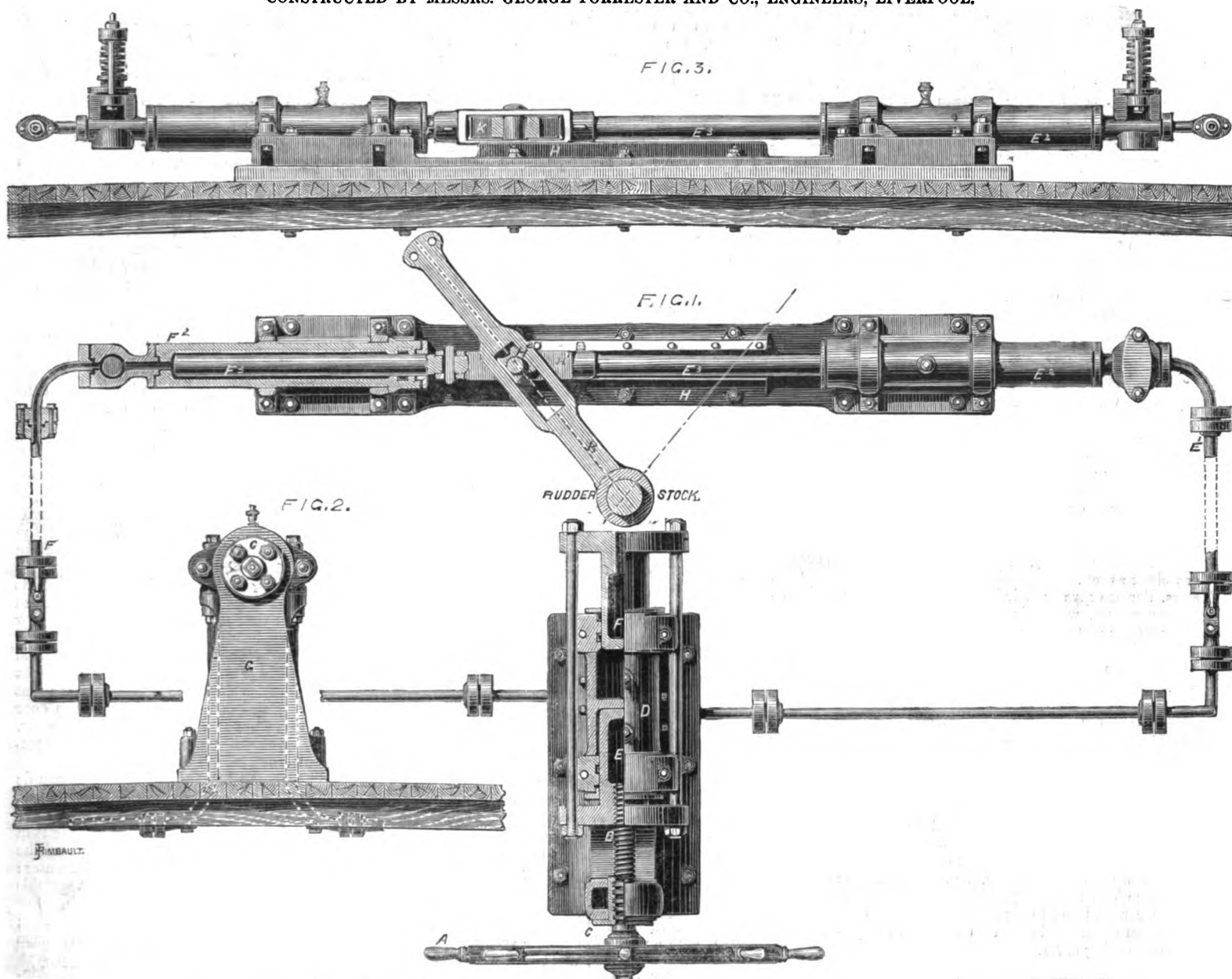
LEEDS INDUSTRY.—All branches of the iron trade are unusually quiet at Leeds; the principal cause of this is that the railway companies are merely buying to meet their urgent wants. The machine trade is also dull, especially as regards flax machinery. The makers of engineers' tools are somewhat bare of orders. The locomotive builders have still some contracts on hand, but it is stated that few new ones are in prospect.

THE SUEZ CANAL.—At a meeting of the Suez Canal Company, last week, M. de Lesseps assured the assembled shareholders—who mustered in great force—that, according to the calculations made, the great canal would be completed by October 1, 1869. The directors were authorised to conclude a loan of 4,000,000L. The meeting was characterised by much enthusiasm; nevertheless, the 20L. shares (fully paid up) have receded to 11L. 5s. each. The new loan, of course, prejudices the share capital, which amounts to 8,000,000L.

LAUNCHES BY THE LAIRDS.—Messrs. Laird, of Birkenhead, have built twelve steam launches for river service. They are each fitted to carry a 12-pounder brass howitzer in the bow, and are 50 ft. long, 11 ft. broad, and 4 ft. 9 in. deep. Their burthen is 28 tons, and they are each fitted with a direct-acting engine of 15 horse power.

ESPLEN AND CLARK'S HYDRAULIC STEERING GEAR.

CONSTRUCTED BY MESSRS. GEORGE FORRESTER AND CO., ENGINEERS, LIVERPOOL.



THE form of steering apparatus above illustrated (Esplen and Clark's patent) has been fitted to several steamers trading from Liverpool, and in every case has given satisfaction. The object of the arrangement is to obviate the difficulty hitherto experienced of placing steering apparatus in any convenient part of the ship, however distant from the rudder. The apparatus, as illustrated, consists of two parts, one at the bridge or in the fore part of the ship, the other at the rudder. The bridge apparatus consists of two hydraulic rams, E F, which are connected and fitted into the double-ended cylinder, D, which is virtually two cylinders cast in one piece with a division between them. The rams, E and F, are moved by the screw, B, which is formed on the axle of the steering wheel, A. The thrust is taken on a collar-brass, C, which is made in two halves, and is held in its place by four strong bolts, being put in from one end so as to be easily put together. The two ends of the cylinder, D, are connected by the pipes, E, and F, to a pair of hydraulic cylinders, E, and F, at the rudder. The rams of these cylinder, E, and F, are connected by the slotted piece, H, and by the pin and brass, H, working in the slotted tiller, K, they move the rudder. The aft cylinders are joined by the framing-piece or bedplate, H, which is bolted on the deck of the ship, and the tiller, K, is extended and formed with an end to take the shackles of the chains of the spare gear. At the bridge the cylinder sits on the frame, G, and there is no communication between the two ends of the cylinders, or between the two ranges of pipes. This being a screw steering gear, it possesses the advantages peculiar to such, immediate action on the rudder, and the brake action of the screw. The screw in this gear being of a much finer pitch than in common screw gear, it possesses this brake property in a higher degree, and the steersman is perfectly free from shocks in rough weather. But the rudder is not held rigidly against any sudden blow it may receive from a sea striking it; the aft cylinders are provided with "concussion-rams," loaded by compressed spiral springs, so as to yield to any sudden blow upon the rudder, and these rams return to their former place immediately, without allowing any of the fluid to escape.

In other hydraulic steering gear, the power has generally been applied through some modification of the Bramah press, and the water which had been forced to one side of the aft rams, or their substitutes, was pumped out and sent into the opposite side of the apparatus; but in all such arrangements there was the difficulty of getting rid of air in the pipes, and the pumping action, producing a continual alternation of extreme pressure and partial vacuum in the pump chambers and pipes, rendered it impossible to prevent the inleaking and accumulation of air.

In the apparatus now illustrated, the fluid is continually under a pressure of several atmospheres, so that any leak must be an escape of fluid, and air cannot leak into the pipes. Practically it is found there is no loss of fluid by leakage in voyages of several days' duration. A small supply tank is attached to the apparatus, from which, by merely turning a cock, any waste of the fluid can be instantly replaced. This tank is not shown in our engravings.

At present, one of the greatest objections to having the steering wheel on the bridge of steamers is the great loss of power caused by the friction of the rods and chains connecting the wheel with the tiller. This objection is entirely obviated by the application of the screw-hydraulic steering gear.

Another great drawback to the ordinary mode of steering from the bridge is the liability of the connections to get foul; this objection is also overcome in the steering gear illustrated. It is also noiseless in its action. The noise caused by the rods and chains in ordinary bridge gear is generally urged against its adoption, especially in passenger steamers. Steam power can be applied to work the gear. In ordinary cases water alone is the fluid used in the cylinders, but in cold latitudes the fluid is a solution of salt, which will not freeze even in a Canadian winter. In the engravings, Fig. 1 is a plan of the whole apparatus; Fig. 2 is an end elevation of the apparatus at the bridge; Fig. 3 is a side elevation of the apparatus at the stern.

EXHIBITION CATALOGUES.

To judge from the fact that there are very many bad and extremely few good catalogues at almost every exhibition, it would appear that the compilation of an exhibition catalogue is a matter of considerable difficulty. At the present Exhibition there are only two catalogues above the general average, and so arranged as to be readily useful to the visitor, and worth preserving after the close of the Exhibition, as a record of the great show. These are the Prussian and English official catalogues. They are both made in the same form and manner as the catalogue of the 1862 Exhibition in London, compiled by Dr. T. Arnstein, on behalf of the Austrian commission. This catalogue justly earned the general approval of all concerned on that occasion, and in preparing their catalogues for the present Exhibition we have been informed that both the English and the Prussian commission specially applied for some copies of Dr. Arnstein's old catalogue as a guide and model for their own work. This has so far proved successful, and the lesson should not be lost on other authors, or compilers, of official catalogues on future occasions.

STEAM-HEATED CORE OVENS.

THE warming of apartments by steam of hardly more than ordinary atmospheric pressure has been long practised; but engineers are but little acquainted with the system of heating by steam, which, although not superheated, is of very high temperature, say 600 deg., and of correspondingly great pressure. This is the system adopted, with much success, by Messrs. Perkins, respectively the son and grandson of the famous high-pressure engineer, Jacob Perkins; and to that gentleman, indeed, we believe the origination of the system is to be ascribed. Immense pressures are quite practicable within small tubes, or boilers made wholly of water-tubes; and Messrs. Perkins have actually worked an engine with steam of 2000 lb. per square inch, the boiler, moreover, having a glass gauge. The engine now regularly driving their factory in Seaford-street, Regent-square, has been worked at a pressure of 450 lb. per square inch, and the safety-valve of the boiler is set to 600 lb. A full description of this engine was given a few years ago in a paper read before the Institution of Mechanical Engineers; and on a future occasion we shall probably give a drawing of it. The boiler is formed of butt-welded tubes $2\frac{1}{4}$ in. in internal diameter and $\frac{3}{4}$ in. in thickness. A soundly welded tube of this size, made from iron of a tensile strength of 50,000 lb. per square inch, would have a bursting strength of 16,866 lb. per square inch, and the tubes are tested to 2000 lb. pressure, and sometimes to more.

Messrs. Perkins's system of steam heating, which we described in our first volume, depends upon the enormous strength of small water-tubes. They generally use tubes of $1\frac{1}{2}$ in. external and $\frac{3}{4}$ in. internal diameter, giving $\frac{3}{4}$ in. thickness. Such tubes, supposing the iron to have a tensile strength of no more than 50,000 lb. per square inch, or the ordinary strength of fair Staffordshire iron, would have a bursting strength

of exactly 25,000 lb., as for every square inch of the diametrical plane along which the pressure acts there would be half a square inch of iron in the two sides of the tube to resist it. Messrs. Perkins take such tubes, of any convenient length, and having first welded up one end, partly fill them with water, and afterwards weld up the other end. If such a tube were placed wholly, or even for a considerable portion of its length, within a good fire, its bursting pressure would sooner or later be attained, and it would burst, with some noise certainly, but if surrounded by, and fastened to, brickwork, not with any destructive effect of consequence. In making experiments to test the full endurance of tubes, Mr. Loftus Perkins has occasionally thus burst them. It will be understood that the tubes have no safety-valves, and yet if only a short portion of their length at their lower ends (the tubes being a little inclined from the horizontal) be placed in the fire, and the remaining surface of the tube be allowed to radiate its heat into an oven, no amount of firing can burst them. Whatever the temperature of the steam, whether 600° or more, it then goes on condensing as fast as it is generated, giving off its latent heat through the substance of the tube. This process may go on for years, the boiler, if we choose so to term the tube, containing always the same water as that with which it was first charged. Messrs. Perkins have also employed these tubes—boilers as they really are themselves, although no steam is taken from them—for heating the water within an ordinary cylindrical boiler, working at a much lower pressure. Such a boiler was worked for many years, and the tubes, when cut open after eight years' work, were found to contain their exact original quantity of water, although this, by absorbing a certain portion of oxide of iron, had become as black as ink.

Messrs. Perkins give to their heating-tubes the name of heat-conductors, which is accurate, although not quite suggestive of their use. Three years ago, Mr. Loftus Perkins applied them to a baker's oven in Hamburg, and a considerable number of them are now fitted in bakeries in England and abroad. Some have already been made to the order of our own Government for the use of the army, and they are likely to be ultimately adopted for all army bakeries, because of their cheapness and convenience of erection.

An admirable application of the heat-conductors is that at the factory of which we gave a description a fortnight ago, where they are employed to heat the core oven in the foundry. Instead of a sooty, smoky den into which none but a salamander could enter, this core oven is whitewashed within, and has a double window at one end admitting light from the foundry yard. We cannot think that any founder, after once seeing such an oven, would wish to continue the present mode of drying cores.

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. 3226, 6d.) Alexander Colvin Fraser, of Colchester, patents making gas-retorts with ribs extending along the bottom of the interior of the retort, and also up the end. On the interior of the top and sides are also formed channels or grooves extending nearly from the back to the front, these grooves, or some of them, being connected with each other by transverse channels. The upper grooves are stated to be designed to prevent deposit, or to enable the deposit, if formed, to be more readily removed; and the bottom ribs are intended to facilitate the escape of the gas from the coal during the process of distillation.

(No. 3232, 4d.) Thomas Gray, of Wandsworth, patents neutralising the free acid contained in bleaching compounds, or chlorine gas, by passing the gas through an alkaline solution previous to bringing it into contact with the line with which it is to be combined, or by mixing some suitable alkali with the ground lime or bleaching-powder, previous to using the latter for bleaching purposes.

(No. 3233, 10d.) Carl Erik Samuelson, of Hamburg, patents the use of a kind of injector for the propulsion of vessels, it being proposed by him to employ a jet of steam to cause the flow of a current of water through a channel extending through the vessel and communicating with the water at each end. Propulsion by such means could, of course, only be obtained at the expense of an enormously wasteful expenditure of steam.

(No. 3236, 1s.) William Robertson and Charles James Waddell, of Manchester, patent an ingenious method of imparting reciprocating motion to the parts of gins, mowing-machines, &c. The apparatus may be described as a modification of the "sun and planet" motion, the connecting rod, to which a reciprocating motion is to be imparted carrying an internal wheel which is kept in what the patentees term "oscillating contact" with an external driving-wheel, or *vice-versa*.

(No. 3242, 8d.) William Warren, of Alstone, near Cheltenham, patents fitting pumps with a lever, so arranged in the lower part of the barrel that when the bucket is caused to descend below a certain point, it opens both the suction and bucket valves, and allows any liquid that may be in the pump-barrel to run back into the well or receptacle from which it has been raised. Under ordinary circumstances the descent of the bucket to a point sufficiently low to cause the opening of the valves is prevented by a removable stop which arrests the movement of the handle. The arrangement is intended to prevent the water or other liquid from freezing by being left in the pipe and pump-barrel, and also to prevent the injury which some liquids might sustain from being left in contact with the metallic surfaces of the pump.

(No. 3247, 1s.) William Ford Smith and Arthur Coventry, of the Gresley Iron Works, Ordsal-lane, Salford, patent improvements in the manufacture of tool holders and cutters, and in the arrangement of machinery for grinding and sharpening cutters. The details claimed in this specification are too numerous for us to describe them here; but we may perhaps give an account of some of them on some future occasion.

(No. 3249, 8d.) Walter Chidcock Nangle, Capt. R.A., and deputy-assistant quartermaster-general, of Woolwich, patents a wonderful construction of armour plating for war vessels or forts. He proposes to coat the surfaces to be protected thus:—first, "with a cushion or pad of horsehair, soft malleable iron, or other suitable yielding material" (!); next, with armour plates, say 3 in. thick, having knobs or excrescences 4 in. thick on their outer surfaces; next, with a layer, about 8 in. thick from the tops of the "knobs," of a composition formed of hides cut into small pieces before being tanned, mixed after tanning with marine glue, and formed into blocks by powerful pressure; next, with a second pad or cushion of horsehair; next, with two layers of rings or flat plates with circular apertures, these rings being set vertically, and the two layers being separated by wire netting, to which they can be secured "by string (!) or other material which will not readily break;" next, with steel or other metal plates having on their outside surfaces projections bevelled at their extremities and curved upward, with a view of causing a shot striking them to be diverted downwards; and lastly, with wood or the composition above described filled in between the projections just mentioned. Captain Nangle proposes to build up this delightfully simple system of armour plating in boxes 5 ft. square, which are to be dropped between the main skin of the ship or structure to be protected and an outer skin!

(No. 3254, 10d.) Robert Clayton, James Raper, John Goulding, and William Howarth, of Bradford, patent arrangements for stopping or starting the tappet shaft of swivel or other looms, by self-acting mechanism governed by the jacquard or other shedding motion.

(No. 3256, 6d.) Clinton Edgecumbe Brooman, of 166, Fleet-street, patents, as the agent of Samuel Maynard, of New York, an admirable method of uselessly complicating the construction of railway wagons. Mr. Maynard proposes to place on each axle, inside the ordinary carrying wheels, two other wheels of smaller diameter, and, in addition to these, to place another axle between the two on which the truck is carried, and to provide this axle with a pair of wheels situated outside the carrying wheels. It is intended that, in the event of the truck running off the rails at points or switches, it should be carried upon the auxiliary wheels, and that by means of a chain which would then be wound upon the third axle, the brake should be applied, and a whistle on the engine opened! Fancy providing each wagon with six extra wheels, an extra axle, and a lot of other gear for such a purpose.

(No. 3258, 8d.) Edmund Small Cathels, of Lower Sydenham, patents casting longitudinal bands or ribs along the exterior of gas mains, the bands being placed so as to increase the thickness of the mains at those points at which they are usually pierced for the connexion of service pipes. A form of gas-regulator or governor specially intended for use in hilly districts is also included in the patent.

(No. 3259, 1s.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Edouard Victor Jules Joubin, of Boulevard Beaumarchais, Paris, an apparatus for cleaning the external surfaces of boiler-tubes. The apparatus consists of a kind of chain, the links of which form a series of cutters, this chain being passed over the tubes to be cleaned, and drawn backwards and forwards until the scale is removed from them.

(No. 3261, 10d.) Thomas Henry Cooper, of Slough, patents an arrangement for preventing the rebound of railway buffers when they are driven home beyond the usual extent, as, for instance, in the event of a collision. The arrangement consists of pawls, which take into teeth formed in the rods of the buffers when the latter are driven home, the pawls being ordinarily maintained clear of the teeth by chains connecting them with the drawbars. Dr. Cooper states that from a careful examination into the results of collisions, he has "been led to attribute much of the evils arising therefrom to the rebound of the buffers"—a conclusion in which we quite agree with him.

(No. 3262, 4s. 10d.) This is a specification—comprising eighty-four pages of letter-press and four sheets of drawings—in which Mr. Richard Boyman Boyman, of Park-crescent, Stockwell, explains his views on the subject of aerial propulsion, and on the use of jets of steam as a motive power. Mr. Boyman's remarks are far too voluminous for us to attempt giving any abstract of them here.

(No. 3265, 1s. 4d.) Samuel Chatwood, of Bolton, patents improvements in the construction of safes. Mr. Chatwood fixes, into the back of the door, studs with heads at their ends, these studs, when the door is shut, passing through holes in projecting portions of the frame of the safe, and also through slots in bars working at the backs of these portions of the frame. The slots in the bars are so formed that when the bars are in a certain position they allow of the passage of the heads of the studs through them; but by moving the bars endways by means of a spindle and handle, a narrower portion of each slot is brought under the head of each corresponding stud, so that the shanks of the studs are embraced and the door held fast. The plan appears to be a very effective one. Some modified arrangements and details of construction are also included in the patent.

(No. 3266, 4d.) Victor Gallet, of Lavausseau de Bennassais, Department of Vienne, France, patents manufacturing cast steel by coating "puddled bar" iron with a certain composition and then melting it in a crucible. The coating composition consists of the following ingredients made into a paste with water: limestone (carbonate of lime), 37 parts; vegetable mould (or clay), 13 parts; carbonate of potash, 10 to 20 parts; oxide of manganese, 3 parts; resin, 3 parts; soot, 10 parts; wood charcoal, 40 parts; and common salt, 1 to 3 parts.

(No. 3268, 10d.) Henry Wren and John Hopkinson, of Manchester, patent an arrangement of duplex machine for dressing slates, in which two radial dressing-knives are provided, one on each side, these knives being moved up and down alternately by connecting-rods extending to a crank-shaft carried across the top of the machine.

(No. 3276, 10d.) Johann Heinrich Grell, of Hamburg, patents fitting vessels with a series of balanced rudders placed in openings formed in the keel, the spindles of these rudders being connected by shafting and gearing, so that they may be acted upon simultaneously.

(No. 3279, 10d.) Henry William Ripley, of Lightcliffe, near Halifax, and Thomas Barker, of Bowling, near Bradford, patent applying to the front of a cylindrical boiler an auxiliary boiler of the "saddle" or "half-moon" form, this auxiliary boiler being connected to the main boiler by steam and water pipes, and having placed under it a "Juckes's" or other self-acting firegrate. It is preferred to employ a self-acting grate, consisting of a series of parallel rotating shafts, having plain or toothed discs of cast iron or firebrick placed on them, the fuel being fed into a hopper at the front of the grate, and carried forward by the rotation of these discs. The flame from the grate is conducted through the flues in the main boiler in the usual way; and the main and auxiliary boilers, instead of being independent structures, may be formed in one, if desired.

(No. 3281, 10d.) Charles Coles Adley, of Dublin, patents making telegraph posts or standards of a pair of inclined struts of angle or T iron, connected by light lattice bracing. A particular form of insulator—which could scarcely be clearly described without the aid of drawings—is also included in the patent.

No. 3289, 8d.) Alfred Vincent Newton, of 66,

Chancery-lane, patents, as the agent of Samuel Harris, of Rochester, U.S., a form of steam motor. The machine consists of two shafts mounted in bearings in line with each other, one of these shafts carrying two or more hollow arms having tangential openings, and the other carrying a cup-shaped disc, in which the arms are enclosed. The shaft carrying the arms is hollow, and steam, being admitted into it, escapes through the openings in the arms and imparts motion to them by reaction, the steam so escaping at the same time acting on a series of vanes or projecting blades, placed around the inner circumference of the cup-shaped disc, and thus imparting motion to it also, but in an opposite direction to the arms.

DRAINAGE OF BOMBAY.—II.

HAVING, in a previous article, hastily glanced over the present condition and the requirements of Bombay in respect to efficient drainage, we now proceed to notice the scheme projected for that purpose by Mr. Russel Aitken, the executive engineer to the municipality of Bombay.

In a preliminary report on the main drainage of Bombay, the merits were discussed of different sites for discharging the sewage of the city, and three sites were suggested, any one of which would fulfil the following requirements: viz., first, that the sewage, when discharged from the reservoir, should not be thrown back on the foreshore; and, secondly, that it should be swept out to sea and carried away from the shipping. These three sites were respectively called the "Oyster Rock Outfall," the "Light-house Outfall," and the "Prong Outfall," and the Light-house site was ultimately decided on, chiefly on account of the sanitary interests of the military cantonment.

The general nature of the projected drainage works is similar to those recently constructed for the main drainage of London, with this exception, that whereas in London the main intercepting sewers only had to be constructed, in Bombay not only will the main intercepting sewers have to be made, but almost all the street sewers will require to be reconstructed, and a plentiful supply of water taken into the houses.

The first thing to be considered is the population requiring to be provided with sewer accommodation. In the year 1815 Bombay contained about 220,000 inhabitants; in 1851, 520,000; and in 1864, 816,000, including a harbour population of 32,000; and it is calculated that, at a similar rate of increase, the population may reach 1½ millions by the end of the present century; and, accordingly, in the present plans, provision has been made to meet the requirements of the last named number. It is also proposed that the city shall be provided with waterworks which will ensure a daily supply of not less than 30 gallons per head of this increased population. The present supply from Vehar amounts to little more than 14 gallons per head for the present population, or not one-half what is required, and surveys are now being made with a view to ascertain the practicability of extending the Bombay Waterworks, without which it would be impossible to introduce an efficient system of sewer drainage.

If sewers for the drainage of Bombay were constructed to convey away the sewage water of the city only, they would not require to be of large size, and they would work very efficiently during the eight months of the year when there is no rain; but during the south-west monsoons the falls of rain are excessive, and will require to be dealt with in an especial manner. It is therefore proposed that, during the monsoon, as much mixed sewage and rain-water as possible shall be taken away by gravitation from the higher portions of the town, leaving the engine power at Colaba to pump what sewage and rain-water it can from the lower parts of the town, and to allow the surplus to escape by overflowing on the Flats. During the fair season, that is, for eight months of the year, all the sewers will gravitate towards Colaba, where the sewage will be pumped up into reservoirs, and discharged into the sea at high water; but during the monsoon it is proposed that the high-lying districts shall be cut off from the main sewer to Colaba, and the sewers allowed to discharge themselves either into the harbour or into Back Bay; the engines at Colaba will then only have to pump the sewage and rain-water from the low-lying districts. The drainage of that part of the island which is bounded by the Bellasis-road, the Duncan-road, the Girgaum Back-road, and the Breach Candy-road is the only part of the town which

presents any real difficulty. The greater portion of this district lies between high and low water mark, most of it being about two or three feet above mean sea level, so that during the monsoon it is submerged, the houses there being like so many islands; a part of the present scheme, therefore, provides for the filling in of this area of about 150 acres, the cost of which is estimated at from 100,000*l.* to 120,000*l.* This would enable the whole of the main drain to be constructed 3 ft. higher than would otherwise be possible if this part of the town were allowed to remain in its present condition, and it would also diminish, by 3 ft., the height to which the whole of the sewage of Bombay would have to be pumped.

The main sewer from the Null Bazaar (which is the most convenient spot for intercepting the sewers of the town, as it is the centre towards which the present drains of a large part of the Native Town gravitate) to the light-house is to be circular, 10 ft. in internal diameter, and to have a uniform fall of 2 ft. per mile throughout its entire length. In order to avoid taking this sewer under the Bhendy Bazaar-road, which is the only available thoroughfare through the Native Town, a new street is to be constructed, seven-eighths of a mile in length and 60 ft. wide, from the Null Bazaar to the Money School, which will give a new and direct road from the Esplanade to Byculla. All the intercepting sewers now proposed, with the exception of the main sewer from Null Bazaar to Colaba, have been calculated to take 8 in. of rainfall per day; but as the main sewer could not, on account of the expense, be made of such capacity, it is proposed to construct a reservoir having an area of about 4 acres and a depth of 12 ft., to hold the sewage collected during one tide in the fair season, or during breaks in the monsoon. The sewers will be discharged shortly after high water through a culvert, which will be carried out to low-water mark. In order to give increased facilities for the discharge of the monsoon water, it is proposed that the present main drain shall be retained as a surface water drain only; and should other overflows be found necessary, they will be constructed either open or covered, as circumstances may require.

The main sewer, 10 ft. in diameter, will be formed of brickwork in cement 1 ft. 6 in. thick, where it is carried through sandy or soft ground. This lining of brickwork will not be necessary where it passes through trap-rock in tunnel, as hollows in the rock can be filled in with concrete composed of Portland cement and sand run in outside a template. The large sewers will be circular, the smaller ones being egg-shaped and of the following proportions: depth 3, diameter of top arch 2, diameter of invert arch 1. Where these egg-shaped sewers are in rock, the lower part will be covered with cement concrete, as proposed for the main sewer through Colaba. The lower portion of all egg-shaped sewers has been estimated for as brickwork in Portland cement, the arch being in hydraulic mortar.

The greatest difficulty hitherto experienced in Bombay has been to obtain good bricks suitable for sewer-works, and it has even been proposed to import stock bricks from England; but it is hoped that the brick-works lately established by the municipality at Panwell will be able to furnish a sufficient quantity of bricks of the required quality.

As the sewers are being built, gully-holes will require to be made to convey away the rain-water from the streets; these will replace the perforated slabstones which are now placed in the centres of the roadways.

The ventilation of sewers in a tropical climate is a very serious matter, and is one which will sooner or later force itself on the attention of the municipality. Mr. Aitken thinks that the true solution of the difficulty will be found to be in a system of mechanical ventilation, and he suggests that screw fans may be driven round by one of Barker's mills, the turbine and the fan being on one shaft, and these fans placed at the bottom of ventilating-shafts would cause an upward current from the sewers, and the water expended in working them would serve to dilute the sewage, and so prevent deposit.

The cost of the above works is estimated at 110 lacs of rupees, which, by deducting the amount to be recovered by sale of land on either side of the proposed new street, would ultimately be reduced to about 85 lacs, or 850,000*l.*

The present system of removing the night-soil of Bombay, says Mr. Aitken, is barbarous, inefficient, and expensive, and leaves the city at the mercy of the lowest caste of the community. And although the system of sewage now proposed may appear to be expensive, yet its immediate execution will be a true

economy in the end, and as civilization advances in India a proper system of drainage will, as in England, be considered not merely as a thing that may be done, but as one which *must* be done.

The above scheme is now under the consideration of a committee specially appointed to report on the best means of improving the drainage of Bombay.

PROGRESS OF INDIAN RAILWAYS.

AMONGST other schemes for railway extensions in India, we learn that one of the last acts of Sir Cecil Beadon was to propose the construction of a railway from Calcutta to Debroghur, and that the Government of India should offer a guarantee of five per cent. upon the capital subscribed, if the Eastern Bengal Railway Company would undertake it. This line would prove of the greatest possible benefit to Assam, which is now almost exclusively dependent upon an uncertain river navigation for communication with the port of Calcutta.

In the Punjab it is expected that the railway from Umritsur to the Beas is certain to be opened during the present month; only three miles of rail, according to the last accounts, required to be laid in order to complete the line. Fences, telegraph, &c., are all complete; and a new dāk bungalow is being built near the station, about half a mile from the present one.

With reference to the East Indian Railway works, orders have been given for laying a double line of rails on the Jubbulpore branch, and the earthwork between Luckesera and Allahabad is to be proceeded with at once. These arrangements imply the completion of this work in the course of 1868, as the materials for the contemplated doubling of the line will be forwarded in three instalments, the last arriving in the beginning of next year. On May 7th the opening of the Allahabad and Jubbulpore Railway was inaugurated by a dinner given in Jubbulpore by Mr. Nicoll, of the firm of Messrs. Waring Brothers and Hunt. Colonel Spence, the commissioner, said that there never had been a line of railway in India completed with such rapidity. In reply to the toast of the day, Mr. Le Mesurier, the chief engineer, stated the following facts regarding the Jubbulpore line: The works extend over 223 miles, from Nynee junction on the main line, near Allahabad, to Jubbulpore. The earthwork amounts to 405,000,000 cubic feet, or sixteen square miles covered with a layer of soil 1 ft. in thickness. In addition to this earthwork, the cuttings are represented by 20,000,000 cubic feet, and the gravel cuttings by a like quantity, and not less than 11,000,000 cubic feet of masonry have been built into place. 50,000,000 cubic feet of ballast have been collected, and about 50,000 tons of iron have been put into place in the road and in the bridges. With a view to facilitating the through traffic between Bombay and Calcutta, which will pass over this line, it is stated that Mr. Temple made a proposition to the Government of India for working the trains on the Great India Peninsula Railway as far towards Jubbulpore as possible, and suggested that the first eighty miles of that railway from Jubbulpore should be pushed on as rapidly as possible, in order that it might be worked by the East India Railway Company's rolling stock. He thought that the line might be advanced sufficiently to admit of working light traffic in the course of about six months. If this arrangement were carried out, a gap of some sixty miles only would be left to the west of Gurrawarra to be traversed by the horse dawk. The *Pioneer*, however, believes that Mr. Temple has under-estimated the difficulties of the construction of the line to Gurrawarra, and that the time requisite for making the route practicable so far would be more nearly twelve than six months.

The Great India Peninsula Railway, with a view to provide for increased traffic, is about to lay two additional lines of rails along a portion of the Island of Bombay. By the next cotton season this railway will have 275 miles of double line, out of 600, and 50 per cent. more cotton wagons than at present. This will enable the company to bring a full crop of 70,000 tons from the cotton districts to Bombay in three months.

The survey for the Neemuch and Delhi Railway Extension has been sanctioned; and the surveying party have started for the scene of their operations.

The Great Southern of India Railway having nearly completed their line between Negapatam and Erode, thus connecting the main lines of the Madras Railway with the great southern districts of Tanjore and Trichinopoly, now propose applying to Government for an additional guarantee of interest to enable them to extend their line to Dindigul, Madura, and Tuticorin. It is highly desirable that the last named place, which

is the great shipping-port for most of the cotton grown in the southern districts, should be connected with Madras by railway, while the extension of the line to Madura would bring those magnificent hills, the Pulnis, within reach of the European agriculturist, planter, and valetudinarian. Little doubt is entertained that the application of the company will be cordially supported by the local authorities.

It appears from official data that the amount of capital estimated to be required by the Indian railway companies between March 31st, 1867, and March 31st, 1868, is 7,649,554*l.* being nearly one million more than was raised in the previous twelve months. Considering the present state of the money market, this moderate increase is not likely to lead to any inconvenience.

As regards the Ceylon Railway, we learn that, as far as the contractor is concerned, the railway might have been opened on the 1st July, as was previously arranged; but in consequence, it is said, of the want of drivers for the incline, the actual opening was not expected to take place for at least a fortnight later.

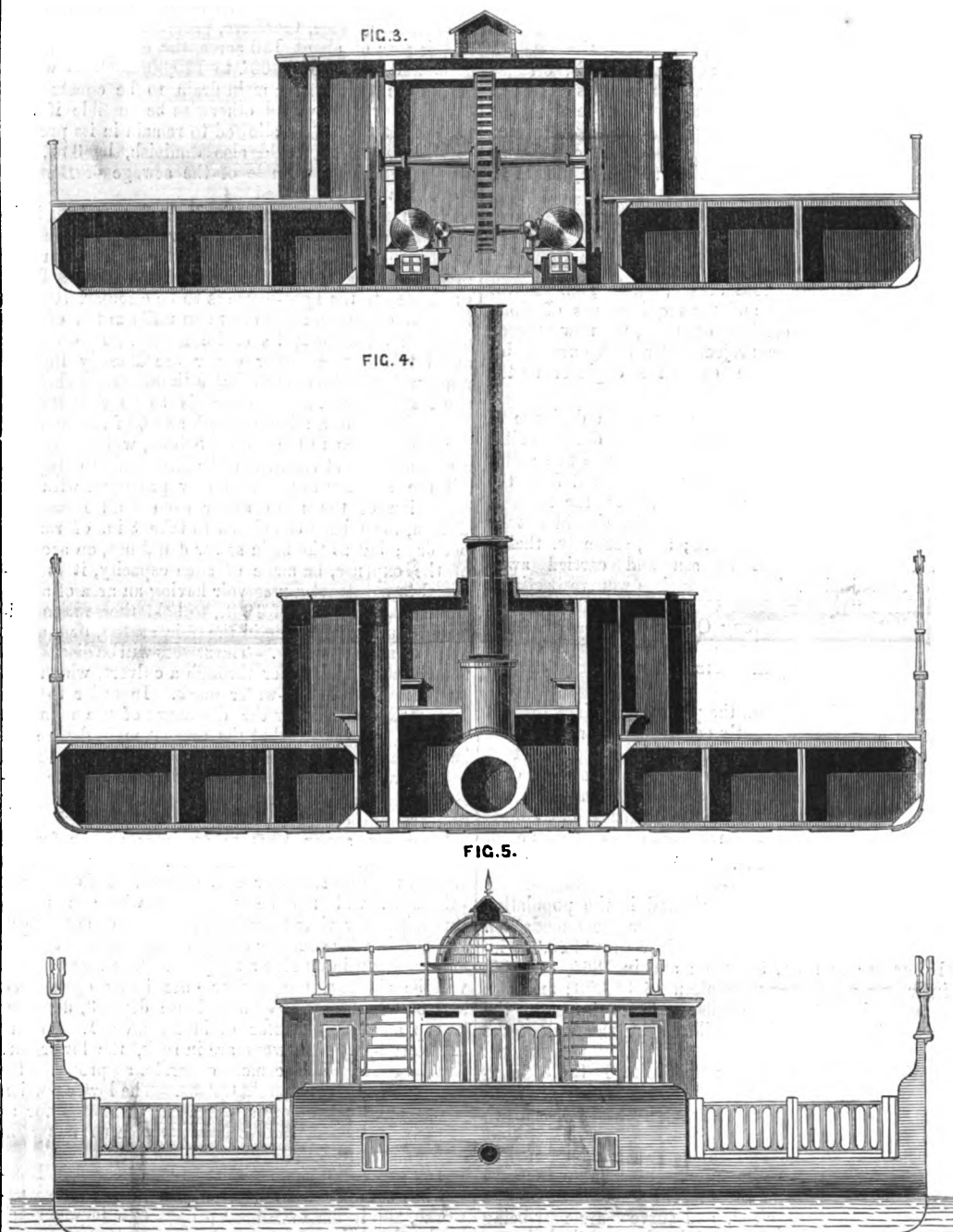
ASPHALT PAVEMENT IN PARIS.

VISITORS to Paris are generally surprised at the appearance of the pavement of a great number of streets in the central parts of the town, and still more at the peculiar mode of making and repairing this asphalt pavement if they chance to see those operations carried out. The asphalt pavement was introduced in Paris in 1854, by M. Mombert, chief engineer, and M. Vandrey, engineer of the municipal service of the town of Paris. The first street paved in this manner was the Rue Bergère. The asphalt used for this purpose is a natural composition of pure carbonate of lime and of bitumen or mineral tar. It is found in abundant quantities at Seyssel (Ain) in France, and at Val-de-Travers, in the canton Neuchâtel, in Switzerland. In the first-named locality the layers of bituminous limestone are from 4 to 7 yards deep, and of very uniform composition, containing about 66 per cent. of bitumen and 34 per cent. of carbonate of lime. The natural stone is crushed into powder by machinery, and afterwards heated to a temperature of about 140° Centigrade. In then remains in the state of a dry, fine powder, somewhat similar in its consistency to moulders' sand, and in this form it is employed in the streets. The roads to be paved are first covered with a layer of concrete made of gravel and cement, and this layer is carefully dried before the application of the asphalt cover. The asphalt powder is then reheated and spread over the surface of the concrete in an even layer of about 4 centimetres, or 1½ in., in thickness throughout. After this the powder is rammed and compressed by means of heated cast-iron rams worked by hand. This being done, a heated roller is passed over the surface. The roller weighs about 4 cwt., and is repeatedly traversed over each short length of pavement newly rammed in. Two larger rollers, one of 16 cwt. and one of about 2 tons weight, are afterwards employed for flattening down the surface of the whole. The pavement is finished and ready for use immediately after cooling, say two or three hours after the first roller has completed its work. The asphalt pavement has now had an extensive and complete trial, and its advantages are very numerous. There is neither dust nor mud produced by it, and its surface wears no more than one millimetre, or ⅛ in., in thickness per annum in streets having a lively traffic. At the beginning there is a compression caused by the weight of the vehicles rolling over the pavement, but the whole gets soon into a state of uniform density, and the street then remains in a perfect state for a long time, requiring very little repair. There is no noise whatever from the wheels of carriages in asphalt-paved streets, so that there is a certain danger caused by this to pedestrians from the want of warning of the approaching carriages. This, however, disappears by degrees, as the public becomes more and more acquainted with this kind of pavement. The tractive force required by the carriages passing over asphalted streets is very considerably reduced, and still more important is the reduction of the wear and tear of carriage-wheels, springs, and axles, a reduction which is due to the absence of all concussion and vibration in the rolling of the carriage-wheels over the smooth and uniform surface of the street.

PUMPING ENGINES AT THE LAMBETH WATERWORKS.—The new engines erected by Messrs. Simpson and Co., of Pimlico, at the works of the Lambeth Water Company, at Thames Ditton, have been recently subjected to a twenty-four hours' trial, under the superintendence of Mr. Hawkesley. The result showed a consumption of coal amounting to only 1.6 lb. per indicated, and 1.9 lb. per effective, horse power per hour.

IRON FLOATING BRIDGE CONNECTING PORTSMOUTH AND GOSPORT.

CONSTRUCTED BY MESSRS. LEWIS AND STOCKWELL, ENGINEERS, LONDON.



In our number of January 18th last, we published a letter from Messrs. Lewis and Stockwell, of Blackwall, in which they gave some of the leading particulars of the iron floating bridge constructed by them for the ferry between Portsmouth and Gosport; and we now give, on the present and opposite pages, engravings of this floating bridge, which have been prepared from drawings with which we have been furnished by the builders. Of the figures on the opposite page, Fig. 1 is longitudinal section, and Fig. 2 a plan; whilst, on the present page, Fig. 3 is a transverse section through the engine-room; Fig. 4, a transverse section through one of the boilers; and Fig. 5, an end view.

The hull of the floating bridge is 100 ft. long by 60 ft. wide over all; the length just mentioned being exclusive of the bows or bridges, which are each 30 ft. long, and which are raised and lowered by chains, as shown in the engravings. The hull is 6 ft. deep under the two carriage-ways, which extend along each side the vessel for its whole length, and 12 ft. deep at the centre, this central portion containing the engines and boilers and two waiting-rooms, one at each end. The average thickness of the skin-plate is ½ in., and the angle-iron frames, which are 5 in. by 3 in. by ½ in., are spaced 18 in. apart, and the plates are rivetted to them by rivets ½ in. in diameter. The hull is strengthened longitudinally by stringer plates and wooden trussed beams, and there are two longitudinal water-tight bulkheads running the whole length of the vessel, besides four transverse bulkheads. The deck-beams are 9 in. deep by 3 in., and they are placed on every other frame.

The bridge is worked by a pair of horizontal high-pressure condensing-engines, having cylinders 2 ft. 3 in. in diameter with 3 ft. stroke; and the crank-shaft of these engines carries a pinion which gears into a spur-wheel on the chain drum-shaft. This last-mentioned shaft carries two chain drums or pulleys, there being two chains, as shown in the engravings. The engines are supplied with steam by a pair of boilers, each 22 ft. long by 5 ft. 9 in. in diameter, these boilers each having one internal flue 3 ft. in diameter. The flue of each boiler is connected with

the chimney by a branch flue carried up through the steam-dome, as shown in the figures. Space for the stowage of coal is provided under each of the waiting-rooms, as will be seen from the longitudinal section.

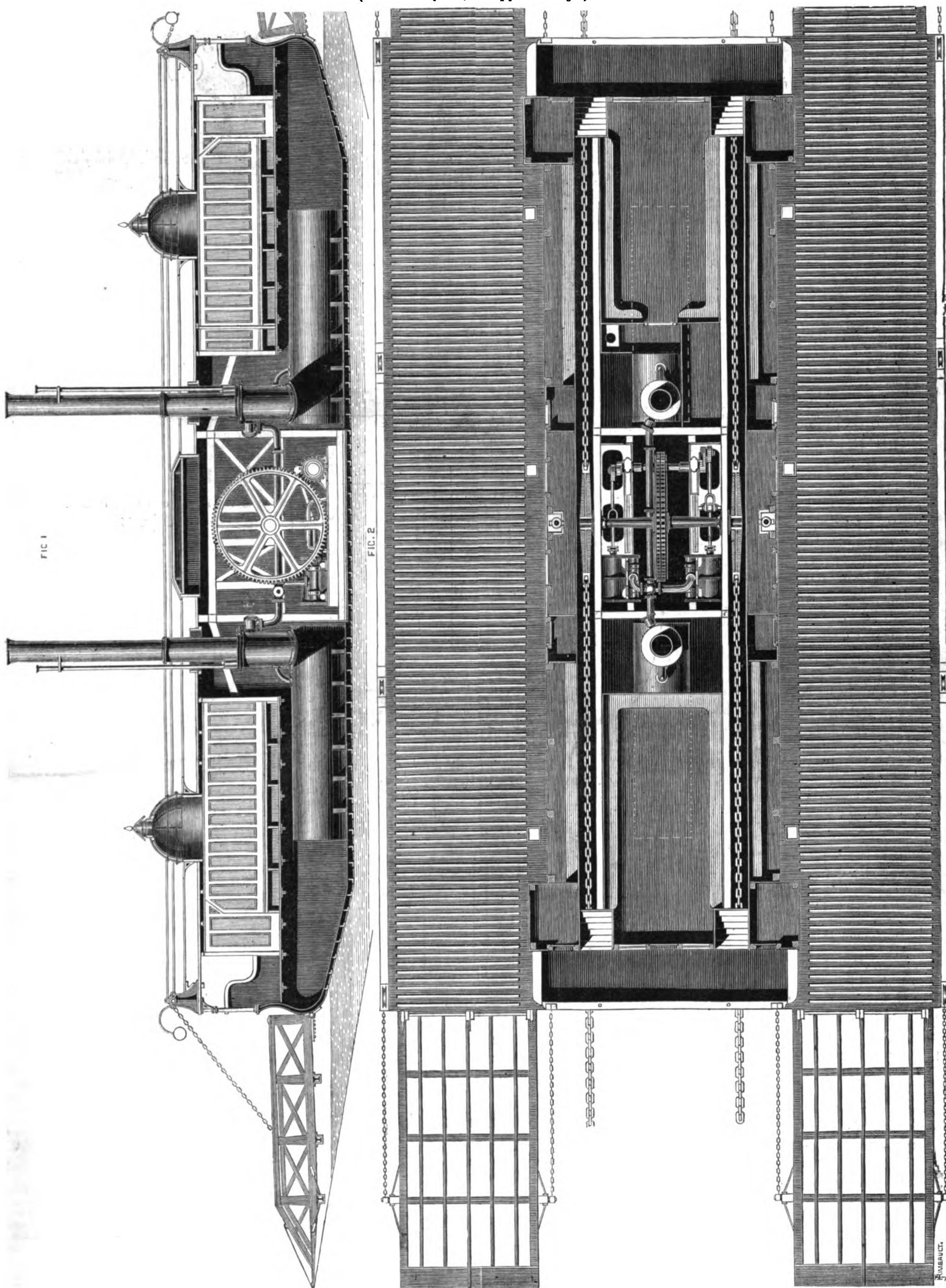
The floating bridge above described has now been in regular use for upwards of two years and a half, and it has answered its purpose admirably, it being found to be quite capable of conveying the heaviest traffic required. At night the bridge is lighted by gas supplied from a small gasholder placed at one end of the vessel, this gasholder being filled daily from the pipes on shore.

SPECIMENS OF WHEEL-CUTTING AT THE PARIS EXHIBITION.—M. Prosper van den Kerchove, of Gand, has exhibited several very remarkable specimens of wheel-work cut by a machine invented by him in 1853, and in constant use at his works since that time. This machine cuts cylindrical and bevel wheels with straight cuts, and a planing or shaping tool, no revolving cutters being used, and it can be employed for the smallest wheels as well as for very large sizes. At the Exhibition a segment of a cut wheel is shown which is one of the finest specimens of work of the kind ever produced. M. van den Kerchove states that his machine will divide and cut wheels up to 18 ft. diameter, both cylindrical and conical wheels; the teeth can be made up to a width of 24 in., and with great speed and accuracy. The inventor has worked his machine at his own works, and it has cut a wheel of 71 teeth about 6 ft. in diameter, and with teeth about 10 in. wide, in fifty-two hours, including the planing of the bottoms of the teeth, which was done by the same machine. The cut averaged three or four millimetres in thickness of cast iron upon all the planed surfaces, and this was effected, with perfect uniformity and regularity, at the average rate of 45 min. for each complete tooth. M. van den Kerchove used to keep the construction of his machine a secret, but we understand that he is now selling similar machines or making them to order at a fixed price.

IRON FLOATING BRIDGE CONNECTING PORTSMOUTH AND GOSPORT.

CONSTRUCTED BY MESSRS. LEWIS AND STOCKWELL, ENGINEERS, LONDON.

(For Description, see opposite Page.)



APPARATUS FOR MEASURING THE DISCHARGE OF WATER.

(Continued from page 116.)

THE advantages of this apparatus consist of the extreme simplicity, intelligibility, and certainty of its action, the steadiness of its performance in deep water, and the high level at which the delivery is made.

The disadvantages are two; one arising from the size of the pipes and expense of the apparatus when large quantities of water have to be measured, 1000 cubic yards per hour, for instance, requiring 10 syphons of 6 or 7 in. diameter; and the second, from a fact, which is applicable, more or less, to all instruments on this general principle, and may possibly interfere with its usefulness in some situations, viz., that as the water is brought to a state of repose within the chamber, and that which is measured by it is only taken from near the surface, the greater part of the silt is left behind, and is not only lost to the fields, but remains to accumulate in the chamber and derange the apparatus.

These objections may, however, perhaps be remedied by a different arrangement, or found of insignificant importance in practice, in which case the instrument may become highly useful in many situations.

In regard to the accumulation of silt, the evil would probably be overcome if the float were arranged to swim in a separate chamber, or if (supposing a 12 in. head adopted) the inlet arm of the syphon were suspended beneath a long float, such as a beam of timber, in a narrow trough, into which the tunnel from the canal opened close to the neck of the syphon. This would tend to keep the water constantly in motion, and probably hinder the deposit of silt.

In the experiments with a model of this apparatus on a small scale, it was found that the quantity of water discharged was much less than was calculated theoretically, so much so as to lead to the belief that, even with a 12 in. pressure, a pipe of 7 in. internal diameter would not be too large to pass 100 cubic yards per hour. This, of course, will be determined practically on the large scale.

Falling Shutter.—Another method on this principle, which has been successfully employed in England for large bodies of water, is that of providing an opening in the side of the canal which is filled by an oblique shutter, moving on a hinge below, and capable of being raised and lowered by the buoyancy of two barges, one on each side, floating in recesses or docks cut into the bank. The upper edge of this large shutter is connected with the barges on each side, so as to be kept at a regulated distance below the surface of the water, and thus a uniform volume falls over it and passes away by the supply channel.

Adjusting Sluice.—Another series of instruments for measurement is formed on the principle of cutting an opening in the side of the canal, and providing an apparatus to enlarge or diminish it in precise accordance with the depth of water and consequent velocity of the issuing stream, so as to maintain a uniform discharge.

The simplest form of adjustment of the area of opening to the velocity of the fluid is that in which a cone of a particular form is suspended to a float, so as to hang with its lower extremity within a circular opening of a regulated size, the diameter of the cone at various points being so adjusted that the area of the space between it and the edges of the circular opening is, at every point, in exactly inverse proportion to the velocity with which the water flows through, and thus the quantity discharged is always uniform. A well is formed at the side of and communicating with the canal, of double the depth of the water, and with a floor or false bottom at half its depth, corresponding with the level of the bed of the canal, a circular opening or regulator being provided through which the water passes from the upper to the lower half of the well, whence it issues to the fields by mouth, placed a little below the level of the floor, as in Fig. 8.

This kind of apparatus is more particularly suited to pass large bodies of water. With smaller quantities the space between the regulator and the cone is small and liable to obstruction. The following Table shows the dimensions of cones to pass various quantities. The co-efficient of discharge being $5\sqrt{h}$, and the method of calculation as follows:

Diameter of the "regulator" for various volumes of water, and cone at different points of depth.

	500 c. yards per hour.	1000 c. yards per hour.	2000 c. yards per hour.	3000 c. yards per hour.	4000 c. yards per hour.	5000 c. yards per hour.
Regulator.....	14 in.	18 in.	27 in.	31½ in.	36 in.	40 in.
feet.	in.	in.	in.	in.	in.	in.
Cone at 1	7.65	6.99	13.38	13.58	14.00	15.00
" 1½	9.15	9.97	16.73	16.28	19.95	21.84
" 2	9.94	11.38	18.30	20.62	22.76	25.05
" 3	10.80	12.86	20.28	23.06	25.71	28.39
" 4	11.28	13.65	21.30	24.40	27.81	30.20
" 5	11.59	14.17	21.98	25.28	28.36	31.38
" 6	11.82	14.55	22.45	25.80	29.10	32.23
" 7	12.00	14.83	22.80	26.38	29.68	32.87
" 8	12.14	15.06	23.12	27.01	30.12	33.32
" 9	12.25	15.24	23.37	27.08	30.48	33.79
" 10	12.40	15.39	23.55	27.34	30.79	34.13

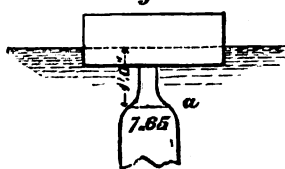
The size of the regulator is determined by the volume of water to be passed, and the depth to which it is intended to continue the drainage of the canal, and the measurement to continue accurate; because the lower it is carried, the larger the opening must be. Supposing 1 ft. be fixed upon, and the quantity of water to be passed be 1000 cubic yards per hour; then, as the area required to pass 1000 cubic yards per hour at 1 ft. width (vide Table) is 216 square inches, to which must be added sufficient area to allow the neck of the instrument to be gradually shaped from it (say 7 in. diameter or 38½ square inches), the total becomes 254½ square inches, giving 18 in. as the diameter of the regulator.

From the area of the "regulator" at every point of depth is

deducted the area required according to the Table to pass the given volume, and the remaining area is that of the circle, which is the section of the cone at that point, and whose diameter is easily found.

In shaping cones according to these tables, it must be borne in mind that no dimensions are stated less than that suited to 1 ft. depth of water, the cone being suspended to the float, so as

Fig. 9.



that point may be exactly 1 ft. below the surface of the fluid. The upper part of the cone between the 1 ft. mark, *a*, and the float may be shaped or reduced in diameter in any form most convenient, as the instrument ceases to measure accurately after the water has fallen below 1 ft. depth.

This method of measurement has been practically tried in a model, and found to be quite accurate, as to the uniformity of discharge of various depths from 12 in. to 2 in. The scale of the experiments was too small to obtain accurate data to fix the co-efficient for the purpose of calculating the absolute results and test the tables.

To obviate the inconvenience of calculating the different parts of the cone-slucie, a modification is described in the next paragraph, by which that inconvenience is got rid of. In the mean time it may be observed that no practical difficulty could be found in the way of causing such cones to work accurately, as the dimensions at different parts can be so easily corrected in the lathe, if found to require it.

The modification above referred to is that of forming the instrument of the shape of a conoid with flat sides, and of a rectangular horizontal section. According to this arrangement the calculations for the different parts are rendered quite easy; but the actual dimensions of the different parts are different from those given above, and are obtained as follows:

Table showing the areas of opening necessary for the discharge of 100 cubic yards of water per hour at various depths $5\sqrt{h}$:

Depths.	Areas.	Depths.	Areas.
feet.	square inches.	inches.	square inches.
12	6.235	12	21.600
11	6.513	11	22.560
10	6.830	10	23.709
9	7.200	9	24.941
8	7.637	8	26.588
7	8.164	7	28.281
6	8.818	6	30.547
5	9.659	5	33.462
4	10.800	4	37.412
3	12.471	3	43.200
2	15.273	2	53.176
1½	17.636	1	74.825
1	21.600	0	infinity

Assuming this Table to be correct, it is to be applied as follows: If a metre to act in water varying from 6 ft. to 1 ft. be required, the areas stated to be necessary at each depth are divided by six, and the quotients give the space between the edge of the cone and the regulator on each side at that point.

The regulator* for an instrument on this plan is rectangular, 8 in. broad for 100 yards, and may be of any length; but a convenient one may be determined by fixing the breadth of meter which would be desirable at the neck, that is, above the 1 ft. mark, and adding thereto the area of the opening at 1 ft. divided by three, that is, for 100 cubic yards per hour 7.2 in.

Let us suppose that the meter is to be made of wood, and that the breadth proposed above the 1 ft. mark is 4 in.; then

Fig. 10.

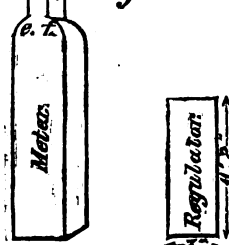
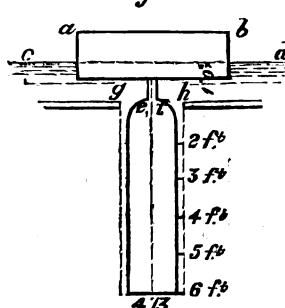


Fig. 11.

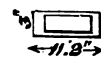


the regulator for a discharge of 100 cubic yards per hour would be 11.2 in. long, and the meter itself would be of the

* The length of the regulator corresponds with the breadth of the metre, and the breadth with the thickness.

form shown in Figs. 10 and 11, where the breadth, *e f*, at 1 ft. below the water level, *c d*, is 4 in., the opening, *g h*, or the

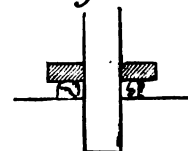
Fig. 12.



length of the regulator, being 11.2 in., the ordinate of the curve on each side at *e f* being 2 in., and at every succeeding foot downwards is 5.6 in. $\left(\frac{11.2}{2}\right)$ minus the opening due to that point divided by six. Thus at 3 ft. depth below the surface the ordinates would be $5.6 - \left(\frac{12471}{6}\right) 2.08 = 3.52$, and so on, for the other ordinates, to whatever depth may be required.

There is an objection to this modification arising from the risk of entrance of particles of grit at the flat sides of the meter, and choking its action. This may be guarded against,

Fig. 13.

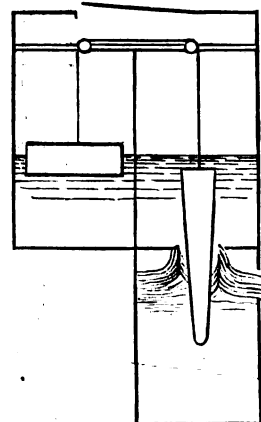


if it be found necessary, by cutting out a flat stone with an opening in the midst corresponding with the regulator, and placing it over the regulator, having a soft rope of straw, coir, or a long pudding filled with a soft material, and kept close to the meter on either side. It would not be required at the ends, or it might be obviated by purposely leaving an opening of a given size between the side of the meter and the regulator and allowing for the area thus added in the calculations.

In practically carrying out all plans of measurement wherein a float is used, which is permitted to fall to the lowest level, it is found very desirable that it should, if possible, be in a separate chamber from the orifice of discharge, because there is not only in parts of the chamber a tendency towards the accumulation of silt, which may prevent the free action of the float, but even when this is not the case, as the float approaches the floor, the presence of its own bulk interferes with the free circulation of the fluid, and vitiates the measurement.

If a separate chamber be used, the arrangement might be as shown in Fig. 14, the cone being reversed. Of course the

Fig. 14.



dimensions of the cone would be precisely the same as in the other plan, according to the depth of water at each point, at the time of its passing the regulator.

The same principle has also been varied by arranging that the meter should only descend a part of the whole depth, by attaching one end of a long lever to the float, and the other to a fixed point, and suspending the cone from another point, as represented

Fig. 15.

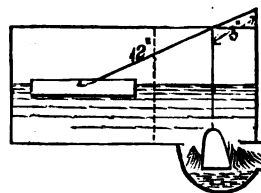
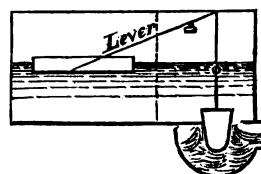
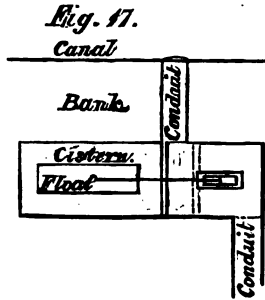


Fig. 16.



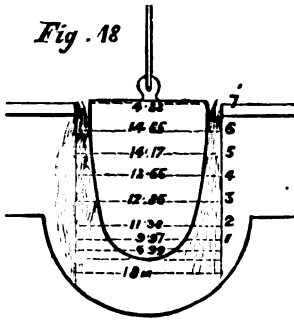
in Figs. 15 and 16. According to this plan, if the float consisted of a beam of wood swimming in a narrow cistern, and the meter were shaped out of a stone passing through a hole in a metal plate, or another stone, as a "regulator," a simple and efficient apparatus would be obtained on either of the plans shown in Figures 15 and 16 above, of which the last

seems to be preferable. In both of these cases the ground plan of the arrangement would be somewhat as shown in Fig. 17.



In this modification the shape of the meter is much changed, being compressed, the ordinates corresponding to different depths of the fluid being the same as before, but the abscissas shortened in the same ratio as that of the levers to one another. This method has been tried with perfect success on a small scale.

For the flow of 1000 cubic yards per hour from a canal of 6 ft. depth, with the two parts of the lever in the ratio of 4 to 1, the



Section showing the dimensions of an inverted cone to pass 1000 cubic yards of water per hour, with regulator of 18 in.

shape of a compressed ordinary conical meter would be about 15 in. diameter at its base and 19 in. height, as shown in the margin. The dimensions at every 3 in. height, corresponding to every foot of water, being the same as those given in the Table on the preceding page.

There is a convenience of the flat-sided meters before described, as of others which will be noticed presently, that a great facility is afforded for adapting them to the requirements of each particular case. The form of the meter and shape of the curve (according to the plan adopted) would be the same in every instance, but the thickness of the flat-sided meter and breadth of the regulator would determine the quantity of water passed. If it were 3 in. as above supposed, 100 cubic yards per hour would flow; if 6 in., 200 yards; if 30 in., 1000 yards, and so on. If the measurement were desired in cubic feet per second, the thickness would be 4 in. for 1 cubic foot, 8 in. for 2 ft., 3 ft. 4 in. for 10 cubic feet, &c., &c.

Rising Shutter.—The same general principle of adjusting the size of the opening accurately to the depth of the fluid to be discharged has also been tried successfully in other ways. Very many plans have been sketched, figured and calculated, and a few tried experimentally; but it is useless to describe more than one or two which promise to be useful on a large scale. The contrivance of these plans will be best understood by first considering that, supposing a shutter suspended in front of a narrow slit or opening in the side of the canal 3 in. in width, and an apparatus made to lift the shutter as the depth of water diminished, so as to maintain its lower edge constantly at a height represented for every depth by the number of square inches stated in the Table at page 124 divided by 3, the consequence would be that the area of opening would in every case be that shown by the Table, and the volume discharged would be for all depths uniform.

According to the above explanation, if the breadth of the opening in the side of the canal or cistern be 3 in. for every 100 cubic yards per hour, or 4 in. for every 1 cubic foot per second, the vertical height of the bottom of the shutter above the sill of the opening must be, when the water is at different depths, as follows, using the formula of $5 \sqrt{h}$.

Table showing the heights of an opening 3 in. broad at different depths for the discharge of 100 cubic yards per hour.

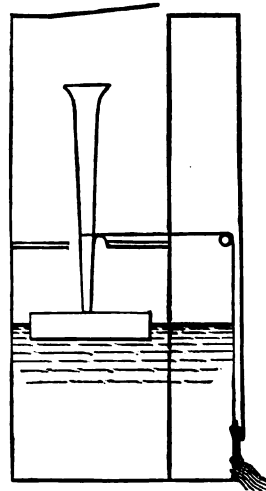
Depth of Water.	Opening of Shutter.	Depth of Water.	Opening of Shutter.
feet.	inches.	inches.	inches.
12	2.08	12	7.20
11	2.17	11	7.52
10	2.28	10	7.90
9	2.40	9	8.31
8	2.54	8	8.86
7	2.72	7	9.43
6	2.93	6	10.18
5	3.22	5	11.15
4	3.60	4	12.47
3	4.16	3	13.40
2	5.09	2	17.72
1½	5.88	1	24.94
1	7.20	0	Infinite.

All the methods hitherto proposed for applying this principle consist of the use of a wedge, of which the length is described in some way by the sinking of the float, and the slope is made by setting off thicknesses corresponding to the heights to which the shutter ought to be raised.

Fig. 19 shows a plan of effecting the object by fixing the wedge vertically on the top of the float, and causing it to pass as the float sinks downwards between two rollers, one fixed, the other movable, carrying a chain which, passing over a pulley, lifts the shutter. In this case the well containing the float is

quite distinct from the conduit conveying the water from the canal to the fields, with which it communicates only by a very

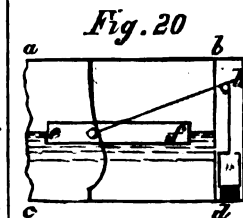
Fig. 19.



small opening, and this obviates the risk of the deposit of silt, or the interference by the float with the accuracy of the measurement.

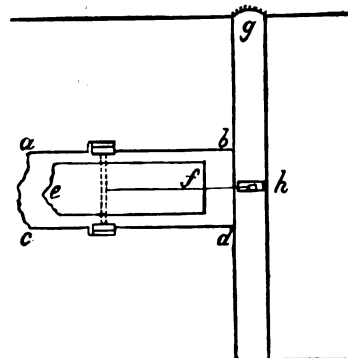
This arrangement may perhaps be found subject to an inconvenience in some situations, viz., the height of the top of the well above the surface of the water; for, if the whole be enclosed and locked up, it is necessary that the well should be as high above the water (to allow of the rise of the wedge) as it is deep. It is not likely that this would ever cause any practical difficulty; but if it did, the wedge might be fixed under the bottom of the float, and sink into a pit below the well; but in this arrangement, as the two rollers must be fixed at the level of the bed of the canal, the plan for communicating motion to the shutter could not be so simple as the one above described.

The last and probably the simplest and most useful form to be described is that sketched below. *abcd* (Figs. 20 and 21) represent a narrow cistern formed in the bank parallel to the line of canal, and communicating with a conduit, *g* *b*



Section showing the cistern and float, and the ridge guiding the rollers and chain.

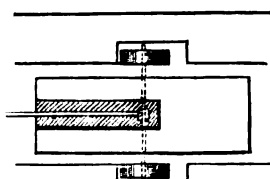
Fig. 21.



Plan showing the cistern, float, &c., and the conduits leading to the sluice and to the fields.

(Fig. 21) furnished with a shutter at *h*, which is lifted by a chain passing over a pulley immediately above it. This chain passes on, and is connected with the float *ef*, which may be a log of wood, and is connected with it by a ring encircling an axis passing through the log at right angles (like the trunnions of a gun) at the level of the surface of the water. The ends of this axis or trunnion are kept by the tension of the chain and weight of the shutter pressing against the faces of two curved ridges which may be either formed by upright timbers or stones

Fig. 22.



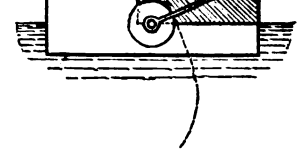
Plan on a larger scale showing the float trunnions and their friction rollers, &c.

properly shaped, fixed in the cistern or cut in upright stones let into its sides. As the water sinks, the ridges compel the trunnions, which are supplied with friction rollers, to travel in the path which they define, and by drawing on the chain to lift the shutter to the precise degree at every height suitable to the depth of the water.

The form of the curve is in every case easily found by de-

scribing an arc of a circle from the top to the bottom of the cistern, of which the centre is the centre of the pulley, *h* (Fig. 20)

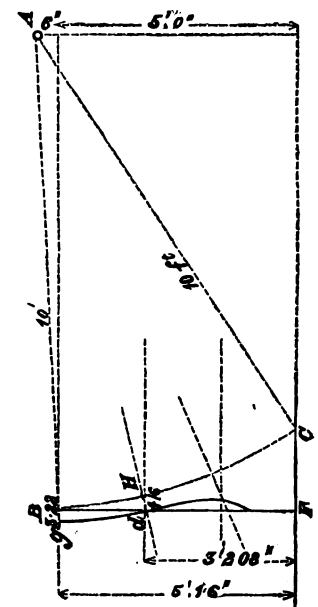
Fig. 23.



over which the chain supporting the shutter runs, and the radius the distance to the inner edge of the post; and from the edge of the circumference of this arc at right angles to it or along the line of the radius setting off the heights, as shown by the Table, page 124, to which the shutter ought to be lifted at each depth of water.

The figure No. 24 given below will explain the method of setting out these curves, in which *A* (the axis of the roller over which the chain supporting the shutter runs) is the centre of the arc, *B* *C*; and *g*, the point in the curve, is 3.22 in. for 5 ft. depth of water (vide Table, page 124) beyond *B* measured on *AB* prolonged. In the same way, at the depth of 3 ft., *d* is

Fig. 24.



the point in the curve measured along the radius, 4.16 in. beyond the curve, and so on for other depths. But it must now be mentioned that the depths of water for which the distances *g* *B* and *d* *H*, &c., are taken, are not reckoned from the floor of the cistern and cell of the sluice, but from the middle of the opening of the shutter, so that *B* *F* is 5 ft. plus half the height to which the shutter is raised, that is, 5 ft. 1.6 in.; and *d* *F* is 3 ft. plus half of 4.16 in., that is, 3 ft. 2.08 in.; and in every case the points in the curve are found where the assumed radius, lengthened by the height of opening of the shutter, describing an arc, cuts an horizontal line representing the given depth of water plus half that opening.

This apparatus has been tried practically on a small scale, and found to answer fully. In fact it is obvious that it must be made to answer perfectly; because if it did not deliver the exact quantity at any particular point of depth, it would be easy to trim and adjust the curve till it did so.

And as the same curve would suit every locality and all circumstances by merely taking care that the length of chain forming the circular arc and the height of the pulley above the floor of the cistern and sill of the opening are correct, it follows that, when once successfully established in any one spot, a template from the curve could be used as a pattern in all others of the like dimensions.

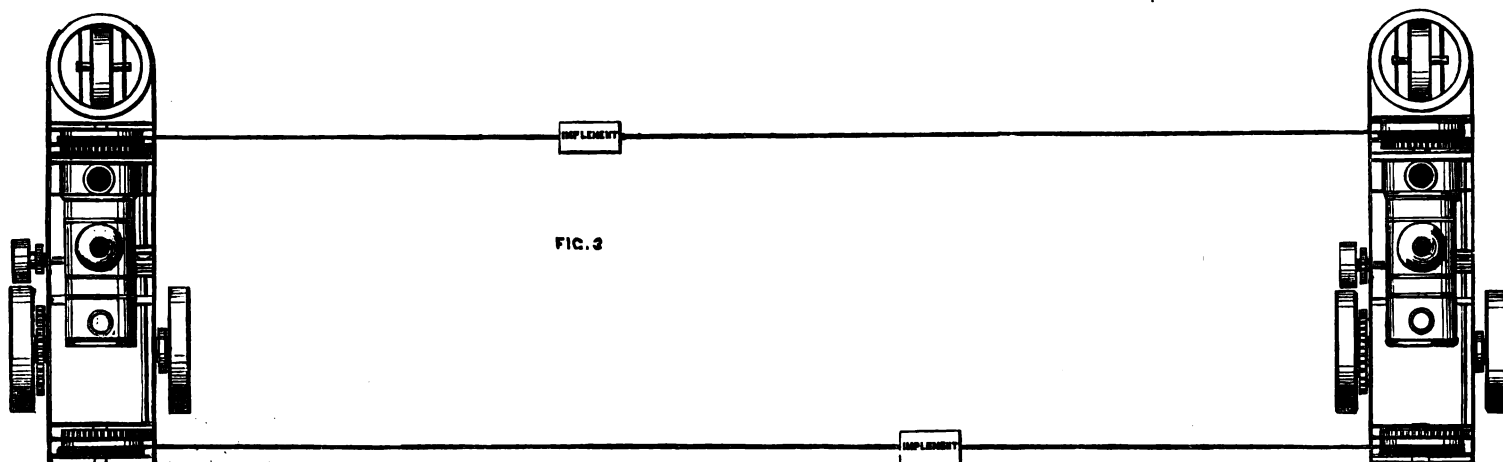
The advantages of this arrangement are, 1st, that all the parts of it may be constructed of ordinary materials and such workmanship as is easily procurable in India; 2ndly, that it is suited to any required volume of water, from twenty to thousands of cubic yards per hour, and to either that measurement or that of cubic feet per second, every 3 in. in the breadth of the opening yielding 100 cubic yards per hour, and every 4 in. 1 cubic foot per second (as explained previously); 3rdly, that it may be made perfectly accurate in all states of the canal; 4thly, that a float is in a distinct chamber, there is no obstruction from silt, which has no opportunity for deposit, the canal water flowing without stoppage through the sluice, and on a level with the bed of the canal.

(To be continued.)

THE NEW RAILWAY PIER AT BURNTISLAND.—This pier was briefly noticed in our "Notes from the North" a fortnight ago. It should have been stated that Mr. John Leslie had charge of the mason-work, while the mechanical details were planned and carried out by Mr. William Hall, of Burntisland. Mr. Hall matured and carried out the plans of the old Burntisland railway ferry pier in 1849, also that at Granton and the works of the Tay Ferry, from the designs of Mr. Thomas Bouch, C.E.

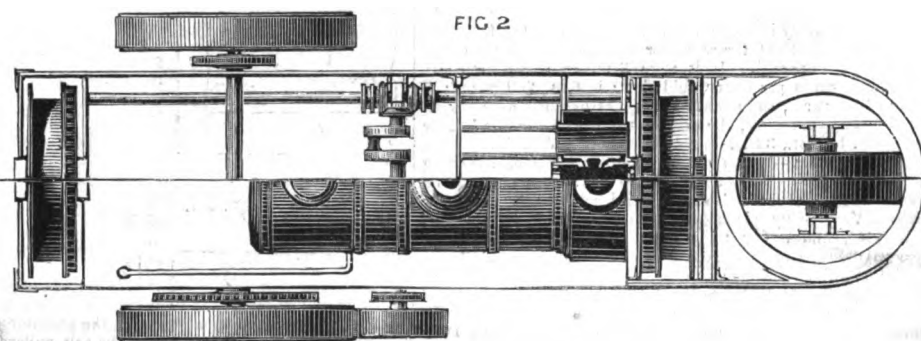
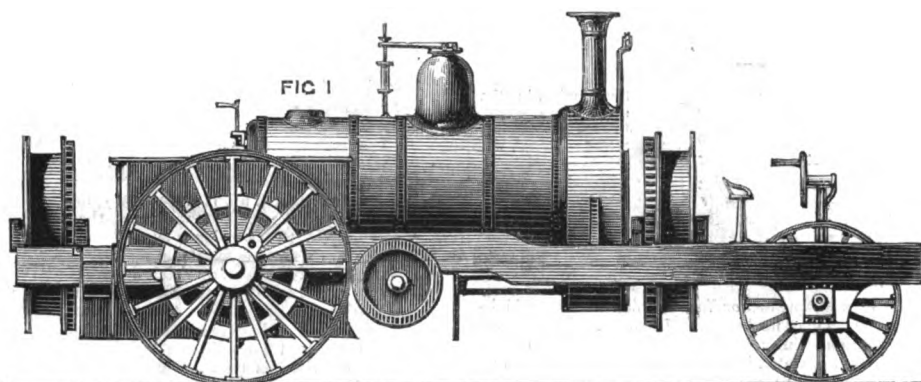
COMMANDER SCOTT'S RIFLING.—It appears that although Captain Scott's central system of rifling has not been adopted, he is to receive a reward from Government. No man better deserves some recognition of his services.

MR. J. PHILLIPS-SMITH'S SYSTEM OF STEAM-CULTIVATION.



WHILE a set of steam-ploughing or cultivating apparatus can get over from ten to twenty acres daily, and, in some of the lighter operations, on light soils, even more than this, it is not to be expected that farmers can afford to sink 1500*l.* or so in engines and tackle, and to engage men, available for no other service, to be employed, at the outside, for but three or four weeks in the year. As we long ago pointed out, the extension of steam-cultivation depends greatly upon the multiplication of steam-ploughing companies, and of these but few have yet been started. In the hands of a company, whose business it is to hire out engines and tackle, and to look to their constant employment, no investment can pay better, and we have the evidence of the Herefordshire Steam Cultivating, Thrashing, and General Implement Company, whose reports show a net revenue, over all expenses, of 26½ per cent. since its formation, two or three years ago. A set of engines and tackle, costing 1500*l.*, and worked by six men whose wages amount to not more, perhaps, than 6*l.* weekly, will let readily at 5*l.* per day, and at this rate will do an amount and quality of work which will well repay the hirer. There are many hundreds of thousands of acres of land in England of which the annual value would be increased, as abundant experience has already shown, to the extent of more than 10*s.* an acre by thorough steam-cultivation, costing at the outset, perhaps, twice that sum, but of which the effects are visible for years, during which the land has many times repaid the original cost of the improvement. If of the thirty-three million acres of land in England we suppose even but one-third to be arable, and worth, say, 18*s.* yearly an acre, there is good evidence to show that the annual value of this land might be increased by more than one-half by steam-cultivation, or say by more than five million sterling annually, representing, when capitalised, an addition of more than one hundred millions to the permanent wealth of the country. As the cultivation of land is also attended with extra expenses for sowing and harvesting, it will not be too much to say, speaking in the light of the late report of the Royal Agricultural Society on Steam Cultivation, that the annual value of the crops would be increased by at least 2*l.* per acre (representing but five bushels of wheat at 8*s.*), and which would alone return far more money than the net profits of our whole system of British railways.

We saw, last week, in Staffordshire, a large farm of the stiffest clay, which had well nigh ruined its former tenants, and which had been again let at a very low rent, but of which 200 acres were being well broken up and harrowed, sometimes to the extent of five operations on the same area. On Saturday last Mr. J. Phillips-Smith, secretary of the Hereford Steam Cultivating Company, accompanied by Mr. Zerah Colburn, waited upon the Earl of Shrewsbury and Talbot, at Ingestre, who, with Captain Talbot, of the Guards, and Captain Talbot, R.N., drove over with them to the Birchwood Park farm, on Lord Shrewsbury's estate, and about twelve miles from Stafford. Here Mr. Smith had at work a pair of Howard's transverse boiler engines, driving a five-tine cultivator at a depth of 12 in. in a stiff lumpy clay soil already ploughed. Nothing but steam could properly touch such ground. It was not only cold, cloggy, and obstinate, but the surface was foul with couch, wire grass, rushes, and thistles. The cultivator was getting through a good ten acres a day, although, taking, as it did, a 5 ft. 2 in. breadth at the rate of 3½ miles an hour, its rate in motion was equal to nearly 2½ acres an hour. The distance between headlands was, however, but 280



yards, and as, at full speed, this was traversed in less than three minutes, the proportion of time lost in stoppages and reversing was considerable.

An immense improvement, however, upon the present double-engine system of cultivation has been made by Mr. Smith. A Mr. Tulloh Osborn, more than twenty years ago, patented a scheme wherein two engines were to work two separate but similar implements to and fro across a field, the traction being effected by chains, wire ropes being then hardly known. On the introduction, however, of the modern system of steam ploughing no advantage was taken of this plan, and the roundabout system with a single engine and its great length of outlying rope was adopted. Then came the double-engine system, the advantages of which are now everywhere recognised, although it has the great disadvantage that while either engine is working, the other is standing. Early last year, Messrs. Howards, of Bedford, endeavoured to remedy this defect something after the manner of Tulloh Osborn, although his plan was well nigh impracticable, from the difficulty of removing the implements, at each bout, into fresh ground. The Messrs. Howards employed two implements of the same sort, and drew each one alternately to and fro halfway across the field. This plan requires, of course, that the engines shall be reversed twice as often as if they drew the implements at the same rate across the whole width of the field. At the Bury Show, Messrs. Fowler and Co. showed an improvement upon this, their double engines drawing two implements, either unlike in kind (as a cultivator and a harrow), or two of the same kind working at different depths, say the leading cultivator to 6 in. and the following one to 12 in. In this way both engines are made to do their

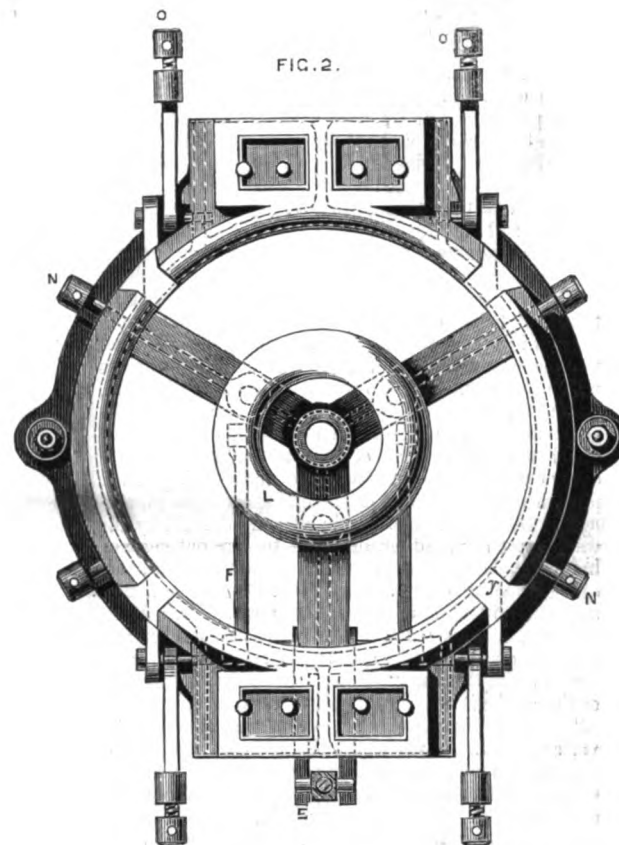
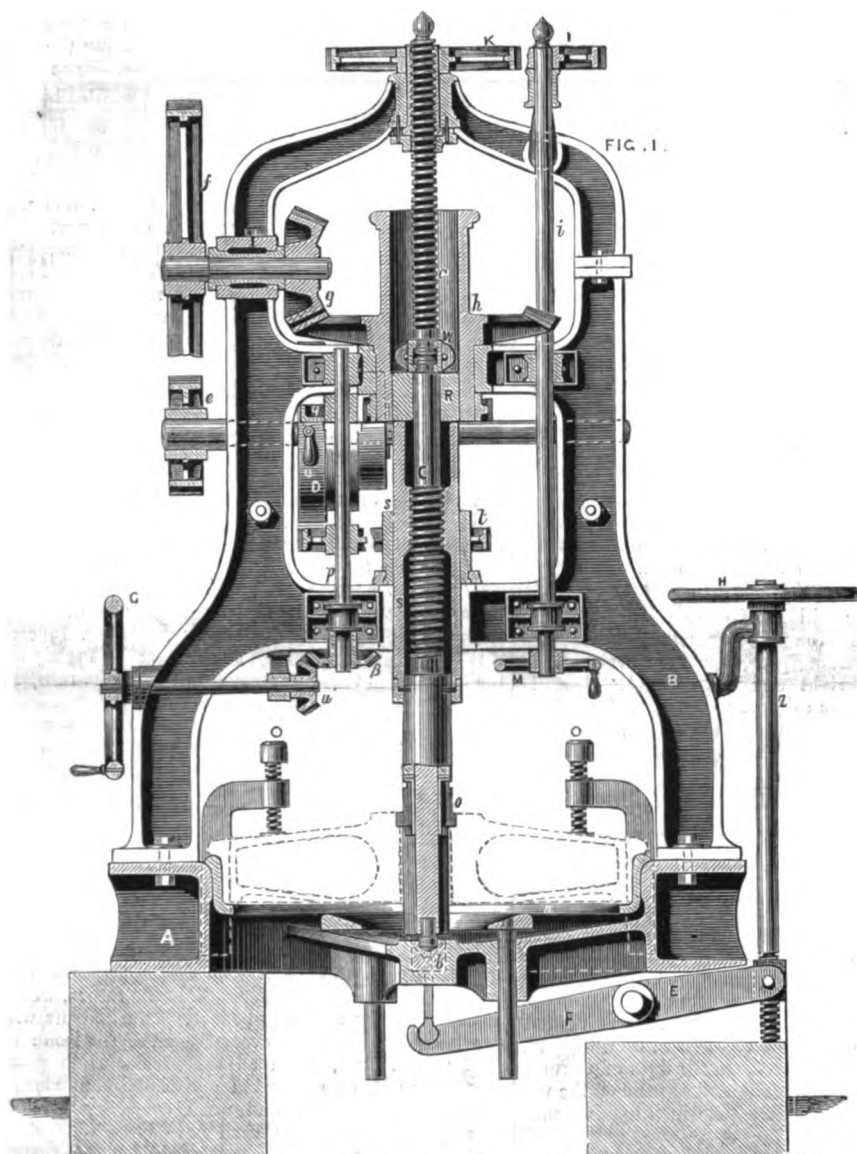
full work without stopping, except at the headlands to reverse the implements. Without, as we have the best reason to believe, any knowledge on the part of Messrs. Fowler, Mr. Smith had patented this important improvement but a little time before them, and they are now excluded from using it. We illustrate the general plan of this system of working at the head of the present page, and we need hardly give any further explanation. The whole idea, as distinguished from Tulloh Osborn's, consists in the use of different implements, the one following the other, or in the use of two implements of like construction, the following implement going so many inches deeper than the leading one. It will need but little reflection to perceive that this forms one of the most important improvements in the mechanism of steam-cultivation yet made, as it will greatly cheapen the cost of the work, keeping both engines always going, and performing two consecutive operations at the same time.

This improvement was clearly explained to Lord Shrewsbury on Saturday, and he fully realised its great importance. He remained upon the field for several hours, and all the operations of cultivating, mould draining, harrowing, and working the engines over the fields and in the roads were exhibited to him, his lordship and both Captains Talbot mounting the engines and riding upon the cultivators, and otherwise acquainting themselves with all the details of working.

Mr. Smith had in operation a cheap yet effective mould-draining plough, forming a channel 4½ in. in diameter at a depth of 2 ft., in a soil almost like pressed brick clay. In the operations of the Hereford Company, Mr. Smith employs his engines at draining in wet weather, and he often finds it more than the engine can well do to bring the plough through to it

WHEEL-BORING MACHINE.

CONSTRUCTED BY MR. A. GANZ, ENGINEER, OFEN.



work. He has devised therefore the simple and excellent expedient of hauling the plough by a snatch-block at half the speed of the engine drum, and with but half the strain on the rope. With improved moulds he expects to go to a depth of 2 ft. 6 in. in stiff clays, and this is even now being attained by first ploughing a furrow 6 in. deep and running the drain plough along this.

Of certain other improvements in traction and ploughing engines, made by Mr. Smith, we have spoken on another page.

Mr. Smith has assisted in the formation of a new Steam Plough Company at Bury St. Edmunds, and it is not unlikely that another will soon be organised at Stafford, and it would be most desirable that the Earl of Shrewsbury and Talbot should be its chairman.

GANZ'S WHEEL-BORING MACHINE.

We give, above, engravings of a machine for boring railway wheels, constructed by Mr. A. Ganz, of Ofen, Fig. 1 being a vertical section, and Fig. 2, a plan. The boring machinery is carried by a pair of uprights, B, bolted to an annular bedplate, A, this bedplate being fitted with a ring or socket, *a*, in which the wheel to be bored is placed. A special ring is employed for each size of wheel, and as these rings fit the wheels exactly, the latter are at once properly centred when placed in the machine. We may mention here that in some vertical wheel-boring machines constructed by Messrs. William Sellers and Co., of Philadelphia, the centring arrangement for fixing the wheels consisted of three eccentric "dogs" placed so as to clip the wheel between them, these dogs being moved simultaneously by an annular rack, which geared into pinions placed on the axes of the "dogs," and which was moved by another pinion which could be turned by hand. This arrangement was found to be a very convenient one, and it enabled wheels varying from 35 in. to 39 in. in diameter to be accurately centred almost instantaneously. To return, however, to Mr. Ganz's boring-machine, the wheel to be bored when placed in the socket, *a*, is held down by four set screws, O, these passing through hinged brackets, which can be turned back, as shown in the plan, so as to leave all clear for the removal of the wheel when finished. The lifting of the finished wheel from the socket is effected by the ring, L, which can be raised by means of the levers, F and E, the shorter lever, E, carrying a nut in which the screw, *z*, provided

with the hand-wheel, H, works. The ring, L, is guided by three studs which are screwed into it, and which pass down through sockets in the bed-plate, as shown in the engravings.

The driving power is received by the belt pulleys, D, fixed on a countershaft, which carries at one end the pinion, *e*, this pinion gearing into the spur-wheel, *f*. The short shaft carrying the spur-wheel, *f*, also carries the bevel pinion, *g*, which gears into the bevel wheel, *h*, this wheel being cast in one piece, with a short hollow shaft which turns in a suitable bearing on the main frame. The motion of this hollow shaft is communicated by feathers to the block, R, and from it to the boring-bar, C, this bar passing down through the boss of the wheel which is being bored, and being steadied by a steel centre working in block, *b*, carried by the base plate. The upper part of the boring-bar, C, is screwed with a square thread, and on this screwed portion the long nut or hollow shaft, S, works. The hollow shafts, *h* and S, each carry a spur-wheel, and these wheels, which are marked *r* and *s*, respectively gear into other wheels, *q* and *t*, fixed upon a vertical countershaft, *p*, the wheel, *q*, being, however, capable of being detached from the shaft, *p*, by means of the handle, *u*. The wheels, *r* and *s*, are of different sizes, and it consequently follows that the motion given to the hollow shaft, S, differs from that of the boring-bar, C, and the former thus revolves slowly around the latter, and is fed downwards by the action of the screw on the boring-bar.

The cutters, *o o*, are fixed to strips, *n*, which slide in dovetail grooves cut in the boring-bar, these strips having projecting lugs at their upper ends, which are held by a cap fixed to the lower end of the hollow shaft, S. The downward feed of the shaft, S, is thus communicated to the cutters without the boring-bar itself having any vertical motion. The boring-bar can be raised clear of the wheel, when required, by means of the screw, *c*, which is connected to the top of the boring-bar, C, but does not turn with it. The screw passes through a nut, which can be worked by the wheels, K and L, the latter wheel being fixed on the shaft, *i*, provided with the hand-wheel, M. The hollow shaft, S, can be raised by means of the hand-wheel, G, and the gearing connected with it, the wheel, *q*, being disconnected from the spindle, *p*, when the shaft, S, is being thus lifted.

CLEVELAND IRON.—The warrant stores contained, at the date of the last return, a stock of 75,312 tons of pig iron. The number of furnaces in blast in the Cleveland district is eighty-nine, and there are now forty-five out of blast. The general casting trade of the district is not very active; considerable quantities of pig iron are, however, being used up for railway-chairs and bowl-sleepers.

THE NEW STONE.—Mr. Ransome has made many grind-stones by his process, and they have been found to be of a perfectly uniform quality, as might be expected from the very nature of their manufacture. Those first made were found, however, to wear rather faster than ordinary stones, but this has been remedied by increasing the proportion of silicate of soda mixed with the sand, and by exhausting the air from below the moulded mass when the chloride of calcium is poured on, the stone being thus made of a much harder quality. Mr. Ransome is now employing hydraulic pressure for moulding certain classes of stone-work, especially thin stone plates of diaper-work for church decorations, and which are, of course, applicable to wall-decoration generally. These stones, about 11 in. by 15 in., and resembling tiles, are very rapidly and accurately moulded under the hydraulic press, and are thus rendered very hard and strong. We believe that about 6000 square feet of these diaper-work stones are now being made at the works at East Greenwich. Although not open to the visits of mere curiosity, these works are always to be seen by those really interested in the use of stone, and engineers and contractors should inspect them, applying for this purpose to Mr. Ransome, the managing director of the Patent Concrete Stone Company, 2, Queen-street-place, Cannon-street, E.C. The Ransome process is only rivalled in beauty, simplicity, and importance by the Bessemer process, and as yet it has not received one-tenth the attention it deserves.

OUR PROSPECTS.—We foresee the day when everything will be done by electricity. Clerks of the Houses of Lords and Commons will be telegraph clerks. Debates will be wired, and each telegraph desk will be a kind of alphabetical piano on which the speeches will be played, and by this means the charms of oratory will be intensified, and an instructive amusement will be provided for the Strangers' Gallery. The telegraph clerks will have to attend in place of the members, and every member will have his own private telegraphic piano, except in cases of coalition. The sovereignty of a hundred years hence will never open the house in person, but send his boots. The journals will contain all the news of the following day, and cheap evening papers will struggle to get two days ahead of them. Naval and military success will depend entirely upon respective electrical resources; and if nations ever should come to blows, the blows will be given in the air, for by that time we shall have balloons fitted with iron turrets and huge guns on swivels.—*The Prophetic News.*

A NEW GEOMETRICAL FIGURE.—*The Engineer*, in its last number, describes the shape of the Millwall Docks, in plan, as being "two sides of a square with the angles bevelled off"! The best method of delineating this novel figure will, we should think, form an interesting study for geometers.

THE BOLTON IRON AND STEEL CO.

THE planning of iron and steel works was, until lately, a branch of old-fashioned millwrighting; but James Nasmyth, Henry Bessemer, and, let us add, the locomotive engineers, have advanced it to one of the most important departments of mechanical engineering. After Mr. Bessemer had built modest works of his own at Sheffield, and John Brown had adopted his process, Mr. Ramsbottom laid out what are still the finest, although not the largest, Bessemer steel works in the world—those of the London and North-Western Railway Company, at Crewe. The converters, the blowing engines, the hydraulic apparatus, the duplex hammers, the great cogging-machine, the Siemens furnaces, the reversing rolling-mill, the tyre-mill, and all the other famous plant of the Crewe steel works; were perfection itself, as compared with anything known before; and many of our readers will remember how Mr. Penn, at the dinner of the Institution of Mechanical Engineers, at Manchester, last year, unreservedly expressed his astonishment at, and admiration of, what he had only the day before seen at Crewe.

While planning the Crewe works, Mr. Ramsbottom had at his side Mr. F. W. Webb, his assistant locomotive superintendent, and who still enjoys the reputation of being one of the cleverest locomotive engineers in the profession. Mr. Webb can, of course, take no credit whatever for the many special machines which Mr. Ramsbottom designed for his steel works, but the first named gentleman was, nevertheless, entrusted with much of the execution of the plans, and had the advantage of an intimate knowledge of every detail of their design, and of the working of the plant when completed.

The Bolton Iron and Steel Company (which, by the way, is not a "limited" concern in any sense) enjoys, besides the advantages of capital and connexion, that of the direction of its works by Mr. Webb, who is now a partner in that company. The works are large, although not so extensive as a few of the greater Sheffield establishments; but we shall devote our remarks mainly to the "steel side," as that department of the works is called.

The Bessemer plant consists of a pair of 5 ton converters, blown at 22 lb. pressure of blast by a pair of horizontal blowing-engines by Hick, Hargreaves, and Co., and which are, we believe, of the same size and pattern as those at Crewe, viz. 36 in. steam-cylinders, 54 in. blowing-cylinders, and 5 ft. stroke. The hydraulic apparatus is of the usual kind, with pumps thrown off and on from the accumulator, which is loaded to 3 cwt. per square inch.

Siemens's furnaces have been constructed to distil all the coal burnt into gas, to be consumed under the steam-boilers and in the large regenerative re-heating furnaces. When the gas is burnt in the flues of the boilers, the mouth of each flue is lined with fire-bricks, and the gas is sent in at the centre as a jet, which draws in air with it, by induction, not only around the gas-jet, but also through its centre by means of an internal air-pipe. No smoke, of course, ever proceeds from the chimneys of the gas-heated furnaces, and, indeed, very little heat proceeds up the chimney. At Crewe, Mr. Ramsbottom places a piece of deal, under lock and key, in the tail flue of each gas-heated furnace, and if this deal is burnt at the end of a week the furnace-man is fined. The Wilson furnaces now working at the Bolton Iron and Steel Works are equally smokeless. The largest steam-hammer for hammering the ingots is one of the three or four largest in the kingdom, having a head of 25 tons, falling 9 ft. The steam-cylinder is 54 in. in diameter. The makers of the hammer were Messrs. Nasmyth, Wilson, and Co., and it is of the same construction as that at Messrs. Cammell's, and which we illustrated on page 288 of our last volume. It has, however, a much larger anvil block, probably the largest single casting in the world, its weight being 210 tons. This block was cast, not *in situ*, but bottom upwards, and a few feet from where it now rests. We hope to give, in an early number, drawings and a description of the arrangements for casting this block, and need only say here that a pit, formed of brickwork lined with loam, was made, and that the run from two of Ireland's cupolas, each charged with 12½ tons an hour, was taken down through a gate to the bottom of the pit. A large quantity of charcoal was first thrown in, and this floated as the iron rose and kept it from chilling. As each charge came in at the bottom, it rose, by its specific levity, through the less highly heated iron in the mould, and the result was a homogeneous casting. A pair of trunnions was cast upon the block at a height at which the upper part preponderated over the lower, and when, after many days, the great cast-

ing had cooled, and the mould had been broken away, brick walls and bearers were built under these trunnions, and the whole casting was tumbled over, big end downwards. Powerful jacks were then got under it, and it was moved horizontally 16 ft. to its present position, where it is bedded on a good depth of concrete and a cement made of iron borings and sal ammoniac.

The rail mills are of much the ordinary class, and are now employed upon an order for 1000 tons of steel rails for the Lehigh Canal and Navigation Company, U.S. Other sections, that for the Great Indian Peninsula Company, for the Bhoze Ghaut incline, where 50-ton engines are worked, were shown us, as also samples of that formidable section, the Metropolitan rail, a flat-footed bar, with a base 6 in. wide, and which is so difficult to roll in steel, and yet we learned a day or two since that the Bolton rails had done well on the underground line, our authority being the resident engineer himself. Some of the Great Indian Peninsula double-headed 86 lb. rails were tried on 3 ft. 6 in. bearings, with 60 tons dead pressure, and deflected but about 5 inches on the average. Curiously, the test brought out the lines of strain on the sides of the rail, there being certain converging lines on the web of the rail, along which the scale had broken off, showing lines of shearing strain, all running to the point of the application of pressure. Then there is the usual ram-test, that of a ram of 1 ton weight, falling freely from any height up to 48 ft. upon a rail supported on 3 ft. bearings. The anvil on which the rail is supported weighs 10 tons 8 cwt., this weight alone being an important element in the test.

The plate-rolling mill is of good size, and has reversing gear, so that the plates are not lifted over the top roll. The reversing gear, which is merely a lever acting alternately right and left upon clutches, is worked by a hydraulic cylinder and piston. The plates are sheared on all four edges after rolling, and some excellent plate-shearing machines, with steam engines on the same bed-plate, are at work. The shears of these machines are of Bessemer steel. We believe that the makers are rather laying themselves out for steel plates, and are, to this end, employing the very best pig-iron and spiegel to be had. This we know, that when the plates are made they are sheared on all edges, and the shearings tested for toughness, and we saw many hundreds of tested samples which had borne much more than the Admiralty test. And yet these plates are guaranteed to 35 tons tensile strain, being 2 tons more than some other makers have guaranteed their plates to meet the Admiralty test. Several plates of the large size of 13 ft. 6 in. by 6 ft. 6 in. by ½ in. have been made, and worked into the flues of Cornish boilers. We have spoken on another page of the use of these plates in steel boilers, for which they are now very largely employed.

As at all first-class Bessemer steel works, samples are taken at each "blow" in the converters, and a small quantity of borings is drilled from each sample and tested for carbon, not by analysis, but inferentially by the solution test of colour, whereby the chemist can ascertain very closely the true proportion of carbon. The use to which the steel is to be applied depends, of course, upon the proportion of carbon, the greater proportion giving a hard strong steel, and the less a tougher quality of less tensile strength. Large steel shafts are now made, and one, made from a 97 cwt. ingot, was sent not long since to a Belgian firm; so that even on the Continent English makers still find a market for English steel, and that in heavy masses, a trade supposed to have been monopolised by Krupp. Another shaft, from an 85 cwt. ingot, was lately made for the engines of Messrs. Kershaw, Leese, and Co.'s great mill at Stockport, where an iron shaft had failed. This shaft was made, not exactly at one heat, as smiths understand the term, but the heat was not suffered to go down from the teeming of the ingot to the last blow of the hammer on the forged shaft. All the Corliss engines now made by Messrs. Hick, Hargreaves, and Co. are fitted with steel shafts, whether specified by the purchasers or not, and the pair of 24 in. cylinders, 4 ft. stroke, making for Woolwich Arsenal, have Bessemer steel connecting rods. A good deal of steel shafting for millwork is also made in lengths up to 20 ft., and up to 5 in. diameter. Steel castings are made also from Bessemer steel, although these are only heavy objects, having no very thin parts. Rolls, and especially the pinions for mill-rolls, and weighing about 3 tons, have been cast with good success.

Bessemer steel tyres, when made on the Crewe plan, have given excellent results, and Mr. Ramsbottom, who, not long ago, used them only under goods engines, now applies them to his passenger engines also. At Sheffield, although there are three Bessemer

steel works, but two make tyres at all, and at one of these establishments they are made only from crucible steel, while several other firms, having no Bessemer plant, make crucible steel tyres. At Bolton, Mr. Webb has gone largely into the manufacture of Bessemer steel tyres upon the Crewe plan of casting a conical ingot, hammering this down to a "cheese" form, punching out the centre, and expanding the hole by hammering the tyre on a beck-iron. The tyre ingots are weighed and carefully pared down, to bring all in a set to the same weight; and if, after paring, some are slightly heavier than others, a little longer heating and scaling in the furnace, according to the judgment of the workman, equalises the weight. The tyre-rolling mill, at Bolton, designed by Mr. Webb, is the best we have yet seen, and we only regret that, having contrived it with some pains, the designer does not care to publish drawings of it. The middle roller is run up to its work by a hydraulic ram under a pressure of 3 cwt. per square inch, but immediately the roll bites, a pressure of 30 cwt. per square inch from another set of pumps is put upon the ram. The handles for working the rolls and the engine are most conveniently arranged. The engine has a pair of 20 in. overhead cylinders, with 3 ft. stroke of piston. The crank-shaft, below, has no fly-wheel, but is counter-weighted, and the engine has no tendency to stop at one part of its stroke more than another. It can be, and often is, run at a piston speed of 1000 ft. per minute, and at the same time may be almost instantly stopped when the tyre has reached the right diameter. The greatest accuracy is attained in the rolling, and more than one set of steel tyres has been sent out to be put upon the wheels without boring or turning. Indeed, it is to be regretted that the wheels are not ready for the tyres when the latter come hot from the rolls, so as to save heating them again.

The whole works are on a large scale, and the facilities for handling heavy weights are excellent. A railway of ordinary (4 ft. 8½ in.) gauge runs throughout the works, and this is interlined with a mid-rail giving a gauge of 2 ft. 3 in. for trucks on either side. Of the cranes, one lifts 40 tons, its jib being made of heavy steel plates. Others have steam-engines on the crane pillar, and, besides all, the ever-ready force of water, at a pressure equal to 770 ft. head, is always available from the accumulator. Could the old Bolton millwrights of a former generation live again, what would they say to the works of their successors? and to what may we not look forward in the future, when, as there is every reason to believe, manual labour will be wholly superseded in every branch of the iron and steel manufacture, when all the great metallurgical operations will be conducted entirely without smoke and with little noise, and when even our present cheapness of production shall have been cheapened beyond anything of which the most sanguine inventor has hitherto dreamed?

THE INSTITUTION OF CIVIL ENGINEERS.—At a general meeting held on the 26th day of last June, the members of the Institution of Civil Engineers made several important amendments in the by-laws and regulations of their association, of which changes one desirable result will be the creation of a student class within the walls of the Great George-street College. It is provided that students on entering the institution shall not be less than eighteen years of age, and that, on completion of their twenty-sixth year, they shall cease to enjoy the privileges of studentship. It is also provided, with scant liberality, that before a young man can become a student of the institution he must be, or at some time have been, a pupil of a member or associate of the institution, a provision clearly enacted for the personal benefit of existing members, rather than for the good of the profession or of society. Still it is something for the learned body to have discovered that they ought to have students under their roof, and make a show of educational power. The step they have taken is a step in the right direction, and when they shall have caught their pupils, the authorities of the college will, doubtless, take measures for their adequate instruction. At present, however, they seem to think that the students after paying their entrance fees may, without disadvantage or scandal to the institution, be left to educate themselves. The secretary's circular informs us with official vagueness that, "although not specifically mentioned in the rules, it is contemplated to grant, under the control of the council, the use of the theatre of the institution to the students for supplementary meetings for the reading and discussion of papers amongst themselves, and possibly also for the delivery to them of lectures upon special subjects, the objects of such supplementary meetings being for the advancement in scientific and technical knowledge of the junior members." As the council commit themselves to nothing by this meagre and comically insufficient programme, their secretary might as well have been directed to put in a word or two of intimation that, sooner or later, upon the occurrence of contingencies which it would be inconvenient to state precisely, the authorities of the institution would establish a system of examination, which should ascertain from time to time the professional progress of students, and put an end to a state of things which permits a man to write M. Inst. C.E. after his name who is as ignorant as any navvy about the principles of mechanical science.—*The Athenæum*.

THE SOCIETY OF ENGINEERS.

TO THE EDITOR OF ENGINEERING.

SIR,—I am desired by the council to forward you a copy of the petition presented by this society to Her Majesty in Council, praying for a charter of incorporation, and I am to request that you will kindly insert the same in your next number.

I am, Sir, your obedient Servant,
GEORGE W. HARRIS,
Secretary.

Society of Engineers, 6, Westminster-chambers,
Victoria-street, S.W., 14th August, 1867.

To the Queen's most excellent Majesty.

The humble petition of William Henry Le Feuvre, of 18, Great George-street, Westminster, civil engineer, president of the Society of Engineers, and of the undersigned members of council and members of the said society

Showeth,—That your petitioners are the president and council and members of the Society of Engineers.

That the society was established in the year 1854 for the advancement of engineering science and practice, and for the advancement of knowledge in regard to all matters relating to the pursuits of civil and mechanical engineers, and relating to those matters which constitute direct or collateral branches of civil and mechanical engineering, embracing within the objects of the society the proper construction and maintenance of all classes of works—such as roads, bridges, railways, harbours, docks, embankments, waterworks, and works of navigation, and in relation thereto, and the art of constructing ships, the drainage and improvement of cities and towns, and utilisation of sewage drainage water, the working of mines and the production of minerals, the use and control of gaseous matters, the use of electricity and telegraphs, the production of machinery and scientific instruments of all kinds, and other matters relating to engineering.

That the society consists of various classes of members—that is to say, members, associates, and honorary members.

That the class of ordinary members is limited to gentlemen who are or have been engaged professionally in engineering pursuits, and who are above twenty-five years of age.

That the class of associates is limited to gentlemen of scientific attainments, or whose pursuits constitute direct or collateral branches of engineering.

That the class of honorary members is limited to gentlemen of distinguished attainments nominated by the council.

That the members of the society now exceed four hundred and thirty in number, and the society has gradually increased in numbers since its foundation, and the members have subscribed and collected considerable sums of money for carrying out the purposes of the society.

That the well-being and usefulness of the society would be materially promoted if the same were created into a body politic and corporate by a charter of incorporation under your Majesty's Royal Letters Patent, by the name of the Society of Engineers, with perpetual succession and a Common Seal, with power to sue and be sued by their corporate name, and with the other powers usually granted to corporations of a similar character, and to be contained in such your Majesty Royal Letters Patent.

Your petitioners, therefore, humbly pray that your Majesty will be graciously pleased to grant to your petitioners your Majesty's Royal Letters Patent, incorporating your petitioners and the other present members of the Society of Engineers, and such other persons as may be hereafter duly members thereof for the purpose aforesaid, and subject to such conditions, restrictions, and provisions as to your Majesty may seem meet.

And your petitioners, as in duty bound, will ever pray.

TUNNELLING-MACHINES.

TO THE EDITOR OF ENGINEERING.

SIR,—We think that it is a matter of sufficient interest and importance to be mentioned in your paper, that General Herman Haupt, of Philadelphia, United States, will arrive in England on the 18th inst., and will be present at the annual meeting of the Cornwall Polytechnic Association, to be held at Falmouth, England, on the 23rd of August. He comes to Europe for the purpose of presenting his system of mining and tunnelling. We forward by this mail, to your address, one of the pamphlets we have published on the subject.

You undoubtedly already know that General Haupt is one of the most eminent civil engineers in the United States, having had charge of many most important public works. He also had the entire management of the Bureau of United States Military Railroads, and was Chief of Construction and Transportation of the armies of the Rappahannock, Virginia, and Potomac.

He regards his system of tunnelling with great confidence, and parties interested in regard to such matters will be glad to know that he can be consulted in regard to them.

We are, your obedient Servants,
BLANCHARD AND MCKEAN.
3, Rue Scribe, Paris, August 13, 1867.

CLEVELAND SHIPBUILDING.—Messrs. Backhouse and Dixon launched an iron screw steamer from their yard at Middlesbrough on the 13th inst. This vessel is 150 ft. long, 22 ft. beam, and 13 ft. 6 in. depth of hold. She is built with double bottom for water ballast, and will be fitted with a pair of engines of 65 horse power nominal, by Messrs. Blair and Co., of Stockton-on-Tees.

NEGATIVE SLIP.

TO THE EDITOR OF ENGINEERING.

SIR,—The old, old question of "negative slip" still continues to "crop" up for periodical discussion, more or less animated and intense, with about the same regularity as are introduced all the old and, to many ordinary readers, mysterious explanations of this apparent paradox.

The numerous learned *theoretical* disquisitions on this subject, rarely supported by marked *practical* observation or experiment, must remind some of your readers of the immense amount of practical engineering force which was once wasted in overcoming a purely imaginary difficulty in steam locomotion, viz., the supposed want of adhesion of the wheel to the rail. From 1804 to about 1814 the ingenious plans of Trevithick, Blenkinsop, and Chapman, comprising projecting heads of nails, or bolts, on the periphery of the wheels, rack rails, and toothed wheels, endless chains, and, lastly, the walking engine with a pair of mechanical legs and feet, were all tried in succession, when, behold! it was then ascertained that the adhesion of the wheels with the rails on which they moved was amply sufficient to propel the engine even when dragging after it a load of great weight. The adhesion question probably caused a loss of ten years in the progress of steam locomotion, and on the negative slip question many years of able and eloquent discussion and teaching, and especially by one (it may indeed be more truly said *the* one) amongst our engineer teachers and writers, who has done infinitely more by his treatises, catechisms, &c., than any other living engineer to instruct the operative engineers of this country at a period (gone by, happily) when education of that, as of all other technical kinds, was so difficult to be obtained, has only left it (negative slip) in the most unsettled, undecided condition. The most plausible explanation, and that which has so deservedly been most generally accepted, is that vessels of a certain contour of "run" invoke an artificial current after or following them by the constant effort of the water to fill up the canal made by the progress of the ship, thus, in a comparative sense, giving the screw a more dense resisting medium to propel in than that which opposes the ship being propelled. Another reason given by your evidently able engineer correspondent, "Helix," of Greenwich, is, "that a certain amount of 'skin' friction is likely to exist on the working face of screw-blades, the effect of which would 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 continued presence, would become a part of it, and consequently would have the effect of increasing the pitch of the blade for the time being." Many other explanations of the paradox have been given by standard authorities, none of them, however, more argumentative than the foregoing. But why (to use a homely expression) search for what we require in the unlikely places before we have searched the most likely and obvious places, for, with sincerely respectful deference, I venture to prove that a sound, practical, common-sense, and, therefore, convincing explanation of the apparent phenomena has been before the engineering world since 1853 at least. In his book of that year, Mr. Hann, then Mathematical Master of King's-college, says: "The only rational way, in my opinion, of explaining it (negative slip) is that which was given to me, in 1849, 'by my able and talented friend, Mr. Holland, one of the Admiralty engineers. He (Mr. Holland) explains that the fore part of the outer edge of a screw-blade strikes against water at rest, whereas the after part of the blade will strike against water having a considerable amount of motion, and will, therefore, meet with less resistance than the fore part, the effect of this will be to 'increase the pitch.' Abundant proofs of the simple truth of this explanation will present themselves to any unprejudiced mind not already decided in favour of either one of the studiously sought reasons first referred to. Is it not a well-known fact, that nearly all ships fitted with the 'Mangin' four-bladed screw have given negative slip, that the engines have been brought up several revolutions, that the force of resistance tending to increase the pitch has been so far successful in some instances, despite the best workmanship and proportions known to the trade, as to twist the blades round on their bosses to the full amount of pitch permitted by the radial slots allowed for alteration if desired, and in other instances have not the bolts by which the blades were fixed to the boss been literally shorn off? Irrespective of modes of manufacture, and supposing it to be cast, blades and boss, solid together, place this daddy longlegs, gawky-looking Mangin screw, with its small boss (hub) and long narrow blades, alongside of a Griffith's of the same power, and it will require no great engineering science to discover how and why the blades of the former twisted themselves into a form of greater pitch, bringing up the speed of the engines, of course, by absorbing more power, and finally mystifying the calculator with *apparent* negative slip; or how and why the latter, with its large boss, long attachment of the roots of the blades to the boss, and the reduced area of outer ends of blades, gives positive slip permitting the engines to get away, and give out their full power.

I have served in a ship which would invariably, when steaming full power in the smooth and tideless sea of the Mediterranean, *apparently* overrun the screw one knot per hour for a number of hours together; but finally, being of cast iron, the blades were fairly strained more than they could bear, and broke. Now, had this screw been of gun-metal, the chances are it would have stood the test, and to some peculiarity in the shape of the ship giving following current, or perhaps to the piling up of a strata of water on the screw-blade faces, or to some other theory, would have been attributed our undoubted (observed) negative slip. Assuming, for the sake of more clearly stating what there is further to be added (to this already, I fear, too long letter), that my remarks will have the effect of converting marine engineers to the views set forth as to negative slip, grounds for serious reflection then suggest themselves; for if half the valuable time and thought, which has been wasted in propping up the fallacious and impractical

theories (for all sound theories must be supported by practice) had been devoted to utilising, or making the most of Mr. Holland's plain and rational explanation, we should before this time have discovered a metal for blades of screws which would be strong enough at a maximum thickness of, say, 1 in., and further experiment would soon teach what pitch to give a screw in manufacturing it, so that it should just realise the pitch required when at work propelling its ship. If increasing the thickness of screw blades would proportionately absorb engine power regarding the speed of a ship, surely the reduction of their thickness must in a contrary sense liberate power, increasing the net propulsive power of the whole machinery.

What has been already said here will, I am afraid, be sufficient to give grounds, if misunderstood, for calling my modesty in question.

Far be from me the presumption of setting myself up as a teacher amongst marine engineers, but the exigencies of my calling having placed me in a position where I had a great field for observation of screw propulsion and its machinery. I have become a sincere convert to Messrs. Holland and Hann's theory, and hence, so as to reap its full benefits, my suggestion of a metal, say Bessemer steel, plated with zinc (as suggested by Young in his book on the fouling of ships' bottoms), or even sheet brass brazed, for screw-blades, which finally I would fix into prominent grooves projecting from a boss or hub of somewhat more than the usual diameter (well cored out); these grooves could be cleaned out exactly suitable for the steel plates, in any screw-cutting lathe, and mechanically to the pitch required.

Yours very truly,
ANONYMOUS.

London, August 6, 1867.

COLLIERY WINDING-ENGINES.

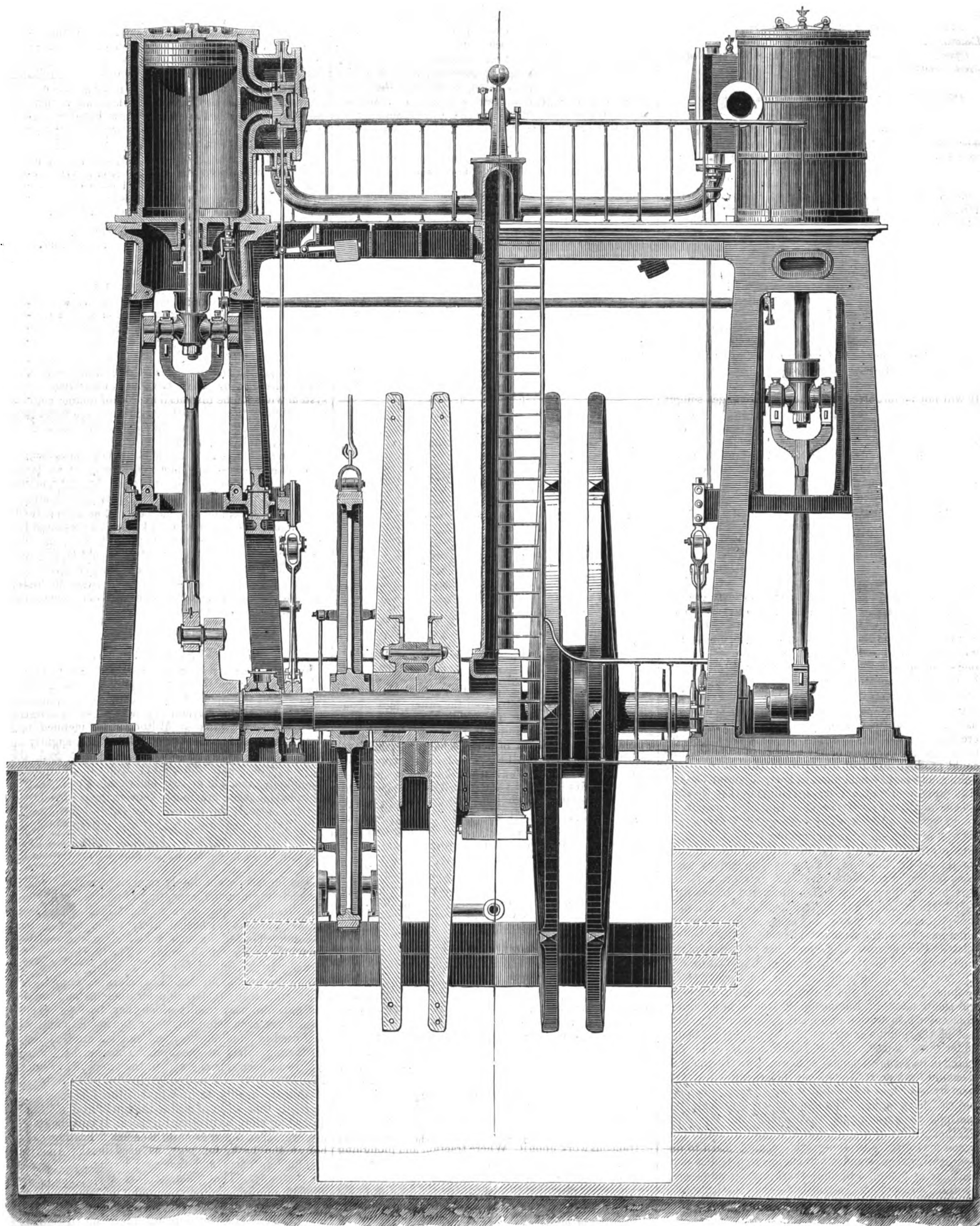
We represent, on pages 130 and 134, a pair of winding-engines shown at the Paris Exhibition, by one of the first engineering firms of Belgium, these engines having deservedly earned the general approbation of professional visitors to the Exhibition. The works of M. F. Dorgée are at Boussu, near Mons, in Belgium. They were commenced some twenty years ago, and since the year 1849 have been under the management of M. A. Andry, a well-known mining and mechanical engineer, whose great experience has been collected during the construction of an unusually large number of important machines and works. M. Dorgée's establishment is occupied with steam-engine and boiler making in general, with machinery for mining and metallurgy, and with sugar machinery. In all of these branches the works have a considerable export trade, their principal customers being France, Holland, Spain, Russia, and Brazil. The engines represented in our engravings are of M. Andry's most recent design, the first pair of their type having been erected in 1862, at Hainaut, for the Société Charbonnière du Grand-Bouillon. The steam cylinders of these engines are placed upon the top of a cast-iron framing of sufficient height to allow for the length of the connecting-rod and crank between the cylinder and the main shaft, which latter is placed at the bottom, with its bearings resting upon the foundation plate. The framing being wider at the base, according to the demands of stability, this type of engines has obtained the name "pyramidal." It virtually consists of two pyramidal vertical frames connected at the top by a cross-girder or bridge, as shown in the front view. The cylinders are 35½ in. in diameter, and 4 ft. 7½ in. stroke. They are intended to work with a boiler pressure of three atmospheres, or 29½ lb., and at a piston speed of about 236 ft. per minute, the winding drums making 26 revolutions in that space of time. The winding drums have an outer diameter of 19 ft. 9½ in., and are destined for working a rope of hemp 2132 ft. in total length. Each engine is placed upon an independent sole-plate 10 ft. 10 in. in length, and 7 ft. in width. The engines are quite independent of the building in which they are placed, resting upon their own foundations, and being entirely self-contained in every respect. The building can therefore be made of a comparatively light and cheap construction. It is 32 ft. 9 in. square in plan, and 36 ft. high. The principal working parts of the engines are at the bottom, and accessible to the attendant, who can also get access to the cylinders, when wanted, by means of the cross bridge at the top. Each of the pyramidal frames is cast in two pieces, which are bolted to their common sole-plate at the bottom, and connected at the top by elliptical collars of wrought iron shrunk into recesses provided for them in both castings. The cylinders are cast in one with their bottoms, and the guide-bars are carried upon a cross bracing cast on to the main framing. The slide-valves are balanced and counter-weighted, so as to move very freely. The reversing gear consists of a link-motion worked by hand. There is a steam brake provided, consisting of a large wooden drum acted upon by a brake block, which is worked by steam from a small cylinder. All the valve-gear of the engines and brake are under the control of the attendant placed at the bottom of the engine-house in a very convenient position for overlooking the entire operations and the principal working parts of the engine. We have only to add that the engines exhibited at Paris are of a workmanship which, even to the scrutinising eye of engineers accustomed to British machine-making, must appear first-rate. Both in regard to design and execution, these engines are far above the average of Continental engineering of the present day.

BESSEMER RAILS IN FRANCE.—The Northern of France Railway Company has ordered 600 tons of Bessemer steel rails, at 14½ 3s. 4d. per ton, from the Terre Noire Works. Deliveries are to be made at La Chapelle. The production of Bessemer steel generally in France has greatly increased of late years. In 1863 this production amounted to 1856 tons, while in 1866 it had risen to 10,790 tons.

RAILS IN HOLLAND.—Contracts for two lots of rails of 5000 tons each have just been let for the Dutch State railways. The first lot was let to Messrs. Hopkins, Gilkes, and Co., of Middlesbrough. For the second lot the tenders submitted by Messrs. Hopkins, Gilkes, and Co. and the Teeside Ironworks Company were identical. The other English competitors for the contracts were Messrs. Bolckow, Vaughan, and Co. (Limited); Messrs. Guest and Co.; and the Ebbw Vale Company.

COLLIERY WINDING ENGINES, AT THE PARIS EXHIBITION.

DESIGNED BY M. A. ANDRY, AND CONSTRUCTED BY M. F. DORGÉE, ENGINEER, BOUSSU.

(For Description, see preceding Page.)

smokeless puddling furnace, which is easier worked than the old kind, and which takes but a ton of coal to a ton of pigs, and gives a ton of blooms to 21 cwt. of pig, or possibly less, is a vast improvement upon anything yet known in the ordinary plant of forges, and deserves to be at once made widely known and to be carefully studied. The furnace is, of course, somewhat more costly than those on the old plan, having 13 tons of castings instead of 10 tons in ordinary furnaces, and having parts requiring careful fitting and adjustment, and requiring also more brickwork at the firing end. But the saving of a ton of coal or more a day, and a considerable increase in the yield, and a probable improvement in the quality of the iron, to say nothing of the absence of all smoke, would of course soon compensate for the greater cost, even if it were very much greater than it is. A working drawing of the perfected furnace is in course of preparation for our columns.

TRIAL OF BURGLAR-PROOF SAFES IN THE PARIS EXHIBITION.

(From our Special Correspondent.)

PARIS, August 13.

THE trial of the burglar-proof safes of Mr. Chatwood, of Bolton, and of Mr. S. F. Herring, of New York, or, as our American friends like to call it, "the great contest of American 'versus' English safes," has commenced at last in the British testing-house at the International Exhibition. The terms and history of the challenge we have already published, but it may be as well to refer to them in a few words before proceeding to report upon the trial itself. Mr. Herring exhibited a safe upon which he posted a challenge offering to test it against any other safe in the Exhibition. Mr. Chatwood accepted this challenge, and an agreement was drawn up to that effect. Mr. Herring then declared that his safe was not really burglar-proof at all, but simply fireproof; but that there was a burglar-proof box inside his safe, which was the article meant, if not named in the challenge. The appearance of these after-declarations created a somewhat unfavourable impression against the American safe-maker, if not against his safe, which occasionally manifested itself during the trial; but the jury certainly tried to do all in their power to maintain the balance as even as circumstances would allow. The jury was chosen by the two competitors, Mr. R. Mallet and Mr. R. F. Fairlie having been proposed by Mr. Chatwood, and Mr. Holmes and Mr. Pickering representing Mr. Herring's interest. These four gentlemen had chosen M. Paul Doulot, engineer of the firm of Cail and Co., of Paris, as their fifth member, and as their president; and Mr. W. T. Hoyle, secretary of the Whitworth Company, acted as secretary to this jury. The jury met at 11 A.M. to day, after the preliminary arrangements had been completed; then the sham burglars were introduced, three in number on either side. They were some of the best workmen that could be mustered in England, America, and Germany. Mr. Chatwood had brought one of his foremen and a workman from his shop; the third man, a foreman at Messrs. W. and J. Galloway and Sons, in Manchester, had volunteered his services on the day of the trial. Mr. Herring had sent expressly to America for a celebrated safe-breaker, who was assisted by a man described as particularly expert at picking locks; and the third, also a volunteer, was the foreman of an Austrian exhibitor of safes, who had a very intimate acquaintance with the construction of Chatwood's safes, having been in the Exhibition ever since its opening, and repeatedly examined Mr. Chatwood's drawings and details of construction, which are exhibited without reserve. These six men, combined in the two respective groups, were an interesting match, although the unequal nature of their capabilities somewhat lessened the interest of the trial. Mr. Chatwood had in his favour the calm and business-like method of his foreman, and an extraordinary amount of skill on the part of Messrs. Galloway's man in the use of his hammer, which attracted the just admiration of every one present. On the other hand, Mr. Herring's safe-breaker showed much judgment and experience, assisted, as it was, by the correct knowledge of the Austrian foreman. The personnel having been mustered on both sides, the tools were brought forward. Mr. Chatwood's men had their tools packed in a neat small leather portmanteau. The contents were the well-known serrated wedges used by expert burglars, some levers screwed together in short lengths so as to pick up easily, a small hand hammer and a block-tin hammer, which gives no ringing noise in striking. Against this the Americans brought in a sledge hammer, the exact weight of which has not yet been ascertained, but which may have been somewhere about 28 lb. There were several levers and crowbars 5 or 6 ft. long, and a complete drilling-frame large enough to inclose the entire safe, and to insert the ratchet brace for drilling. Last, but not least, came some steel wedges of an enormous size. Call these burglar's implements! The jury immediately objected to the employment of this portable blacksmith's shop, and the sensible suggestion was made to allow equal weight, and a maximum size of implements only on each side. This, however, could not be adhered to, since the American tools were not prepared for such a condition, and all parties, anxious to see the trial through, agreed to allow the heavy American tools to be used, with the exception only of some of the very large wedges. The jury allowed the sledge-hammer to the Americans, reserving to Mr. Chatwood the right to use a similar one if he thought necessary. This, although it changed the entire nature of the trial, was wise on the part of the jury, since it has been proved by the trial itself, that without sledge-hammers the trial would have lasted much longer than anybody would have cared to witness the operations, except perhaps Mr. Chatwood and Mr. Herring. The operations commenced at 2.45 P.M. There was a clear space all round each safe reserved for the workmen and the two sets were divided by a screen. In front of the latter Mr. Walker, the well known watch-maker of Cornhill and Regent-street, placed one of his beautiful chronometers for taking the

time occupied by the different operations. A piece of wood, sufficiently small to be enclosed in the little box inside Mr. Herring's safe, was put into this latter box, and a piece of similar size was put into Mr. Chatwood's safe; but Mr. Chatwood would not put his block into the small box inside his safe, as he declared that the contest was between the two safes, and not between a series of boxes hidden one within the other. Mr. Chatwood's workmen commenced by applying their small wedges to Mr. Herring's safe, while Mr. Herring's men tried their chance at drilling through the door in front of Chatwood's lock. The wedges did their work expeditiously, although the want of acquaintance with the details of Mr. Herring's construction caused some loss of time, the workmen attempting to drive in wedges at a place where the outer plate of the door overlapped the other part, and could have been removed by a cross-cutting chisel, so as to allow the immediate insertion of the wedge. In spite of this drawback, however, Mr. Herring's safe was completely thrown open in 29 minutes. The audience cheered, and Mr. Herring called out that this was only the fire-proof part of his safe, to which the English workmen replied by knocking out all the drawers and shelves of the safe and throwing them out on the floor. Meanwhile the workmen at the other side had erected their drilling-frame, and worked the ratchet-brace, but without success. The drill touching the spiegelisen, which is behind the outer plate of Chatwood's safes, refused to cut, and the work had to be given up as impracticable. They also tried to pick the lock and so apply steel screws and punches to the door, but they made no progress in that direction, and had to give up all idea of forcing the door. As far as the trial had gone on with real burglars' tools, it had lasted till 3.45 P.M. After that the sledge-hammer came into request. Mr. Herring's men commenced the attack upon the dovetailing at the corners of Chatwood's safe by driving in chisels with the sledge. Mr. Chatwood then requested that his men should also be provided with a sledge-hammer for breaking the small box which contained the wood block, and this was at once agreed to by the jury. The hammer was brought in at 4 P.M., and then an amount of battering began at each of the two safes, which will be remembered for some time by every one present. The fragments of chisels and wedges were flying about the room, and the din was so terrific that crowds of spectators collected outside. "This is not burglar's work," somebody remarked; "the police would soon stop such a proceeding." But the police in the Exhibition had quite enough to do to keep off the people attracted by the noise, and, as usual, they were courteous enough to hear nothing. The work went on for about half an hour. The English workmen had the disadvantage of working upon a very small surface, as afforded by the door of the small box, enclosed as it was inside a large chest, which prevented a fair blow from being struck in any direction. Here the unusual skill of the striker proved of great value; his blows very rarely missed, although they were sometimes applied in the most trying positions. At Chatwood's safe the manual skill was less; but the men, knowing every joint and every pin, made steady progress, step by step, all parts being perfectly accessible for their operations. The attack was made upon the side of the safe next to the lock of the door; the dovetails were wedged open singly, and each of the connecting studs binding the outer plate to the inner structure was cut through by itself with large chisels. At 4.35 P.M. the outer plate of Chatwood's safe was removed entirely, and the spiegelisen laid bare. In this form spiegelisen, as is well known, has no resisting power, on account of its brittleness, and it therefore took a short time only to knock off this material with the crowbars, so as to arrive at the inner plate of Chatwood's safe. The same operation was repeated on this latter, and at 5.5 P.M. a ridge was opened through which the ashes and other powdery substances forming the protection against fire commenced to fall out. It took half an hour more to open up a crevice at the side of the door, through which the paint of the interior could be seen, yet the peculiar construction of the bolts prevented all possibility of widening that breach, and the work had to be recommenced at the other side. The progress with Mr. Herring's safe was of a different character. The box was fastened inside the safe by an angle-iron girder, which had to be cut through to get access to the front-plate of the door. Behind this the box itself consists of a thick front-plate, tied to the back plate by a great number of steel bolts, about 1 in. diameter each, and rivetted in with countersunk heads. Behind the front-plate there is a construction somewhat resembling the plan of the Chalmers target, viz., a series of steel plates put on edge, and having their interspaces filled with franklinite iron, which is very nearly the same material as the German spiegel, only made of American ore. The connexion between the front and back plate of Herring's box came out to great advantage under these circumstances, since the smallness of the surface exposed to the attack, and the close proximity of the strengthening points, afford no proper working space nor leverage for the tools. This, however, is easy enough with so small a box as that inclosed in Mr. Herring's safe, while it is doubtful whether a larger safe of the same make would allow anything like the proportionate strength of connexions. At 5.50 P.M. the workmen on both sides were allowed to rest, and operations were recommenced at 6.35. At 7.15 the outer plate of Herring's box was thrown off, and wedges were immediately inserted to force open the rest of the door. Daylight was immediately afterwards visible in the small box of Herring's safe, and it would have been possible to remove small valuables, such as coins, from this chest through the crevice made. The want of a larger wedge was felt towards the end of this operation, and the suggestion was made to allow Mr. Chatwood's men one wedge of a size similar to those which were used on the other side. This, however, was not carried out, as Chatwood's safe had been broken into and the block of wood removed from it at that time, 7.25 P.M., the men having removed the side plate entirely, and cut a hole into the thin sheet-iron plate which forms the inside skin. The hole was just large enough to insert the hand and pull out the small wood block, but there was no access to any one of the drawers in Chatwood's safe, nor would it have been feasible to get at the block if it had been placed in the inside chest without expending a very considerable amount of further time and labour. Mr. Herring's safe being by this time so nearly destroyed that it appeared to be the work of a few minutes only to force the small box open,

it was resolved to complete this operation on the following day. The trials were consequently adjourned at 7.40 p.m.

PARIS, August 14.

The jury met at 11 o'clock this morning, and, after deliberation, called upon Mr. Chatwood's men to complete their work, which was done in three minutes. This is only one of a series of tests which these safes are to undergo, and it will be acknowledged by every competent man that it was not of a very scientific character. The *résumé* stands simply as follows: The two safes were both "third-class bankers' safes" according to the maker's catalogues. They had each a small separate compartment inside the safe proper. Mr. Chatwood deposited his wood-block in his safe proper, making no use of the inside chest. Mr. Herring deposited his wood block in the small chest within his safe. Mr. Chatwood's men were skilful, but unacquainted with the exact construction; Mr. Herring's men showed less manual dexterity, but an intimate acquaintance with the construction of Chatwood's safe. The tools of the English workmen were proper burglars' tools, while the tools of the American workmen were boiler-maker's implements of full size, and incomparably heavier than the others, including even the sledge-hammer given to the English workmen at a later hour. Under these conditions Herring's safe was opened in 29 minutes, and the contents of it thrown out to the public. Chatwood's safe proper had a hole made in its side in 4 hours 35 minutes working time. Herring's small box inside the safe was completely broken open within 4 hours 45 minutes working time. Chatwood's small box inside the safe was not opened at all in this trial.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Forthcoming Meeting of the British Association at Dundee.—The arrangements for the meeting of the British Association Sept. 4th, at Dundee, are being hastened forward with great energy by the local committee. Not satisfied with the lodging accommodation available in the town, they have persuaded the Caledonian and North British Railway Companies to run morning and late evening trains between Dundee and Perth, Coupar-Angus, Arbroath, St. Andrews, and Coupar-Fife. Such trains will, of course, be suitable also for the ordinary residents in those towns. Among the items of interest that lie immediately outside the real business of the meeting, I may mention that there is to be an agricultural show open for two days; there is likewise to be a dinner given by the town council to the office-bearers, and some 200 of the most distinguished members of the association; and besides the entertainments by the Earl of Airlie and the Earl and Countess of Strathmore, previously mentioned, the town council of Arbroath gives an invitation to 100 members; and the town council of Montrose, the Natural History and Antiquarian Society of the same town, the University of St. Andrews, Lord Kinnaird, Sir David Baxter, Bart., and others, are to dispense hospitalities on the occasion. All sorts and conditions of people, and many organised bodies, are straining every nerve to make the Dundee meeting an agreeable one to the *savans* who wend their way north next month. It is confidently expected, if not even finally determined, that Professor Tyndall will deliver a scientific discourse to a specially-convened meeting of the working men of Dundee. His distinguished colleague in the Royal School of Mines, Professor Huxley, did such a thing at Nottingham last year, and established a precedent that might well be remembered in connexion with future meetings. The evening discourse to members of the association are to be delivered by Mr. A. S. Herschel and Mr. A. Geikie, the eminent geologist, and local superintendent of the Scottish Geological Survey. In selecting the presidents of sections considerable deference is this year paid to Scottish science. The Mathematical and Physical Science section is to be presided over by Professor Sir William Thomson; and the sections of Geology, Chemistry, and Mechanical Science are to have as presidents, respectively, Mr. Geikie, and Professors Thomas Anderson and Macquorn Rankine, both of Glasgow University. If all the sectional presidents *acquit themselves* as well as the one last mentioned can, the work will go on systematically, expeditiously, and instructively.

The Yacht Fiona again.—Since the famous clipper yacht America competed with Britishers in our own waters, there has never been anything in the shape of a yacht, under 100 tons burthen, capable of standing against the famed Fiona. At the Royal Albert Yacht Club regatta, last week, the Fiona, 78 tons, won the race for Earl Vane's prize of 50*l.*, and that for the Albert Cup. In the latter she was beaten by the Oimara 165 tons, but allowing for difference of tonnage she was declared the winner. These are both Clyde-built vessels; Fiona, of Fairlie, being the builder of the Fiona, and the Oimara being built by Steel and Co., of Greenock. People in the Clyde ports are naturally much elated at this great success.

New Steam Ferry Boats.—A dreadful catastrophe having occurred two or three years ago at one of our ferries, to wit, the drowning of about twenty persons who were crossing the Clyde in an ordinary rowing boat, a steam ferry boat of greater capacity and safety was put on the station in December, 1865. This has proved so successful that the Clyde Trustees have just had another constructed for passengers only, and to ply in the harbour, and one for passengers, carts, &c., to ply at Govan. The former has been constructed by Messrs. Howden and Co., of Glasgow. It is an iron vessel with three water-tight compartments, and is 37 ft. long by 12 ft. wide, and can carry fifty passengers at a time. The boiler is of the upright tubular sort, 34 ft. in diameter, and the machinery consists of two 6 in. cylinders with 9 in. stroke, together with the crank and propeller shafts so constructed and arranged as to give a speed of 300 revolutions per minute. There are two propellers—one at each end, and carried on the same shaft, and they turn in reverse directions, both acting simultaneously in propelling the boat. The speed is about 4½ miles an hour, but this is in excess of what is required, and so the boat has enough of momentum, by the time she is halfway across the river, and the engines are then stopped. Her speed is about twice that of the 1865 structure, and at the same time burns only about one-half of the fuel. If we mistake not, the features of novelty in this boat were suggested some years ago by Mr. James R. Napier.

The steamer for the Govan ferry was built by Messrs. Simons

and Co., of Renfrew, from designs by Mr. Duncan, the trustees' engineer. Her dimensions are 45 ft. by 29 ft. in the centre, and 12 ft. at each end, and depth of 8½ ft. amidships. Ample room is afforded for two carts and fifty or sixty persons; and then, in order to have the weight equally distributed, the boiler is on one side and the machinery on the other. It should be mentioned that the machinery consists of a non-condensing high-pressure engine of two 10 in. cylinders with 12 in. stroke. By means of a pinion on the crank-shaft the propelling or chain-wheel is driven, and on the periphery of this wheel the working chain travels, the ends, of course, being made fast to the shore; and by these appliances the vessel is passed from side to side. Auxiliary steam power is employed in the lifting and lowering of the hinged entrance gangways at the ends of the vessel, and the exhausted and waste steam from the boiler and main engine are sent into the water, so as to avoid the possibility of frightening horses on board. Both of these boats have been experimented with to the satisfaction of the Clyde Trustees.

Lighthouse Inspection Trips.—The annual visit of inspection to the several lighthouses in the Firth of Clyde was made recently by the Lord Provost of Glasgow and the other trustees, "assisted" by a large party *invited*. The splendid and well equipped Highland steamer *Gael* was employed on the occasion. The Lord Provost of Edinburgh and his co-trustees have also just had their "outing" among the northern lighthouses, even unto the Orkney and Shetland Islands; and now, on the part of the Government, and to see, we suppose, that the other inspectors have done their duty properly, the deputy-master, Captain Arrow, and several other elder brethren of the Trinity House pay the Clyde a visit in the steam yacht *Irene*. They have done the Irish coast and part of the English, and are now on their way round the coast of Scotland, and will conclude their pleasant annual holiday by a run down the east coast of England.

Shipbuilding News.—Messrs. J. and G. Thomson the eminent shipbuilders of this city, have just concluded a contract with Messrs. Burns and McIver for a first-class screw steamer of 2500 tons for their Atlantic service. She is to be named the *Samaria*, and is to be ready early next season. It is announced that Messrs. Scott and Co., the well-known Greenock and St. Nazaire shipbuilding firm, are able to resume work. This must be good news for Greenock. Provost Grieve, of that town, has given them orders to build an iron sailing ship of large dimensions for him, and this will doubtless give employment to a number of men who are now out of work.

Death of a Pupil of Telford.—Mr. Alexander Gibb, C.E., a pupil of Telford, the eminent engineer, has just died at Aberdeen. Soon after completing his apprenticeship, he entered into partnership with his father, an extensive contractor, and the firm of John Gibb and Son constructed many important works all over the kingdom. Among them may be named the Broomielaw Bridge of this city, and the Dean Bridge, in Edinburgh. Mr. Gibb himself was the engineer of the various lines of railway entering Aberdeen, and with the public life of that city he was intimately connected for upwards of forty years. One who is given to hero-worship likes to get back to the life of a great engineer, even though it be through the death of one of his gifted and esteemed pupils, as Mr. Gibb was.

A HOT-WATER BOTTLE EXPLOSION.—Mr. Fletcher, the engineer to the Manchester Boiler Association, gives some space in his last report to an account of the explosion of a hot-water bottle used as a bed-warmer, and by which explosion a child was killed, and two persons seriously injured. The bottle was of earthenware, of about a quart capacity. It had been put to warm a bed on a previous occasion, when the cork had been tied in with a waxed end. When the bottle was wanted again, instead of being emptied and refilled with hot water, it was put, tightly corked, into the oven of a kitchen range. In a short time a violent explosion ensued, a corner of the oven door was split off, and the fragments of iron and earthenware thrown into the room with so much force that three persons were seriously injured, one of them, a child, dying the day after. This explosion in an engineering point of view is of considerable interest, and involves important principles. The explosion of household boilers is always attributed to the water supply being allowed to run short, and then suddenly re-admitted on to red-hot plates, which is supposed to be productive of a wonderfully disruptive force; while, with regard to explosions generally, it is too frequently thought that a gradual accumulation of steam is insufficient to produce the disastrous results attendant on them, which are therefore attributed to some sudden generation of pressure from the detonation of gases or other imaginary cause; while others again hold the opinion that no boiler can explode if suitably supplied with water, and that though it might rend, it would do so without violence. There is no getting away, however, from the facts of this explosion: its simplicity renders it most convincing. There was no pipe to suddenly re-admit the feed, as in the case of the household boiler, on to the supposed hot plates, while the circumstances forbid the explosion's being attributed to any other cause than quiet internal pressure from the gradual accumulation of steam, which, it will be seen, did not quietly rend the bottle, but violently exploded it. This little incident supports the views expressed in the Association's report for January, 1867, relative to the explosion of household boilers, viz., that they were due simply to the gradual accumulation of steam, and might be prevented by an efficient safety-valve.

THE LONDON AND NORTH-WESTERN RAILWAY.—The rolling stock of this company has cost 5,105,666*l.*, and 70,000*l.* worth more is asked for by the directors. The passenger trains ran 5,239,733 miles in the first half of 1867, and the goods trains 5,677,300 miles, the total being at the rate of about 21,500,000 miles yearly. The present stock of engines numbers about 1500.

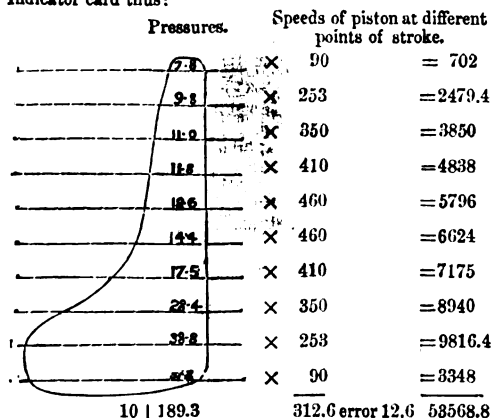
GUN COTTON.—An explosion of gun cotton has occurred at Messrs. Prentice's works, Stowmarket, but without personal injury, and without in any way interfering with the further operations of the factory. The cotton was being dried, and was, it appears, over dried; and it is given out in the papers that gun-cotton explodes at 170° Fahrenheit. This is a clear mistake, although the actual temperature of explosion is not perhaps accurately ascertained.

INDICATED HORSE POWER.

TO THE EDITOR OF ENGINEERING.

SIR,—I have sometimes been inclined to doubt whether engines working with extreme expansion really do develop the power which is usually deduced from indicated cards, and I should like to inquire if any of your readers have ever calculated their cards taking the speed of the piston at the different points of the stroke. The diagram below may illustrate my meaning more clearly. I have not been able to calculate the speeds of the piston more accurately, and the error amounts to 12.6 in 300, or about 4 per cent.

Suppose an engine, one cylinder, 5 ft. stroke, 50½ in. diameter, 30 revolutions per minute, then we shall have
Area of cylinder, 2002 square inches, say 2000 square inches.
Speed of piston (average) ... 300 ft. per minute.
Speed of crank-pin (if direct acting) ... 471 ft. "
Indicator card thus:



Average pressure 18.93

Usual Method:

$$\frac{18.98 \times 2000 \times 300}{33000} = 344 \text{ indicated horses.}$$

Now take

$$\frac{10 \mid 53568.8}{5356.88} \quad \frac{5357 \times 2000}{33000} = 325 \text{ indicated horses.}$$

325 less 4 per cent. error above alluded to = 312 horses, where 344 is the result by the usual method. This error, it seems to me, will always be greatest where the degree of expansion in one cylinder is greatest. If I am right, I hope some of our mathematical friends will kindly differentiate the speeds of piston, so as to eliminate the error which I have made.

Your obedient Servant,

Newcastle-on-Tyne, August 13, 1867.

J. W. R.

THE MONEY MARKET.—Money is now abundantly offered in the Stock-Exchange at 1 per cent., and there is every indication of a continued increase in the supply.—*Times City Article.*

THE COMPANIES ACT.—Considerable anxiety is expressed in the city lest in the hurry at the close of Parliament there should be a risk of the Bill for the Amendment of the Companies Act of 1862, which has already passed the House of Commons, being thrown over to next session. A representation from a number of leading firms is therefore about to be addressed to the Duke of Richmond, as President of the Board of Trade, calling attention to the fact that the existing paralysis of commercial enterprise is believed to be in a great degree attributable to the circumstance of many millions of capital invested in joint-stock securities being unobtainable through the absence of the powers which the new bill would supply, and praying that every effort may therefore be made to pass the measure through the House of Lords.

THE PNEUMATIC DISPATCH IN PARIS.—The number of telegraphic despatches received at the central station in Paris has increased so considerably that the administration, finding it impossible to send them by porters in all directions to their respective destinations, has adopted a plan which is already in use for the transmission of letters. A continuous series of iron tubes, 65 millimetres (2½ in.) in diameter, has been laid down from the central-office in the Rue de Grenelle St. Germain to the Hôtel des Postes and back again to the Central-office. This continuous line touches besides at the Cercle Impérial in the Rue Boissy-d'Anglas, then at the Grand Hôtel, the Bourse, Hôtel du Louvre, and the Hôtel de la Charité. The despatches to be sent off are put into a cylinder fitting loosely into the tube, but provided with a leather disk which closes the vertical section of the tube completely. At each station there is a cistern of water and a reservoir of compressed air; the water, supplied by the town pipes, serves to compress the air, while the latter, rushing into the transmission tube as soon as a communication with it is opened, drives the cylinder before it with extraordinary celerity. Each cylinder may contain as many as forty despatches, and a new one is sent off every ten minutes.

FIRE PROTECTION.—The Select Committee on Fire Protection recommend for all towns and places in the kingdom, governed by municipal corporations, local boards, &c., a general Building Act, to be similar to the Metropolitan Building Act. They recommend fire-proof floors for dwellings situated over shops and warehouses, better means of escape from the roof in case of fire, and further legislative precautions to secure a constant service of water under all new Water Acts. Increased stringency in the regulations as to the storage of inflammable oils is recommended, no storage to be allowed to oils, petroleum, &c., having an igniting point as low or lower than 110 degrees.

BOLTON.—The Lancashire and Yorkshire Company, the most prosperous of the large railway companies in the kingdom, has perhaps the worst station in England, at Bolton, a town of 75,000 inhabitants. In construction, accommodation, and attendance, we have met with nothing so bad.

NALDER'S GOVERNOR.

TO THE EDITOR OF ENGINEERING.

SIR,—In your last impression you published an illustration of Nalder's governor, of which you believe that it will answer well. I believe also that it will answer very well; and if you will allow me a little space, I will point out why it will answer better than all the usual governors, if it is rightly proportioned.

A perfect governor, acting uninterruptedly on the throttle-valve or expansion-gear, must satisfy the following conditions:

1. It must allow the engine to work with more or less power at the regular number of revolutions.
2. It must restore the regular speed of the engine as quickly as possible, if it has been altered.
3. It must, like all other contrivances, be as simple as possible.

The first condition is, in Nalder's governor, perfectly satisfied the balls being at liberty to take any position within the necessary range at the regular speed of the engine. This will be easily understood if it is remembered that the centrifugal force of the balls at a constant speed is in direct proportion to their distance from the axis of rotation, and that the deflection of the spring due to the centrifugal force of the balls is also in proportion to this force. If, therefore, the springs are calculated and set so as to be in equilibrium with the centrifugal force for the position in which the throttle-valve is quite open, and the engine should at once run faster, the centrifugal force will increase, the balls will bend the springs and shut the valve until the right speed is regained, when the balls will remain in their last position until a new deviation from the proper speed alters their position again.

This first condition is also satisfied in the parabolic governor, and in Farcot's governor (illustrated in *ENGINEERING* of May 10th, 1867), but not at all in Watt's and in Porter's governors, where every change in the position of the throttle-valve requires a corresponding change in the speed of the engine. Also in Pickering's governor (illustrated in *ENGINEERING* of September 28th, 1866) this condition is not satisfied, because the distance between the supports of the springs alters so materially that equal increases in centrifugal force do not produce equal increases in deflection.

The second condition of sensibility can be satisfied by making the centrifugal force very large in proportion to the resistance of the throttle-valve. This can be effected either by making the mass of the balls large, or by giving them a very high speed. The latter is by far the better way, because the sensibility is in direct proportion to the square of the speed.

Nalder's governor, if it is not for convenience fixed on the crank-shaft, may be made for any speed, and, with 300 or 400 revolutions, it will be quite as sensitive as the governors of Porter and Pickering, which work at about this speed.

In this respect it is therefore equal to the governors of Porter and Pickering, and superior to those of Watt and Farcot.

That the third condition is satisfied in Nalder's governor a look at the drawing will show.

Watt's and Porter's governors are also very simple, but the first does not satisfy either of the above conditions, and the second not the principal one. Farcot's governor satisfies the first condition, and, if Porter's improvement is applied to it, it will also satisfy the second condition; but it will be a very complicated contrivance.

Pickering's governor is about as good and not quite so simple as Porter's.

From the above it will be seen that Nalder's governor, if driven at a high speed, is superior to the usual governors, and, being simple in construction, it might be applied to many smaller engines, where regularity of speed is very desirable, but where a governor like Farcot's is so expensive.

Yours respectfully,

A. W.

Leiston, Suffolk, August 12th, 1867.

THE INDIAN BRANCH RAILWAY.—The Government guarantee of 5 per cent. interest for 999 years, upon 4,000,000*l.*, was some time ago extended to the Indian Branch Railway Company, for the construction of 672 miles of cheap surface lines in Oude and Rohilkund.

BOILER EXPLOSIONS.—There is at last a diminution in the number of these disasters. Where about 75 happened in the kingdom in the year 1866, but 16 have been reported for the first half of 1867.

MINES.—The report of the Select Committee on Mine Inspection recommends that every steam boiler in connexion with mines shall be provided with a proper steam-gauge, water-gauge, and safety-valve, that the man working the engine shall have the means of knowing the position of the load, that the use of safety-lamps should be imperative, and that it is expedient to prohibit in all cases the deduction of the price of timber used in propping from the wages of the miner. The committee consider that the present staff of inspectors should be increased without lowering the standard of men at present employed.

BROADHEAD.—The Sheffield saw-grinders at a full meeting have virtually endorsed all the atrocities of Crookes and Broadhead, resolving that the men who had "risked their lives and liberties for what they believed to be for the good of the institution" should not be deserted!

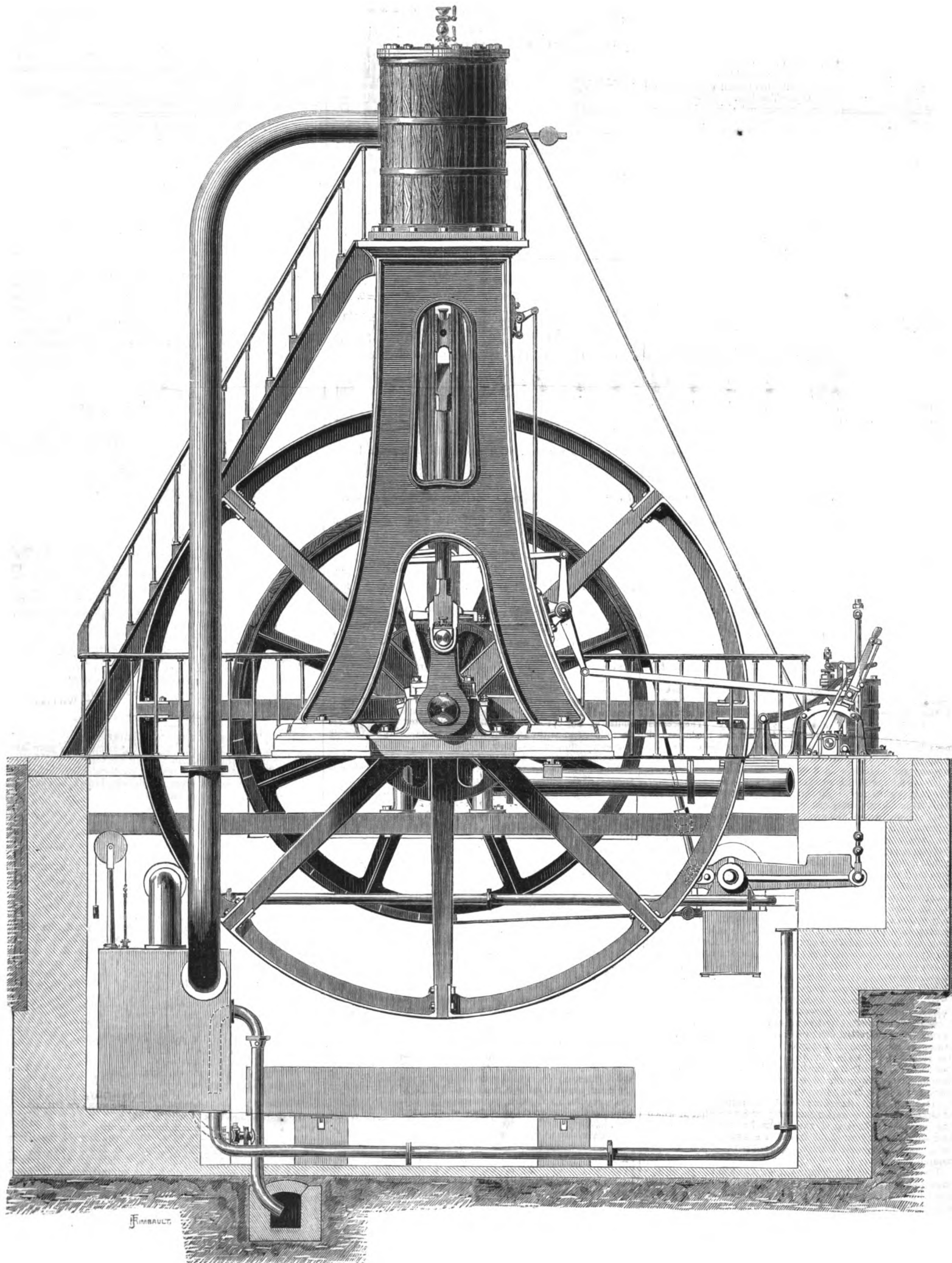
THE NEW DOCK AT MALTA.—On the first instant, the first stone of the new graving-dock at Malta was laid, 41 ft. below sea-level, under the arrangements of the Admiralty civil engineer, Mr. Lovell. This dock is described as the largest, when completed, ever constructed, its length on floor being 430 ft.; at coping, 468 ft.; width of floor 42 ft. 6 in.; width at broad altar, 84 ft.; width at coping, 104 ft.; depth from coping to floor, 39 ft.; and depth on sill, 33 ft. 6 in. The 85 horse (nominal) pumping-engines are lifting 27 tons of water 45 ft. high per minute, the effective work being thus equal to 824 horse power.

INDIAN RAILWAYS.—The amount of capital spent on the Indian lines last year was greatly in excess of that in any former year, viz., 3,942,598*l.*

THE GAS COMPANIES.—There is prospect of a compromise at last between the companies and the authorities, the former to supply sixteen-candle gas at 3s. 9d.

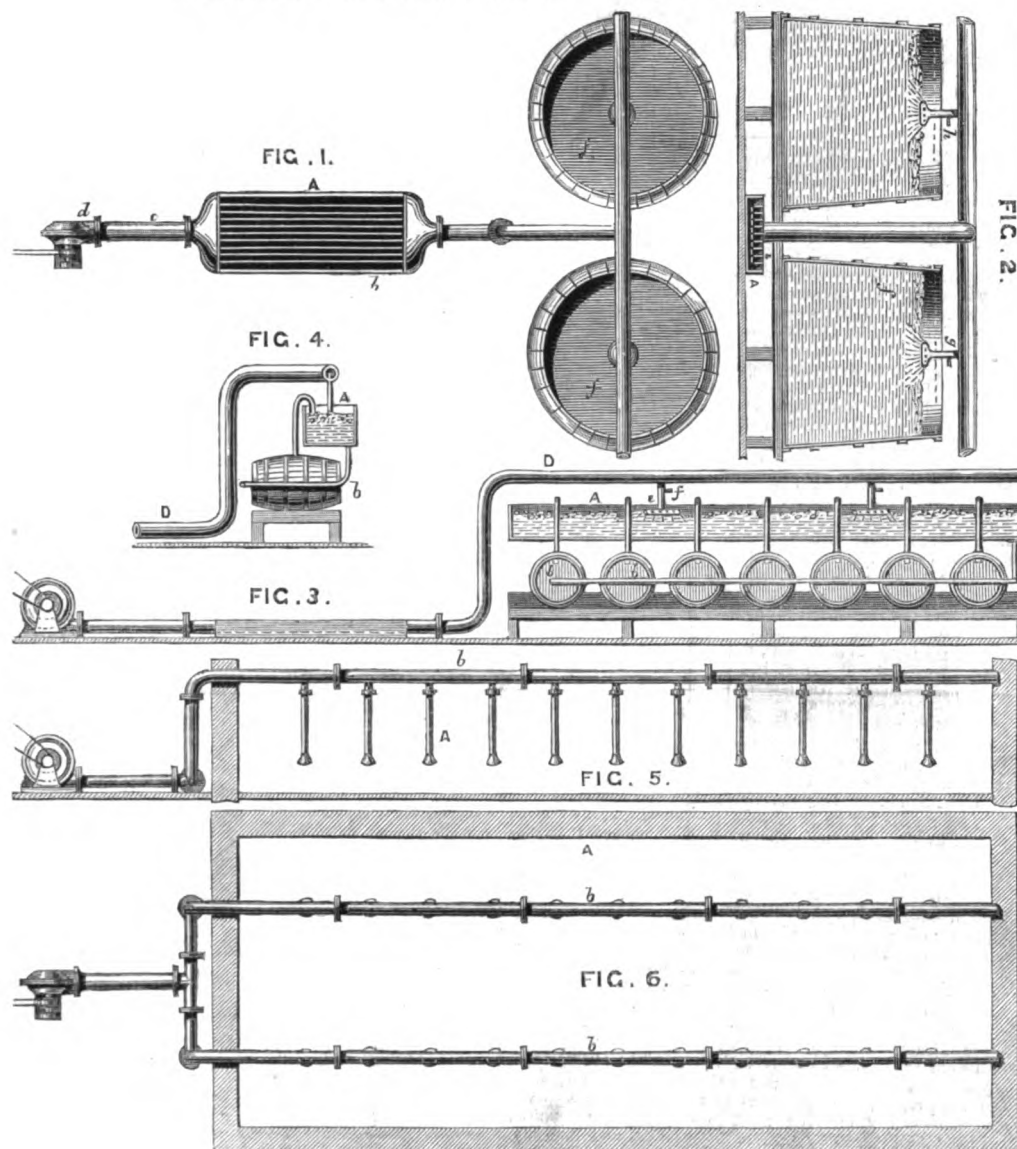
COLLIERY WINDING ENGINES, AT THE PARIS EXHIBITION.

DESIGNED BY M. A. ANDRY, AND CONSTRUCTED BY M. F. DORGÉE, ENGINEER, BOUSSU.

(For Description, see Page 129.)

ATMOSPHERIC TUN-ROOM ATTEMPERATOR.

DESIGNED BY MR. ANDREW BARCLAY WALKER, WARRINGTON.



IMPROVEMENTS in the system of brewing and distillation have been recently patented by Mr. Andrew Barclay Walker, brewer, of Warrington, which appear to mark a new era in the art of brewing and distillation in this country. The process to which we refer has for its special object the production of more healthy and vigorous fermentation, and the preservation of the yeast, or barm; in fact, the production of beers in the summer months fully equal to those made in October.

It is well known to those at all conversant with the manufacture of beer, that there is no part of the manufacture where such vigilance and attention is required as in the fermentation of the wort. Slight imperfections in the earlier stages, provided acidification has not set in, may be corrected by a healthy fermentation, and a good and wholesome beer produced; but if every previous manipulation has been skilfully executed, imperfection in the fermentation will only result in a worthless and unwholesome production. It is not our object to refer to the whole of the chemical decompositions embraced by the term fermentation—such as the lactic, the acetous, the putrid, and the vinous, &c., in which certain compounds are formed by oxidation. A body in the state of acetous or lactic fermentation, on coming in contact with saccharine matter in solution, generates acetic or lactic acid in the liquid. Hence the necessity of preserving the store yeast, by which the first action is induced in healthy condition, and entirely free from putridity or acidity, otherwise the wholesomeness and flavour of the beer would be seriously injured, as well as its keeping qualities endangered or entirely destroyed.

Mr. Walker has closely studied the natural laws by which the superior qualities of beer brewed in winter are obtained, and put those laws into operation by the construction of a very simple apparatus in the form of an atmospheric attemperator, by the use of which the atmosphere in the gyle tun-rooms, or that portion of the atmosphere directly over the worts in a state of fermentation in the gyle tuns, is attemperated to that degree of temperature in summer or winter at which the process of vinous fermentation may be most successfully conducted. The temperature being never permitted to rise above or fall below that degree of temperature which experience has proved to be that at which the azotic constituents of the worts become most speedily oxidised by the oxygen of the atmosphere, and this temperature being equally maintained throughout the whole process of fermentation.

The annexed figures, 1 and 2, show the application of the atmospheric attemperator. A is the attemperator, which consists of a rectangular frame in which a series of flattened tubes, b b, are arranged side by side, with spaces of about 5 in. between

them. The spaces between the tubes are filled with spring water or ice, or any freezing mixture of salts or acids, and at one end the tubes are connected by the pipe, c, to the fan, d, whilst at the opposite end they are connected to the pipe, e, which leads up to the fermenting tuns, f, branching off directly over each tun, and having a vertical tube, g, pierced at the bottom with small holes for the exit of the air. The supply of air to each tun is regulated by the slide, h, so as to suit the progress of the fermentation.

As soon as the fermentation commences, and the yeast begins to form on the surface of the wort, the fan is put in motion, and a current of air is thus driven through the tubes of the attemperator, and caused to pass over the surface of the wort until the fermentation is completed.

In winter it may not always be necessary to employ the freezing mixture, as the temperature of the air from the fan alone may be sufficiently low for the purpose of healthy fermentation.

Mr. Walker affirms that since he has adopted the system his fermentations have been of the most healthy and vigorous kind, and languid or sluggish fermentations have been entirely unknown in his establishment. The decomposition of the saccharine matter becomes more perfectly assimilated in the menstruum, the albuminous matter is more freely separated in the form of yeast, and the saccharine matter more expeditiously converted into alcohol and carbonic acid, whilst from the suitability of temperature immediately over the gyle tuns the yeast more readily absorbs the oxygen, and thus a vigorous fermentation is sustained throughout the process. The genuine soundness of the beer is ensured, and besides a superior tone and quality are imparted to it, which it retains unimpaired to the last glass drawn from the cask.

The system of preserving the yeast, or barm, in the yeast-trough during the process of cleansing is illustrated by Figs. 3 and 4 annexed. A is the yeast-trough or receiver into which the yeast passes from the puncheons, b b. D is a tube leading from the attemperator already described; e e are pipes for distributing the air over the surface of the yeast in the yeast-trough; and f is the valve for regulating the supply of air. Whilst the process of cleansing is going on, the air from the attemperator or fan is kept playing over the surface of the yeast as it rises from the puncheons into the trough. Mr. Walker informs us that by this simple process of preservation a vigour and vivacity is imparted to the yeast, which gives it a great power of inoculation; there is no variability or uncertainty in its effects, and the fermentations are of the healthiest character.

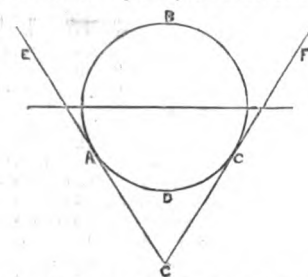
The same atmospheric attemperator has been applied to the manufacture of malt, so that malt may be made in the summer as well as in the winter. Hitherto it has been impracticable to make malt in the summer equal to that made in winter, or, in fact, to make it at all in the summer, owing to the unsuitability of temperature. Mr. Walker proposes to apply the same system of attempering to the malting-rooms as to the gyle tun-rooms. The annexed Figs. 5 and 6 will suffice for illustration; a is the malting-room; b b pipes leading from the attemperator directly through the malting-room, a few feet above the floor; c c are flexible tubes attached to the pipes, b b, with rose perforated caps at the ends. Whilst the malt is on the floor in process of germination, the temperature of the room is regulated to that degree of temperature best suited for malting by currents of attemperated air from the attemperator distributed over the surface of the malt on the floor.

The sole manufacturers of these attemperators are Messrs. Morton and Wilson, of London and Stockton-on-Tees.

SHAPING-MACHINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In your article on a new engineering factory, in your number of the 2nd inst., you mention a shaping-machine fitted with a not uncommon movement, viz., a crank-pin working in a block which slides in a slotted vibrating link for the purpose of giving a quicker motion on the return than the forward stroke of the tool, and you then go on to say, "The speed varies inversely as the distance of the block from the fulcrum upon which the lever vibrates, the speed being, of course, greatest when the block is nearest the fulcrum." I imagine that this hardly explains the matter, as at first sight it would appear that, as the crank-pin arrives at the two extremities of its stroke at regular intervals, the backward and forward strokes of the link, and therefore of the tool, must each be made also in equal spaces of time, and that the position of the block in the link could not affect it; but still in practice we know such is not the fact. I have only discovered the reason of the seeming anomaly by making a diagram, of which I send you copy. A B C D represents the path of the crank-pin, and E and F the positions of the link (working on fulcrum, G) at the two extremities of the stroke. By this you will see that the points, A



and C, in the path of the crank-pin are those at which the link is at the extremities of its stroke, and that these do not coincide with the extreme positions of the crank-pin, and, therefore, for the forward or cutting half of the stroke the crank-pin has to travel through the arc of the circle, A B C, whilst for the return half of the stroke it has only to travel through the arc of circle, A D C, and therefore the latter is made in the least time. The knowledge of this, I think, shows the movement to be a more ingenious one than at first sight appears, and that, although your explanation was correct, it was not the whole truth.

If I have misunderstood the matter, I shall be glad to be corrected by either you or any of your correspondents.

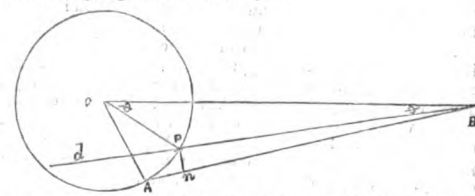
Yours truly,

FREDK. WILLIAMS.

Middlesboro', August 10, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—In your mention of a shaping-machine in your last edition, you say the variation between the forward and backward strokes depends on the relative positions of the crank-pin and fulcrum. A more correct reason, will, I think, be found in the following trigonometrical analysis:



Let C be the centre of the circle described by the crank-pin, A; P A a small arc; and P n a perpendicular on B A.

Let $\angle A C B = \theta$, $\angle A B C = \phi$, $C P = a$, $C B = c$.

Then,

$$\tan. \phi = \frac{a \sin. \theta}{c - a \cos. \theta}$$

which gives the relative positions of B P and C P.

Again, since the angle P B n is so small,

$\therefore P n$ is at right angles to n B and P B.

$\therefore P n A$, $d P n$, $A P C$, are right angles.

$\therefore d P A = P A n$.

But since P n A is a right angle,

$\therefore P A n + A P n = \text{a right angle}$.

And the result is evident.

Yours obediently,

MARGRAVE DILLON.

Middlesboro'-on-Tees, April 12, 1867.

COAL IN PRUSSIA.—In 1857, the production of the Sarre group of collieries was 1,725,000 tons. In 1864, the extraction had been carried to 2,600,000 tons, while it now exceeds 3,000,000 tons annually; indeed, the extraction is said to be solely limited by the want of labour. France consumes more than half the coal produced in the Sarre group.

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR,—Notwithstanding the needless animosity displayed by some of your correspondents, and the liberal use of slang terms in denouncing improvements they do not understand, and with which they have had no personal experience, it may safely be prophesied that Corliiss engines will be extensively introduced in this country.

If such a term as "rattletrap" can be rightly employed in this discussion to describe mechanism that is eminently successful, with how much greater propriety can it be applied to the letters of "Observer" and some of his supporters.

It would be a waste of your space, and, I fear, try the patience of your readers, to discuss "the question of wire-drawing" versus "expansion." I take it for granted that our most successful steam engineers have no sympathy with "Observer" on that ground.

Is it not acknowledged, that efficient and comparatively frictionless valves and gear, adapted for variable expansion, are very rare and a great want at this present time? I think most of our practical engineers will say, Yes.

On such a point I receive with great respect the statements of those gentlemen who have the maintenance and repair of the engines of large companies, as they are more familiar than engine builders with the troubles incidental to steady regular work. The experience of these gentlemen would give us a serious list of casualties, and maintenance outlay in connexion with the most improved plans of valves and gear now in use.

This being so, it is to the advantage of steam users to have all hopeful plans for economising fuel fairly and fully tried; and to give any plan a chance of success, it must be carried out by those who believe it to be the best plan (or approximately so); and is it not an indication of a weak cause when evidence is refused because it comes from those who are professionally or pecuniarily interested in the success of any improvement?

There have been letters in your columns from engineers, manufacturers, and steam-users, who have designed, manufactured, and used Corliiss engines, and yet "Observer" appears to ignore, in toto, both the opinions and evidence of these gentlemen.

Fortunately for the latter, the failure or success of the engine under discussion does not depend on the dictum of any indignant correspondent. Time and experience will prove whether the friends of the Corliiss engine are "deluded" men, or whether the term may not be much more truly applied to "Observer" himself.

I write to you as one who has had considerable experience with the Corliiss valves and gear, and I am now making several marine engines on this plan in consequence of the efficient performance of a pair I had fitted nearly two years ago. All my experience has led me to be most hopeful of future results, and although I am not prepared to say these valves and gear can be applied in all cases, or at excessive speeds, I certainly do honestly believe that for engines of from, say, 15 in. diameter and upwards, and for speeds not exceeding 120 revolutions, the Corliiss valve promises to be most efficient and trustworthy.

Valve-gear may be generally divided into two classes:

First, that in which only one valve is used for exhaust and cut-off.

Second, that in which one or more valves are used specially for regulating the cut-off, and is generally termed expansive valve-gear.

The Corliiss valve-gear comes into competition only with the second class.

Simplicity is of great importance in machinery, but it may be purchased at too high a price.

In the choice between a few parts and severe friction and many parts and reduced friction, the engineer is often justified in preferring the latter, "complication" being a comparative term, and often most untruthfully applied.

The most important requirements for valve-gear that enables the steam to be used economically are:

1. A variable cut-off.
2. Minimum friction.
3. Accessibility for repair.
4. Simplicity.

In the manufacture of mechanism that may effect a saving of thousands of pounds per annum, cost of construction is secondary to cost of maintenance and certainty of action.

No great results in economy of fuel can be obtained without increased first outlay. The question is, whether the increased first cost will be more than repaid by the saving of a few years. These remarks apply to all improvements, and the cost of the Corliiss valve-gear cannot be decided even fairly discussed in correspondence. It may be more or less costly than other expansive valve-gear, its details can be made by self-acting machinery, and, in my own experience, it compares favourably with other plans offering the same advantages. With reference to the four chief requirements of valve-gear noted above, the following are undoubted facts as to the Corliiss valve-gear:

1. In ordinary working the cut-off can be varied at pleasure by hand or governor to give from $\frac{1}{16}$ th to $\frac{3}{4}$ th steam, the exhaust remaining constant.

2. The power required to close one valve of a 38 in. cylinder using 60 lb. steam is under 200 lb., applied in line of valve face, and I do not believe there is any other valve in general use that can be moved with certainty by that power.

And here lies the secret of much of the efficiency of the Corliiss valve-gear, the valves working so easily, that the steel facings of the detent, measuring in contact 3 in. by $\frac{1}{4}$ th, will last for years.

3. Each valve can be removed separately, and for large engines the valves are more easily overhauled than those in general use.

4. Simplicity is a comparative term, and with the Corliiss valve-gear, as in many other successful machines, it has to give way to more important qualifications.

There is one vital advantage in the Corliiss valve-gear as a set-off against its apparent complication. I allude to its certainty of action. In one pair of engines, working at 85 to 90 revolutions per minute, there was not a false stroke out of thirty million distinct escapements, and this is the experience of all I have had to do with.

As to economy of fuel, where there is a free exhaust, a large expansion, and the vitality of the steam is maintained by jackets

or superheating, economy is inevitable. In discussing the merits of the Corliiss engine, I refer to it as a machine, capable of using the steam so as to produce maximum results with a minimum expenditure.

As I have written this letter amid the press of many engagements, I am certain not to have done justice to my theme, and, if necessary, I shall be glad to supplement these remarks in your next or following impression.

I am, Sir, yours obediently,

J. FRED. SPENCER.

Sunderland Engine Works, August 14, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—The hypothesis started by you last week, that the several anonymous letters which you have received expressing an unfavourable opinion of the Corliiss engine, have been written by my hand or by my dictation, is simply erroneous, though, had the fact been otherwise, I cannot see what it has to do with the question at issue. No doubt the epithet of "rattle-trap" may appear a meaningless expression to some persons; but I fear that in this case its main fault is that it is too graphic and too just. I do not know what a knowledge of the history of the Corliiss engine has to do with the question under discussion, which is merely to determine whether any point of solid superiority can be established for the Corliiss engine over common engines. No one has denied, or, I take it, can deny, that the Corliiss valve gear is the more costly and complex, and the point which I wished to elicit is, whether any such superior economy is produced by its use as would afford compensation for these disadvantages. Although, however, you have enumerated a great many Corliiss engines which have been already made and worked in this country, and although you have published letters from a number of zealous correspondents, who have been anxious to say all that they could in favour of the system, I do not find that one tittle of evidence has been given to show that any unprecedented or remarkable economy is obtained by the adoption of this engine, and my belief is that there is not. This belief cannot be changed by anything short of attested facts; and if such facts are producible, why, allow me to ask, are they not forthcoming? The truth is, that they are not producible; and the advocates of the system are driven to fence with this plain demand, seeing that they cannot satisfy it. Mr. Salt says it is within his knowledge that certain Corliiss engines are giving "excellent results," an assertion quite too vague to be of the least value; for what he might consider "excellent results," others might only regard as evidence of mediocrity. I agree with Mr. Salt in thinking that it would be a matter of interest to have reports collected respecting the working of the Corliiss engine, as compared with the working of engines upon the ordinary plan. But the difference between Mr. Salt and myself is this, that whereas he surrenders his faith before this information is collected, or any point of superiority proved, I decline to yield mine until, by this or some other expedient, adequate testimony of superiority has been afforded.

I agree with Mr. Salt in thinking that none of your readers are likely to give much consideration to arguments based on the opinions of anonymous letter-writers; and it is equally probable and equally proper that the refusal should be extended to argument based on any opinions, whether anonymous or not. I also agree with Mr. Salt in thinking that "we want statements of facts from those who can give them;" but I think that any attempts at conversion to the Corliiss faith should follow, and not precede, the production of these credentials. Such statements of fact, moreover, must not only not be anonymous, but must be attested by men of known skill and integrity. But while it is indispensable that in any statement of facts names should be given, as in reality they constitute the inducement on which the facts are accepted, the introduction of names into controversies which, starting from a few admitted truths or axioms, deduce certain conclusions therefrom by a process of logical demonstration is not merely useless, but objectionable, as it brings an extraneous force into a question which should be worked out by scientific deduction alone. Certainly I shall not hesitate to express my opinion of the Corliiss engine in my own name on the proper occasion; but as in this discussion I do not pretend to furnish facts, but only call for them, to what end should my name now be paraded, except to influence conclusions which should be evolved wholly from the evidence presented?

I am, &c.,

OBSERVER.

TO THE EDITOR OF ENGINEERING.

SIR,—I did not intend troubling you again with any further observations of mine on the above subject, but having read the remarks of Messrs. Gill and Inglis in Friday week's ENGINEERING, I hope you will allow me as briefly as possible to reply to them.

Mr. Inglis after all does not quite agree with me, when I said that the results as stated by Mr. Gill could not have been brought about by the alleged superiority of the Corliiss valve alone; he thinks, however, it might not be due to the greater degree of expansion obtained. I should be sorry to misquote Mr. Inglis or any one else. I thought, however, that all engineers agreed that the best plan to get a maximum amount of duty from an engine was not by cutting off steam at an earlier part of the stroke, however beneficial it might be to do so on the score of economy of fuel. Leaving this part of the subject without further comment, which I think unnecessary, I come to his explanation why the Corliiss engine did give out more absolute power than the one that preceded it. He says, 1st, that there was no wire-drawing action of the valves; 2nd, that the passages for the inlet and outlet of steam were much shorter, and consequently less back pressure on the piston, and lastly the absence of the ordinary throttle-valve. Now I don't think Mr. Inglis means seriously to tell us that the difference in the lengths of passages in the two engines could make a difference of $\frac{1}{4}$ lb. in pressure, neither would the pressure on the back of the piston be increased to that amount, supposing the parts to have the usual proportions. Then comes the wire-drawing of the valve.

Mr. Gill tells us the valve in the previous engine was "the common short slide cutting off steam at some definite part of the

"stroke." If we suppose this valve to have the ordinary amount of lap, the cut-off would take place after the piston has travelled five-eighths to three-fourths of the length of the stroke, the amount of wire-drawing in such an one could not be sufficient to affect in any material degree the power of the engine. Then, as to the throttle-valve, its function is to close when the load on the engine is relieved, an increase of speed being the consequence, and, on the other hand, to open when the load is increased, and the speed lowered; however pernicious, therefore, a throttle-valve may be with a light load, it cannot be said to have the effect of wire-drawing when the engine is pulled up by the overload, which we are told was the case. I come therefore to the conclusion that the first engine failed to do the same amount of work as the Corliiss engine, not because it had longer passages, not because it had shorter slide, not because it had a throttle-valve, but simply because each or all these were badly proportioned or badly adjusted.

Mr. Gill's letter does not touch the question of power. He speaks of the superior way the Corliiss engine was regulated, and of the admirable cut-off, and says, here is the clue to the greater efficiency and economy of the Corliiss engine; but this has no possible reference to the only question to which I have all along addressed myself, viz., that of power.

No one can attach greater weight to practical experience than I do; at the same time it is very necessary to be on our guard against placing implicit reliance on such evidence, because erroneous conclusions are often drawn from well established and authentic facts. Here we have a case in point:

A gentleman sees a Corliiss engine doing the work that the previous engine refused, and innocently comes at once to the conclusion, that this desirable result is brought about by an improved system of regulation and expansion combined.

In taking leave of this subject, allow me to thank you for inserting my previous letter, and to apologise for the length of this, my last one.

I am, Sir, your obedient servant,

JOHN PINCHBECK.

27, Leadenhall-street, July 30, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—Your correspondent "Economy" has no desire to hide under a cognomen, if at all objectionable. The question is one of general interest, viz., What is the relative duty of the Corliiss engine named, working 600 ft. with 100 lb. when working as high pressure, and when, with the same total pressure, it is working condensing?

At Bury St. Edmunds has been accomplished with a non-condensing engine, we learn, with an eccentric driven slide and variable expansion, an economy which exceeds that claimed for the Corliiss engine, and beyond that of most single-cylinder Cornish engines. How is this? Perhaps some one would say, do not condense at all!

Economy begs respectfully to suggest that, in endeavouring to get the fullest duty out of steam in condensing engines, that it is better not to permit the expanded steam in the cylinder to go direct into the condenser.

During its expansion it legitimately parts with considerable heat, which apparently is annihilated, but reappears as dynamic power, viz., that of the engine. The greater the power developed, the more heat disappears. Any attempt to put this heat back is robbing Peter to pay Paul. This steam thus divested of part of its heat in fair return for power developed is not fit to be expanded into the condenser in contact with that cylinder, wherein it is expected to give out its full expansive duty above the pressure of the atmosphere.

It does not seem possible to prevent its moisture being rarified into the condenser, and thus producing partial cold; but it is practicable, I would state, and is more profitable to keep this cooling effect of the condenser away from the expansion cylinder.

Thus in an "approved form" of compound engine these evils are avoided, and the high-pressure cylinder is of a size suitable to receive the high pressure of steam, and partakes of all the favourable conditions of the Bury engine, or, if preferable, constructed with the highly commended Corliiss valve, slide-plug arrangement; the second cylinder, being of ample diameter, and placed close alongside, with the shortest ports between the same ends of cylinders, and the pistons reciprocating oppositely, except that the larger one has lead in advance in unison with the time of exit from the first cylinder, and thereby giving no back pressure.

If high speed is desirable, in this arrangement all the reciprocating and rotative parts balance their like, and thus become a part of the flywheel, which is preferable to imperfectly balancing reciprocating parts by a revolving dead weight, itself being out of balance.

Separate cylinders thus, at their own respective temperatures, should give out the full duty due from perfect expansion and complete condensation. Can the Corliiss or other equally effective non-compound engines effect all that the Bury engine does, and all that ought further to be obtained from the perfection of the condensing process?

W. E. C.

Leeds, August 14, 1867.

TO THE EDITOR OF ENGINEERING.

SIR,—With your kind permission, I will express my conviction that the bare assertions of your correspondent "Observer" have so far overshoot the mark, that, instead of putting down a really good engine, he has inadvertently done a kindness to the makers of the Corliiss engine by stirring up inquiry. Since the commencement of this discussion, I have daily heard favourable accounts of these engines. I am convinced that promoters of the Corliiss engine have only to make public the economical results obtained to largely increase their trade in the manufacturing districts of Lancashire and surrounding counties.

With reference to "Observer's" letters, I have no hesitation in expressing my conviction that, however great an authority he may be on other engineering questions, he is utterly incompetent to decide any important question relating to steam engines as employed by the textile manufactures of this country. He may be a brilliant theoretical engineer, and well up in the amount of heat generated, as he states, by throttling the steam

during its entrance into the cylinder. But we provincials have long since discarded such theories, and wish to deal with tangible theories which can be turned into 31 per cent. consols. It would be a waste of time to enumerate the thousand and one inventions which have raised this country to its position of wealth, nearly every one of which has in turn been condemned as impracticable, or as safe to die a natural death. We have never lacked a modern Janus who could read the future.

We cannot be too careful how we trust such advisers as "Observer," who never see success in any invention not of their own scheming, and my object in writing is to urge upon the users of steam power not to be blindly led by the dictums of men interested in strangling all improvements. The mill-owners of this country are wasting tens of thousands of pounds sterling annually by using both badly constructed engines and boilers, and will continue to do so so long as they believe in the impracticable nonsense flowing from the pen of "Observer." For what has he done to entitle his opinions to rank above the practical experience of other engineers? Has he carefully and calmly set to work and fully investigated the merits or demerits of the Corliss engine with a view to invest his capital? And has he devoted a large portion of his time and staked his professional character on the success of these engines, as Mr. Douglas and others have done? Which, I ask, are in a position to instruct us most on this subject—"Observer," who only treats us to empty assertions, or those engineers who invite all interested to see for themselves what has been and is now being done with these engines? Let "Observer" accept Mr. Douglas's challenge, and visit the Corliss engines now at work, and which have been running nearly night and day for over three years—a feat which very few of the modern common engines accomplish.

I myself know there are large numbers of compounded engines working at a very high rate of expansion, and yet consuming 4 lb. of coal per indicated horse power per hour. There are many condensing engines in the manufacturing districts even consuming 6 lb. of coal per indicated horse power per hour, while I know there are Corliss engines supplied with steam from similar boilers to those supplying the ordinary class of engine, which consume under 2½ lb. of coal per indicated horse power per hour. "Observer" instances a case where he says the duty obtained from a Corliss engine is less than from a pumping-engine of ordinary or common class. Now this is a fallacy, as any competent engineer who is at all conversant with the principles, construction, and working of the Corliss engine must at once admit. Let the two classes of engines change places, and it would at once be evident that the Corliss engine used the least quantity of steam for a given unit of work, and the change in the results would be accounted for by the difference in the boilers used; for, after all, the only true test of an engine is by the pressure and quantity of steam used in performing a given dynamical test, and not in the consumption of coal. The province of the engine is to distribute or apply the steam. The boiler generates the steam, and as it is a good or a bad boiler, so is it economical or wasteful. The engine may add to the waste of fuel by the imperfect manner in which the steam is admitted, distributed, and discharged.

The Corliss engine possesses every automatic qualification absolutely necessary for a perfect steam engine in the most eminent degree. Indeed, not even the Allen engine can compete with it in rapidity of action, and adaptability to the most varying load. The valves are easily worked, and there is the least volume of steam beyond the available capacity shut in for expansion when the slightest increase of motion in the governor has shut the steam valve. The separate exhaust valves allows any high rate of expansion, with the most free exhaust, so there need be no compression beyond the slight amount allowed (if any) for cushioning. It is utterly impossible to obtain the same economical distribution of steam by any system of slide-valves, either single or double, worked either by the same or separate eccentrics, stops, cams, wedge motions, &c., &c., and Mr. Daniel K. Clark gives us a very full account of double slide-valves as applied to quick engines, all of which he condemns. Double slides have been used more effectually in stationary engines, and a fine diagram obtained, but their action is very limited, and there is not at present any mode of varying the cut-off so quickly, and to such an extent, as with the Corliss valve-gear. There can be no objection to the general arrangement of the Corliss engine beyond the valve-gear. And the valves are so easily worked, being nearly perfect equilibrium valves; the gear is so light, and of steel, and very sensitive, and hitherto has not failed; while in every other class of engines we have daily disasters, many with new engines just on starting. A case of this kind came under my notice only the other day, yet the whole class to which (common engines, *vide* "Observer") this engine belongs is not to be discarded as failures. Many engines of every type give trouble, and some wear out very rapidly and have to be soon replaced, while others, even by the same makers, work to a good old age; and the same will be the case with the Corliss engines. The great stumbling-block to improvements, is the influence of old firms with enormous sums of money locked up in patterns, all or some of which must be utilised, and thus the manufacturing engineers have every inducement, as a rule, to oppose practice different to their own. Thus mill-owners and others have often very unsuitable engines supplied, varying according to the whim or rather the class of patterns his friend the engineer happens to have in stock.

I will go more into the particulars of the Corliss engine in a future letter.

I am, Sir, your obedient Servant,
Manchester, August 5, 1867. J. W.

JARROW.—It is expected that Messrs. Palmer and Co. (limited) will obtain a Government contract shortly for one or two iron-clads. The company has now a large ship on hand for Messrs. Guyon and Co., of Liverpool.

NORFOLK ESTUARY COMPANY.—It is expected that no further calls will require to be made on capital account on the shareholders in this company, as a shareholders' fund, amounting to 10,617½ of Indian 5 per cent. stock, has been formed, principally from "contributions" received in respect of improved land. By means of loans from this fund it is expected that the works remaining to be executed will be provided for.

THE DRAINAGE DISCUSSION.

TO THE EDITOR OF ENGINEERING.

SIR,—The principal objections of Mr. Gower, in his letter of August 6th, against my plan of town drainage are, if I understand them well, comprised in his doubts whether it is practical to abstract from sewage liquid the putrid elements, and whether this liquid is not still too dirty to be purified by any known filtering process, after human excreta, kitchen remnants, and the more bulky garbage are withdrawn from it; for which reason he concludes for this additional purification in favour of the irrigation process, hoping thereby also to draw some use from it.

Now I must confess that there are questions involved in these considerations very difficult for me to answer, for the reason that I, as well as he, find myself upon terra incognita. Neither he nor I know of any sewage liquid, of the class above referred to, treated with the irrigation process, as I first thought, out of his former letter, the case with him was; for the instance quoted of Bury St. Edmunds, where I am informed that the excreta of about five-eighths of the population finds its way in the sewers, will here not answer; besides, Mr. Gower seems not to know of the increase of cross-covers, the expenses incurred by pumping it 50 ft. high, by rent of land, &c. The Beddington meadows are, of course, also no case in point, for these receive the excreta of all Croydon.

In the absence, then, of known facts or personal experience in that matter, we are both reduced to speculation as to what the best mode is for dealing with such sewage liquid, and we agree, it seems, fully in the policy of abstracting all putrifying elements from it beforehand. These premises being fully understood, I doubt not but we shall finally be able to find during this discussion what, under ordinary circumstances, the best plan is by means of a fair comparison of advantages, disadvantages, possibilities, and impossibilities, and a general exchange of ideas.

Let us see. Mr. Gower thinks it difficult to withdraw the entire amount of urinous fluids, &c., from the sewers. Now, it may be difficult, but it is by no means impossible. If the great amount (for it really does amount in many towns to large volumes) of these liquids did so pass off, there is no doubt but that the irrigation process should at once, so to speak, rise in the market; for the ingredients contained in them, both mineral and organic, already in a state of solution, give them for that purpose at once a great value. But we are now discussing, not what actually occurs in badly drained towns, but what should be done to improve the present state of affairs, which, what between irrepressible sewer gases, loss of fertilisers, and taxes on the citizen, is, Heaven knows, bad enough.

So, in the first place, I advocate, as I have frequently proposed in my writings, the erection of public urinals and privy closets at far more frequent intervals in towns than now is the case. This is a necessity, not only for the sake of cleanliness and decency, but also on the score of health; for medical men attest to the injuries suffered, above all by ladies, in the absence of such conveniences, when away from home, and having to traverse large distances. Not only that they have thus often to endure much agony, but with many men, crippled, old, or strangers not knowing where to go to, the case is fully as bad. It will not do for municipal authorities to ignore this much longer. In many towns the only alternative lies between indecent exposure, a compulsory visit to some beer or gin shop, or an agony which often becomes intolerable.

There should be arranged for women and children, at frequent intervals, retiring localities, not in the middle of large streets, as here and there the disgusting practice is, but in the line of the buildings and kept under the care of a female attendant, to see to the cleanliness of the place, prevent improper intrusion, &c. The locality should be divided in two classes, one free and the other subject to a small charge for those who desire additional privacy or comfort; and both have a sufficient anteroom for adjustment of dress, &c. The building should have nothing to call obtrusive attention to it, but still be marked enough to enable it to be found easily, while the attendant should have a distinguishing dress or badge, be enrolled among the police, and be subject to its discipline and regulations.

For males, similar frequent localities should exist, with different interior arrangements, of course, but also under proper surveillance. The conveniences of each building to be connected with a pipe and valve for nightly thorough pneumatic scouring. In this manner a large amount of fertiliser, now wasted, would be collected, the streets saved from pollution, public decorum preserved, and much bodily suffering prevented. Mr. Gower will, no doubt, agree with me that this is not only possible, but would be highly useful.

Another material which now enters the sewers and should be kept out is the street dirt, composed chiefly of grind and sand, dung and urine of horses, cattle, &c. In a well-drained town the most of this collects in the street gully-traps. The best form I have seen of these is the one invented by Mr. J. Newton, C.E., and used largely in the borough of Preston. They are made of cast iron, easily set, durable, cheap, and, above all, very efficient; placed at very frequent intervals, they really collect all the solid and unsolved impurities, which can be easily taken out by the town scavengers and carried off by the same carts which remove the house rubbish, ashes, &c. Each dwelling, or household, should have a similar small gully-trap to its kitchen drain-pipe.

Much and in fact nearly all the street dirt can, however, and should be nightly taken up by large, well-constructed street sweeping-machines, discharging the *débris* in tenders or separate carts behind them, and which, when full, are exchanged for empty ones, the latter going back and forwards, following the route of the machine. I have seen some of these contrivances in the United States which did their work with almost miraculous neatness and dispatch. The compost picked up in a good manure, and its sale goes towards defraying the expenses incurred. This process is at once cheaper, more effectual, and infinitely more rapid than the manual one, no matter by how large a squad of men undertaken.

It will thus be seen that there are already known to actual successful practice contrivances whereby the houses, the privies, and the streets can be kept perfectly clean, and that thereby the sewers receive nothing but water. That this water, now

stripped of all the grosser impurities, but coming from streets, lavatories, kitchens, butcheries, factories, &c., is by no means fit to be discharged yet in rivers or harbours is evident enough. In some way, the remaining organic matter, which alone is the cause of putridity, must be withdrawn from it. I have already said, in one of my former letters, that if this be done by the irrigation process, *tant mieux*; but I doubt the possibility. In that case the crop obtained must bear out the expenses incurred. Now, except perhaps in cases where fields requiring irrigation *anyhow* can be reached by gravitation only, I do not think that it can be made to pay, seeing that even much richer fluid fails to do that; and as to the purification thereby expected, we have not only practical proof that this has never been properly accomplished, but much direct analysis to the contrary.

Hence my answer to Mr. Gower, when he first mooted the question, was that some such filtering process as that of Mr. Spencer seemed to me the best, and I stated my reasons for saying so. I may add here that the fluid, after this process, has been carefully examined by competent chemists, and been found to be perfectly pure. Instances can be read in the published accounts concerning the waterworks at Spalding, Lincolnshire, at Southport, Lancashire, at Wakefield, and even at Warley, of which the water which once retained the sewage proper, I omitted to state in my former letter, has also been tested. See also the *Lancet*, of 23rd March of this year, where the Spencer process is in a report on the subject fully approved.

With Mr. Gower's opinion that water which has been contaminated with sewage can never be made again fit to drink, &c., no matter how thoroughly purified, I cannot coincide. The word "pure" means pure, and nothing else, and pure water is always good. But water perfectly free from all organic matter, and still holding in solution a small percentage of certain minerals, is also very wholesome, and even more so than perfectly pure and rain-water. I agree, however, with Mr. Gower that this kind of purification can never be obtained by drainage over meadows.

Mr. Gower is also wrong, I think, in supposing that water, which is so impure as to be unfit for our consumption, may be without harm discharged in rivers. Surely the oxidation of the putrid elements, which are always nitrogeous compounds, goes on in them as well as in any other water, and the proceeds of this combination are in the form of gases given off to the atmosphere. If these gases become present in a certain overdose proportion, the air becomes at once a circulating medium for all sorts of sickness.

To sum up, I think there is ample evidence that, with the arrangements I have proposed, the desired cleanliness can be obtained, and the water, after usage, be discharged again in the watercourses in a really pure condition.

Let us now see the financial effect produced. Mr. Gower acknowledges excreta of sewage to have a value of 8s. 6d per head. This agrees also with Mr. Latham's reports and with the various valuations made by competent authorities. If we add to this the value of the organic matter escaping out of the sewers in the form of gases, and from the settling tanks and distributing ditches, we shall have fully again the ten shillings stated to be the value of *undiluted* and *unfermented* human fecal matters of an average head of city population, counting all ages and both sexes according to the analysis of the same authorities. That is to say, fecal matter in above condition is worth to the farmer that price for the fertilising of tillage land, it holding the same elements as ½ cwt. best Peruvian guano, and producing the same amount of increase in yield of crop.

Supposing this crop to be wheat, the increase would be 3½ bushels, worth, at 50 shillings per quarter, just 20 shillings.

By the irrigation process it appears that the diluted sewage of 120 inhabitants can produce at its best only 20L worth of hay or grass annually, whereas if the same elements had been applied according to my system the produce would be 120L worth of grain. The irrigation process, to be practical at all, necessitates low-level inundated fields close to town, with very offensive settling tanks and ditches, and, after all, does not save the rivers from pollution. By my system the whole of this combination of nuisances can be done away with, the utilisation take place on any land capable of growing food, level or hilly, high or low and situated anywhere on a route of transportation.

Under these circumstances it is not difficult to decide which plan is the best.

That distinguished agricultural chemist, Professor Way, compares diluting human excreta with water to mixing grains of gold with enormous large lumps of quartz, and says that no process is practicable whereby more than a very small part of the noble ingredient can be recovered again, and the illustrious Liebig denominates the introduction of water-closets and the so-called English sewerage system, in a sanitary and agricultural point of view, a national calamity. That there is good reason in this judgment I think is evident enough.

I am, Sir, respectfully yours,
CHARLES T. LEBNUR.

2, Royal Exchange-buildings, E.C.,
August 12, 1867.

WOOD-WORKING MACHINERY IN THE PARIS EXHIBITION.

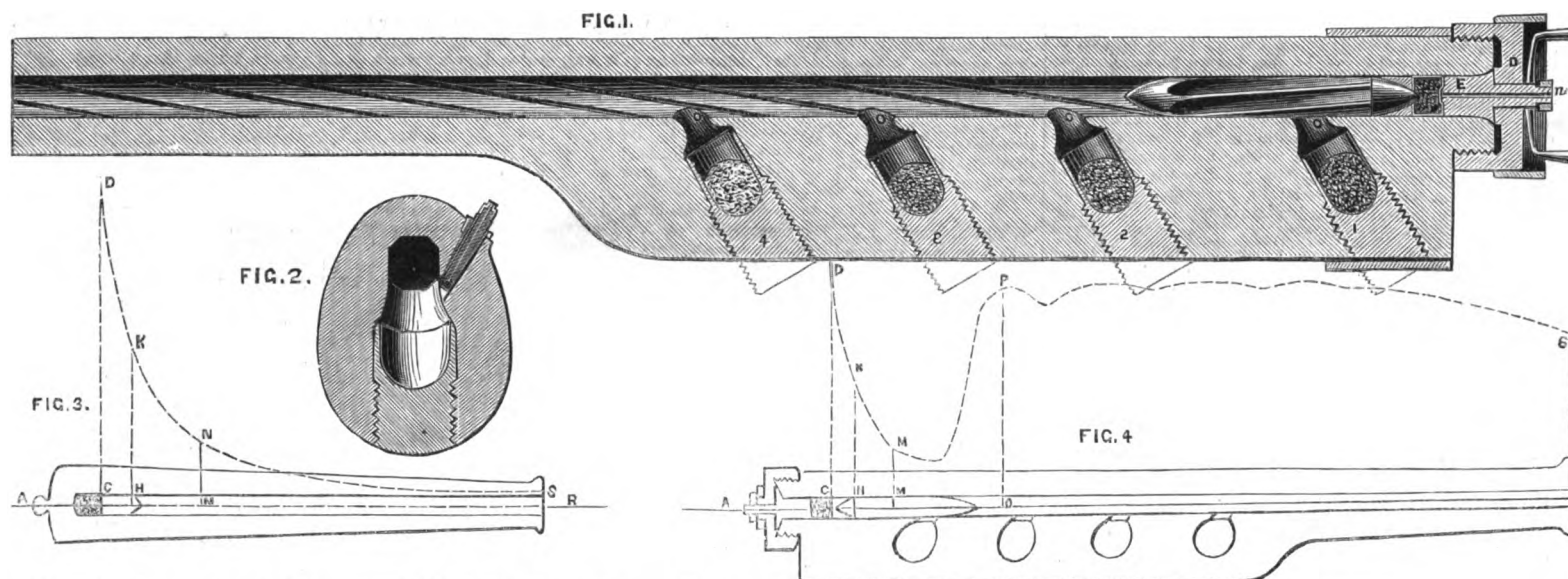
TO THE EDITOR OF ENGINEERING.

SIR,—An official report of English wood-working machinery has been published in the *Illustrated London News*, of August 3rd, in which commendation has been accorded to several exhibitors of the above description of machinery, and to which no doubt they are entitled. Without imputing any motive, I think justice has not been done me by the total omission of my name from this report, as it is to me that the only silver medal (the highest prize in this section) has been awarded. The expense and pains on my part of contributing to the English display of machinery (mine being all in motion) has, of course, been very great, and it certainly is not unnatural for me to expect to be at least mentioned in connexion with the others; and, moreover, it appears to me a very poor compliment to the jurors "to make conspicuous by its absence" the name of the recipient of the highest award.

I am, &c.,
S. WORSAM.

London, August 13, 1867.

LYMAN'S "ACCELERATOR" GUN.



MORE than ten years ago, in February, 1857, Mr. Azel S. Lyman, of New York, took out a patent for an "accelerating gun," this gun having the charge of powder partly placed in the breech, as usual, and partly distributed in a series of chambers opening to the bore at various points, the charges in these chambers being successively ignited as the projectile passed their respective openings. Mr. Lyman also proposed covering the muzzle of the gun with some elastic material, and exhausting the air from the bore so as to remove the atmospheric resistance from the shot whilst passing through the gun. A small gun was constructed on this plan, and tested at New York and elsewhere. This gun consisted of three heavy $\frac{1}{2}$ in. rifle barrels screwed together so as to form a continuous tube 9 ft. long. A small chamber holding 50 grains of powder to start the projectile was provided at the breech, and around it was an annular chamber containing 400 grains of powder. At a distance of 34 in. further forward was another chamber, containing 900 grains of powder, and beyond this again, and a distance from it of 34 in., was another chamber containing 750 grains, this last chamber being 37 in. from the muzzle. This gun was loaded with a sharp pointed steel bolt 8 in. long by $\frac{1}{2}$ in. in diameter, and weighing $6\frac{1}{2}$ oz.; and this bolt was driven by the above-mentioned charges—amounting to $4\frac{1}{2}$ oz. of powder—an average distance of $4\frac{1}{2}$ in. into laminated armour composed of $\frac{1}{2}$ in. boiler plates, and in other instances $4\frac{1}{2}$ in. into solid iron.

Subsequently some experiments were made on a gun of $2\frac{7}{8}$ in. bore constructed on Mr. Lyman's principle, and more recently Mr. Lyman has proposed the gun represented in Figs. 1 and 2 of the annexed engravings, these engravings being reproduced from a recent number of the *Scientific American*, from which journal the following particulars are also derived. The proposed gun, shown in longitudinal section in Fig. 1, and transverse section in Fig. 2, is 18 ft. long, and 6 in. bore, and weighs 33,000 lb. The shot would weigh 300 lb., and the charge of powder would be 100 or 120 lb., this charge being distributed as follows: initial or breech charge, 5 lb. of very slow "mammoth" powder; in first accelerator, 25 lb. of "mammoth"; in second accelerator, 25 or 30 lb. of No. 7 powder; in third accelerator, 25 or 30 lb. of cannon or mortar powder; and in the fourth accelerator, 25 or 30 lb. of mortar or musket powder.

The accelerator plugs, 1, 2, 3, 4, may be made of soft cast steel fitted closely in and protecting the cast iron from the fire of the powder. Instead of these steel chambers, ordinary plugs only half the diameter of the powder chambers, as shown in Fig. 4, have heretofore been used; but though no cast-iron accelerating chamber has ever failed, it is believed that a protection of half an inch of soft steel, as shown—which will keep the fire out of any defect that may exist in the cast iron—will increase its durability.

The breech-loading arrangement consists of a cap, D, which is screwed on the outside of the breech like Whitworth's; but in front of this cap is the tapered plug, E, with its stem projecting back through the cap, and with the nut, N, on its end, so that when the breech is opened the cap will make half a turn before it strikes this nut and lifts the plug from its seat, without necessarily revolving it at the same time. This greatly lessens the friction and the power required to open the breech.

The initial charge is in a metallic cartridge made heavy around the back edges, so as to insure against the possibility of any leak around the plug. It will be perceived that, though this plug is pushed back even the $\frac{1}{8}$ of an inch when the gun is fired, the space around the end of the plug next to the powder will not be perceptibly enlarged. The sabot may be made of copper or sheet brass tube, filled with paper pulp and nearly as long as the tapered end of the shot. With some forms of shot the sabot is dispensed with. The valve openings (see Fig. 2) through which the accelerators are loaded need not be over an inch in diameter for common cannon powder, but for the first accelerator, which is charged with mammoth powder, this valve should be about 2 in. in diameter. A copper cup on its end prevents windage. The valve stem projects up through the hollow screw with a cap nut on its end, which keeps out water in case of rain; and like the breech plug is so arranged that when the screw has made about half a turn, it strikes the cap and lifts the valve from its seat without revolving it, thus saving friction.

The principles upon which the construction of Mr. Lyman's gun is founded may be explained by reference to Figs. 3 and 4. Fig. 3 is a diagram from Robbins's "Principles of Gunnery," for showing the pressure applied to the ball in different parts of the

bore of the gun. He supposed the powder to be in moderate quantity and of good quality, and all converted into an elastic fluid before the shot left its seat. Let A B represent the axis of the gun. Let the perpendicular, C D, represent the pressure of the fire on the shot at the moment it leaves its seat. Then when the shot is driven forward so that the gas from the powder has doubled its bulk, the pressure is reduced to one half (on account of the cooling of the gas by expansion, it would practically be reduced far below one half, but as there was probably some powder not consumed, we will represent it as one-half), and its pressure will be represented by the perpendicular H K. When it has expanded into four times its original space, the pressure will be represented by the perpendicular, M N, and the line, D K N S, drawn through the top of all the perpendiculars representing the pressures, would be a hyperbola. Now these perpendiculars representing the pressures at the points from which they are drawn, the area of the figure, D K N S B C, would represent the power applied to the ball.

It was reflecting on this diagram and its demonstration by Robbins that first suggested the idea of an accelerating gun. Practically, with common cannon it is found that while the strain at the breech is enormous, the pressure before the shot leaves the muzzle is but little, and where the gun is long, even less than the resistance of the air which is packed before it. For this reason shortening the barrel often increases the force of the shot.

Fig. 4 shows the diagram described by an accelerator. In this we must use a small quantity, and very slow powder, at the breech for the initial charge, because we use a long, heavy shot. Then when the curve has run down considerably, and the shot is well under way, it passes over the first accelerator, containing perhaps ten times as much as the initial charge. The fire sets back, down into, and lights this, and raises the pressure or curve nearly as high as the perpendicular made by the initial charge.

When this accelerating charge is fired, instead of there being only three or four inches depth of elastic fluid in the breech to expand, there is over ten times as much, and the curve runs down less than one-tenth as fast. When it passes over the second accelerator it fires another large quantity of powder, and the curve runs down still more slowly, and the area of the figure included between this curve, the perpendiculars, C D and B S, at each end, and the axis, A B, of the gun, which area represents the power applied to the ball, may be ten or twenty times as great as in the first case, while the pressure in the barrel of the accelerator is not over one-half or three-fourths as great.

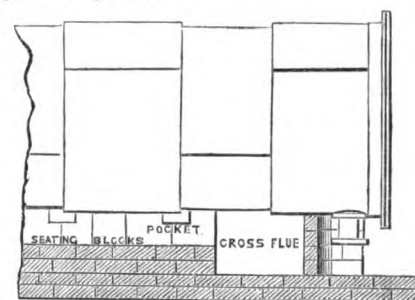
The "accelerator" of $2\frac{7}{8}$ in. bore, which has been already mentioned, was tested at the Navy Yard, Washington, with the following results:—The gun had but 4 in. depth, $\frac{3}{4}$ lb. of mammoth powder in the breech, but it had enough of the strongest cannon powder in the chambers to have filled the bore 30 in. deep. The shot was $17\frac{1}{2}$ in. or about 7 diameters long. The twist of bore, being 1 revolution in 3 ft., kept this long shot point on. The gun stood at the same port-hole that had been occupied by a Whitworth gun, in the battery 204 yards from the target, which was standing in the water. The shot passed through the 5 in. iron plate, the 18 in. of solid oak, a brace behind it about 1 ft. thick, in which it broke off a 1 in. bolt. The brace was standing at such an angle as to tend to glance the shot downward, but it went on about 100 yards. Mr. Lyman considers that no other gun would have thrown that shot that distance with the same elevation—about 304 yards with 15 min. elevation—even if the target had been out of the way. The performance was certainly an exceeding good one; but we fear that there would be many difficulties in using the accelerating gun in regular practice.

GRANTON HARBOUR, N.B.—The vacant frontage at this fine harbour, which is a formidable rival to Leith, is now nearly all taken up by an extensive saw-mill being erected upon four acres of ground by Messrs. Thomson, of Alloa. This saw-mill is placed contiguous to the splendid patent slip of the Duke of Buccleuch and the forge works of Messrs. Hawthorns and Co. The saw-mills, planing machines, &c., are to be driven by a powerful Corliss engine, by Mr. Douglas, of Kirkcaldy.

SOUTH YORKSHIRE.—The South Yorkshire iron trade continues quiet. Business at Sheffield is also dull.

BOILER-SETTING.

THE occurrence of another fatal explosion of a boiler rearing upon a mid-feather wall has led Mr. Lavington E. Fletcher, in his last monthly report to the Manchester Association for the Prevention of Steam-boiler Explosions, to urge the members of the association to discontinue the use of that dangerous mode of setting, and to adopt side walls with suitable seating-blocks instead. This latter plan is superior on many grounds. If the flues are damp, the moisture rises more readily through the mid-feather than through the side walls, as there is in most cases less height of brickwork in the former for it to travel through. Also any water that may either fall on to the boiler or leak from the seams is more liable to lodge in contact with the plates on the top of the mid-feather than on the side walls, the bearing surface of the mid-feather being at the bottom of the boiler, so that it collects all the drainage, and being horizontal, so that it retains it, while that of the side walls is inclined, and thus affords the water an opportunity of escaping. It is not thought, however, that the corrosive tendency of moisture is the only cause of the injurious effects of mid-feathers, but that it is materially promoted by mechanical action. A boiler does not "ride" so comfortably on a single longitudinal seating as when carried on two; and when the weight of a large boiler is thrown entirely on a mid-feather, a change of form frequently takes place with every change of pressure. This has been distinctly observed on the application of the hydraulic test, the internal pressure raising the boiler, while it might no doubt be seen in some cases on getting up steam. In making internal examinations of boilers set on mid-feathers, the plates at the bottom of the shell are not unfrequently seen to be flattened all the way along at the centre line, so that the mid-feather can be distinctly traced even inside the boiler. It will thus be seen that an alternate flattening movement is carried on throughout the line of the mid-feather wall on every variation of internal pressure, which tends not only to strain the ring seams of rivets and make them leak, but by its buckling action to "fatigue" the metal, and thus very much to accelerate the ravages of corrosion from moisture upon the body of the plates, so that a mid-feather wall may be said to produce a description of longitudinal "farrowing" along its bearing surface.



Boilers set on mid-feather walls should have the brickwork ploughed out at the transverse seams of rivets for purposes of inspection. Without this it is impossible to ascertain the condition of the plates, since, although they may appear perfectly sound on each side of the mid-feather wall, especially if it be a wide one, may yet be dangerously wasted in a longitudinal "farrow" all along the centre line. These openings need not be large; it will be sufficient if they are about 9 in. long by 3 in. high, and cut completely across the wall, so that if a light be held on one side they can be seen through. They need not be permanently filled up after an inspection, but merely stopped temporarily with a little fire-clay, so as to be easily reopened whenever re-examination is necessary. The pockets are shown in the annexed sketch.

In conclusion, Mr. Fletcher earnestly recommends that no boilers having a diameter of 5 ft. and upwards should be set on mid-feather walls; but if, in the case of small boilers, and under exceptional circumstances, any of these walls should still be adopted, then the boilers should rest on suitable seating-blocks instead of on bricks; while the bearing surface should not exceed an inch in width for every foot in the diameter of the boiler, and sight-holes, as explained above, should be ploughed out at each of the ring seams of rivets.

THE BRIDGE OF ST. LOUIS, PARIS.

M. GEORGES MARTIN, ENGINEER, PARIS.

(For Description, see next Page.)

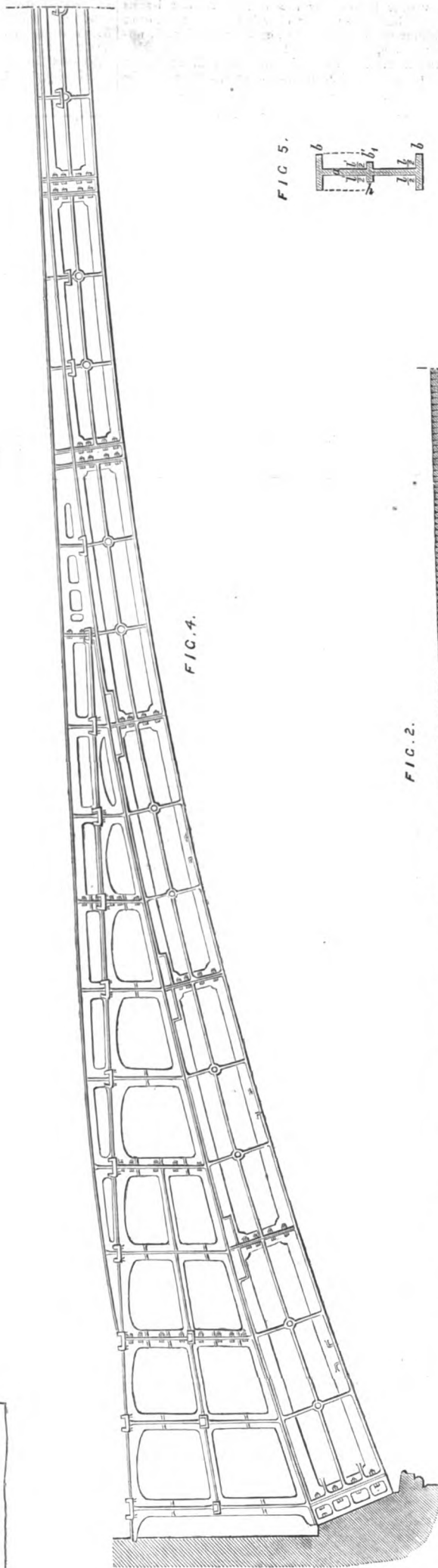
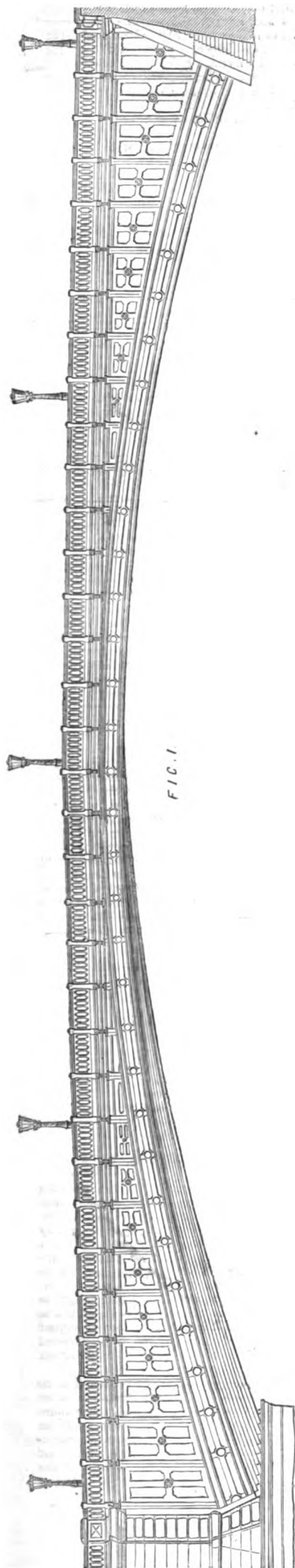
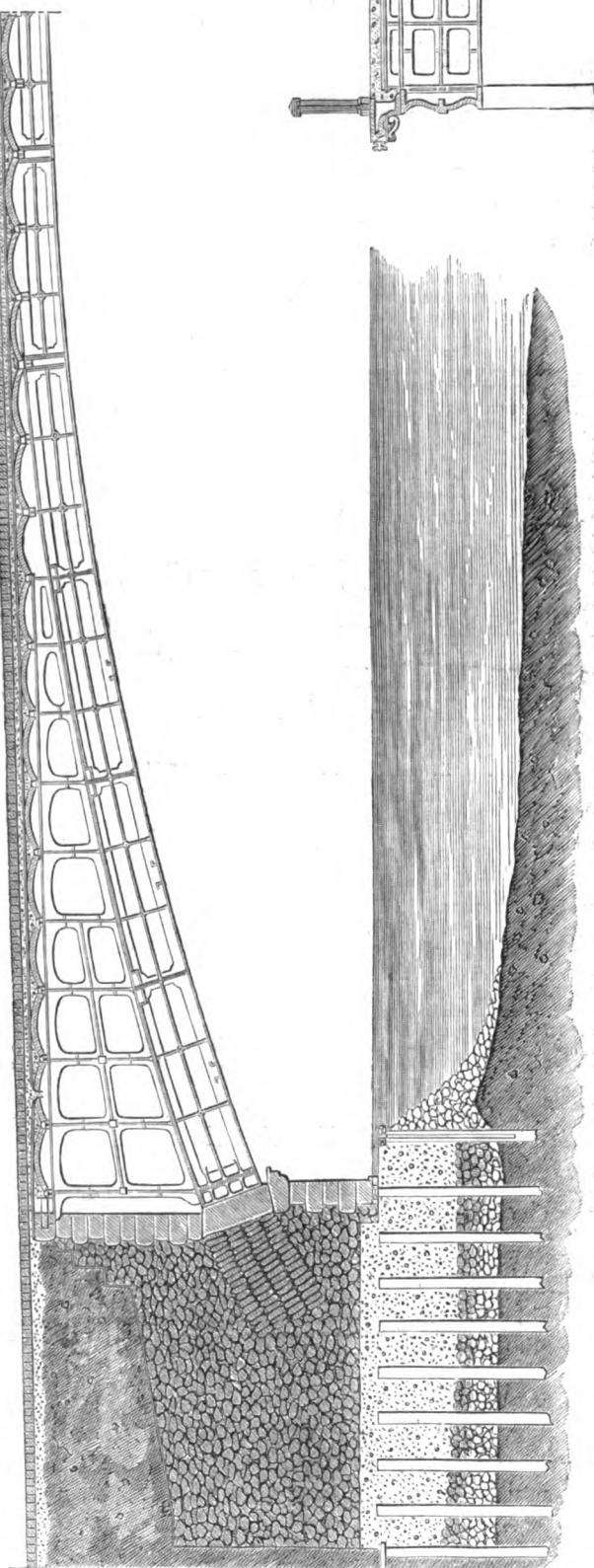
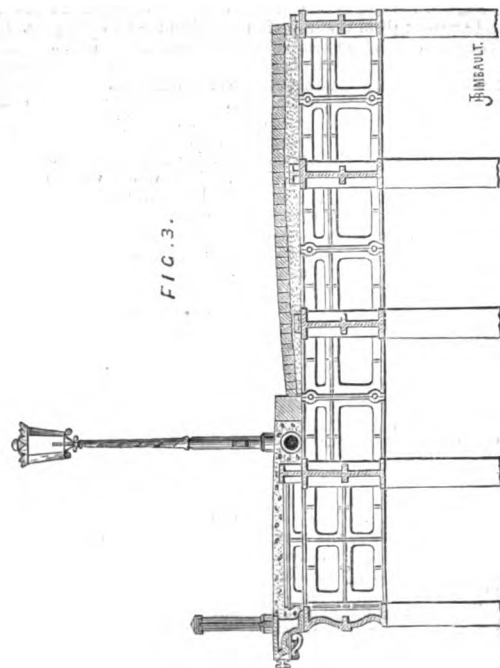


FIG. 5.



FIG. 4.

FIG. 3.



BRIDGE OF SAINT LOUIS AT PARIS.

M. GEORGES MARTIN is one of the most successful constructors of cast-iron bridges on the Continent. He has built some ninety arches of cast iron, and amongst these are some of the largest spans ever erected. At the Paris Exhibition, M. Martin shows drawings of several of his most interesting constructions, and amongst them the bridge illustrated on the previous page. It is an arch crossing an arm of the Seine river at Paris in a single span of 64 metres, or 210 ft. It is the largest cast-iron arch ever made in France, and its proportions and dimensions make it one of the boldest designs of its class. The arch is formed of nine parallel cast-iron principals connected laterally by bearers of cast iron, which distribute the load between the different arches, and prevent any undue strain from being brought upon any one of the arches or principals singly. The whole width of the bridge is 52 ft. 6 in., the distance between the parallel ribs being 6 ft. 6 in. The outer arches are ornamented in a style somewhat approaching the character of iron ornaments of the middle ages. The inner arches are plain, the metal being 2 in. thick at the ends and 1½ in. in the middle. They are of double T section, with a small central rib, as shown in Fig. 5. The depth is 8 ft. 7½ in. at the crown and 5 ft. 11 in. at the abutments, and their sections are at these two points 101½ and 126½ square inches respectively. The middle arches are of the same height at the crown as the two outer principals, but their sections at the crown and abutments are 142½ and 155 square inches respectively. The superstructure is formed of arches of hollow bricks, resting upon parallel cross-beams of cast iron 6 ft. 6 in. apart from centre to centre. These arches are made of a single ring of bricks, and have sufficient strength to support 10,000 kilogrammes on the square metre of surface, or 2043 lb. per square foot; they therefore form a very light and very strong structure. The weight of cast iron employed in the bridge is 745 tons, and there are only 10 tons of wrought iron in the entire structure. Altogether the quantity of iron is 723 kilogrammes per square metre of surface of the bridge, or 148 lb. per square foot.

The test load was 600 kilogrammes for the square metre of superficial area, and the test was made both by loading the entire bridge and also by proportionately loading alternate quarters of the arch, so as to ascertain the effect of an unequal distribution of the load. M. Georges Martin contracted for the construction of the ironwork of this bridge for the total sum of 875,000 francs, or 366.21 francs per square metre of surface. The total cost of the bridge was 684,000 francs, or 27,360 £, which was divided in the following manner:

Masonry	...	10,400 £.
Cast-iron arch	...	15,000 £.
Extras for labour, &c.	...	1,960 £.

£27,360 £.

THE CINCINNATI SUSPENSION BRIDGE.

(Continued from p. 99.)

THE weight of the main span of the Cincinnati bridge, including cables, suspenders, and stays, is nearly 1500 tons of 2000 lb. each. But not all this weight is supported by the cables. Owing to the efficiency of the trusses and girders, over 100 ft. of floor at each end may be considered as resting upon the towers. Allowing the full weight of the cables, stays, and suspenders, and including the weight of the floor for a length of 800 ft., we may reduce the above weight at least 200 tons, and assume the total weight suspended at 1300 tons. At a mean temperature of 60 degrees, the deflection of the cables is 89 ft. or 1.565 of the span. The ratio of tension due to this deflection is 1565, which makes the tension of the cables equal to $1300 \times 1.565 = 2034$ tons.

The cables contain an aggregate number of wires of 10,400 No. 9 gauge, each wire possessing an average strength of 1620 lb. The total strength of the two cables united is therefore $1620 \times 10,400 = 16,848,000$ lb. ... = 8,424 tons. To this strength we have to add the supporting power of 76 stays of a strength of 90 tons each, or ... 6,840 tons.

Aggregate strength of cables and stays ... 15,264 tons. When the greater efficiency of the short stays inside of the tangents is considered, the total strength will exceed 16,000 tons. The proportion of tension caused by the permanent weight to the ultimate supporting power of the cables and stays is therefore as

$$2034 \div 16,000, \\ 1 \div 8.$$

or nearly. When the floor is crowded from end to end with pedestrians, as is the case on every fine Sunday, this transient weight may be estimated at 900 lb. per lineal foot, which is equivalent to 30 lb. for every square foot. People may be packed closer, but then all free locomotion ceases. So long as they move promiscuously, one-half in one direction on the one side of the floor, while the other half moves on the other side, occupying roadway as well as side-walks, the above estimate is full, and will not be exceeded. Such a load, therefore, will be equal to $800 \times 900 = 720,000$ lb. ... 360 tons. Add permanent weight, ... 1300 "

Total maximum weight, ... 1660 tons. The tension of the cables resulting from this is equal to $1660 \times 1.565 = 2598$ tons.

† The ratio of tension to supporting strength is as $2598 \div 16,000 = 1 \div 6.158$. Ordinary good loads on the main span may be estimated as follows:

6 four-horse teams loaded	...	60 tons.
6 two	...	80 "
6 one	...	10 "
100 persons	...	6 "

Total ... 111 tons. Add weight of structure ... 1300 "

Total ... 1411 tons.

Tension resulting is $1411 \times 1.565 = 2208$ tons.

The ratio of this tension to the supporting strength is as $2208 \div 16,000 = 1 \div 7.246$. We therefore have about eight times the strength for the support of the permanent weight, seven times for ordinary loads, and six times for maximum loads.

One of the great causes of destruction to which frail structures are exposed on this continent are hurricanes. Ordinary heavy gales, which are of almost daily occurrence in the Ohio valley, need not be considered here, because they do not affect our bridge, neither horizontally nor vertically. But let us suppose a severe hurricane moving directly east and west, or at right angles to the line of the bridge, exerting a uniformly uplifting power of 50 lb. per square foot upon the whole lower surface of the floor. Now, assuming further that 1000 ft. of the length of the floor are thus uplifted at once, there would be a surface exposed equal to 36,000 square feet, and the uplifting force would be

$36,000 \times 50 = 180,000$ lb., or	...	900 tons.
Now the resistance opposed to this force is the weight of the floor	...	1300 tons.
Weight of cables in centre	...	100 "
Resistance of anchors in towers	...	500 "

Total resistance ... 1900 tons.

The strength of the floor is such that no breaking up in part can take place; either the whole of it will go or remain intact. It is plain that the simple weight of the structure itself will be ample to resist such a power. Nor can any considerable horizontal deflection take place, because the *cradle power* of the cables is too great, and ample means have also been applied in the floor itself to maintain its integrity and position. It is true that hurricanes will occasionally blow with a greater force than has been assumed above. But if ever such a calamity should overtake the bridge, I apprehend that but few structures in the adjoining cities would be left intact. It is highly improbable that the full force of a hurricane should ever be directed against the whole length of the floor; but if this should happen, even then the power of resistance will be equal to the shock.

To further guard against injurious oscillations which might be produced by the blow of a hurricane, eight heavy counter or check stays are anchored to the towers below the level of the lower cornice, and run up to the cables. Their sole office is to counteract any undulations which might be imparted to the cables by a severe blow. In ordinary conditions their services are not required.

For the information of those who have little or no experience in the practical working of suspension bridges, I will remark here that they must divest themselves of the idea generally taught in text-books, that the efficiency of a suspension bridge depends upon the maintenance of its equilibrium. This is a mistake. No such equilibrium need be maintained. In all systems which are subject to variable loads and to the kneading action of passing weights, a compromise must be made. A small item is to be sacrificed, while a much larger and more important one is to be secured.

One great and most important advantage of the suspension system is its *flexibility*, whether for railway or for common travel. This of course appears like a paradox, because just the opposite is taken for granted. I have never before distinctly expressed myself on this subject, but it is due to my profession that I should do so now. And for the information of young novices, I will further remark, that hereafter, whenever large spans for railway traffic are to be constructed, this view will be maintained as one of the cardinal doctrines in bridge engineering. I also take it for granted that the time is approaching when suspension railway bridges will be considered the only structures applicable for spans exceeding 250 ft.

Ever since the 18th of March, 1855, from thirty to forty trains have passed daily over the Niagara bridge. With the exception of the renewal of the timber girders, and some other wooden parts, which showed signs of decay, no part of the suspended system has ever been disturbed. The work this day is just as strong as it was on the day when the first train of cars passed over. Are twelve years more wanted to demonstrate satisfactorily the perfect (not partial) practicability of suspension railway bridges? The Niagara Bridge Company contemplates the substitution of iron for timber in the superstructure. When this is done, where is the railway bridge in this country or in Europe which, in point of economy and strength, will favourably compare with the Niagara bridge? That work does not now exist. If a rival test was to be instituted between the Niagara, the Britannia, and the Cologne bridge, to ascertain their relative efficiency in the support of heavy trains at high speeds, I should unhesitatingly expect the Niagara bridge (because of its elasticity and flexibility) to support this test without sustaining the least injury, while the tubular bridge would feel the effects of a series of rapid concussions more severely than the lattice-work at Cologne, and the latter would feel it more sensibly than the Niagara bridge. It is surprising how long preconceived notions will occupy the minds of professional men because, forsooth, high professional and popular names have dictated so and so. But facts will persist in telling their own tales. The Niagara as well as the Alleghany and Ohio bridges will remain standing proofs of the new doctrines I am here for the first time laying down—perhaps for the benefit of those professional men only, who are to come *hereafter*.

Addressing, therefore, the next generation of engineers, and not the present, I will further say, that the flexible suspended truss will be considered by competent men the only system admissible for large spans. Trusses exceeding 250 ft. designed without the suspension feature will then be condemned as professional blunders, and as an unjustifiable waste of material. This will be equally true for single spans as well as for a series of spans. Neither tube nor lattice will be known in large spans to the engineer of the future. In the place of these, strong upper chords will support the tension of wire cables, suspended on each side of triangular trusses, whose proportions are calculated less for strength than for stiffness. Horizontal stability will be insured by an efficient bracing of the upper and lower floor, and this will be so much easier accomplished since no bucking or lateral deflection can take place in the absence of powerfully compressive members.

When a train enters upon the Niagara bridge, the stays at that end are comparatively more taxed than the cables. As the

load proceeds, the cables are more taxed than the stays, and the reverse process goes on through the other half of the span. Every train produces a slight advancing wave not perceptible to the eye. Owing to its flexibility, this waving action may be repeated *ad infinitum*, without any injury to the structure. Without the stays this flexibility would be too great. Owing to the far-reaching effect of the stays, in conjunction with the stiffness of the trusses and girders, and also the stiffness of the cables, the deflection caused by passing loads is reduced to such an extent that the natural elasticity of the materials composing the floor is ample to meet it, no matter how often this action may be repeated. To attempt a degree of rigidity equal to that of a tube would be a step in the wrong direction; it would be a positive injury. The structure would then suffer more from its unyielding stiffness than it now does from its flexibility, because of the forcible contraction and expansion in consequence of variations of temperature, and because of its exposure to severe gales and hurricanes, it might be bent and twisted without being able to recover.

Tubular as well as lattice and other iron truss bridges are subject to short concussions and vibrations, caused by the passage of trains and other loads. No such action can be noticed, neither in the Niagara bridge nor in the Alleghany or Ohio bridge. By the elastic nature of the cables, stays, trusses, and girders, concussions are rendered harmless; they cannot affect locally, neither can they be translated or transmitted through the whole work.

A single wire suspended between two posts will transmit vibrations readily and distinctly. So will a number of wires suspended alongside of each other in parallel positions, without touching each other. Each wire, when struck, will readily repeat its successive waves, visible to the eye. Now, while these oscillations are going on repeating themselves, throw a string around the wires in the centre of the curve, and collect them into one bundle, and notice how much this will interfere with the transmission of waves. The more these ties are multiplied, the more will the effects of the vibrations be destroyed, *because the solidity of the wires is interrupted*. Now this simple experiment illustrates exactly the effects of vibrations upon a wire cable or wire rope. Vibrations which will readily repeat and transmit themselves in a single solid wire or rod will lose their force in a *bundle* of wires or rods. While the reverberatory effects of the concussions of a train moving through a solid tube are not only deafening to the ear, but destructive to the metal, they are neutralised and rendered harmless on the Niagara bridge. The reverberatory effects of a train moving at the rate of ten miles per hour over that bridge are as little observed as those resulting from the ordinary speed of five miles per hour.

It is due to the stockholders of the Ohio bridge, who have honoured me with their confidence, and have entrusted me with their capital, that I should state my views more fully respecting the durability of their work. Myself being a large shareholder, but without any further interests in the value of property of the adjoining cities, I am equally, if not more concerned, in this question. With reference to simple strength, it is evident that ample provisions have been made. The fact that for the ordinary duties of the bridge seven times the strength has been provided ought to be a sufficient guarantee for its future unimpaired stability. Indeed, it would appear that all further explanations on this head are superfluous. But certain popular notions about *vibration, granulation, and crystallisation*, and other occult and mysterious changes to which iron is *supposed* to be subjected, are so prevalent, and have become so misty in the public mind, that I consider it of the greatest importance in this report to state my views clearly on this subject. I have done so on a former occasion, in my last report on the condition of the Niagara bridge in 1860. And as I have had no occasion whatever to change my views since, I shall in part have to repeat here what I said then.

Two kinds of changes are known which may affect the strength of iron and of all other metals. One of these changes results from oxidation, and is well understood. The other change appears to be caused by a molecular action which impairs cohesion, and consequently the strength of the metal.

So far as oxidation is concerned, all the iron parts of the bridge, except the anchorage, are open to inspection, and may be painted from time to time. The wires composing the cables are well protected by varnish, and so closely and compactly compressed, that all interstices are filled with linseed oil. This protection is further increased by the outside wrapping, so that no apprehension need be entertained on that score. On taking apart the cables of the Suspension Aqueduct at Pittsburgh, after seventeen years' exposure, and the effect of tripping water, leaking from the trunk, and with little or no care bestowed upon them, the wires inside were found just as free from rust as on the day they were put in. A well manufactured cable may be considered as perfectly free from all danger of rusting. Concerning the safety of the anchor chains, enough has been said in a former chapter.

The other change to which iron and in fact all metals are liable has been investigated by many distinguished men of science. Such philosophers as Arago have made elaborate reports on this question, on the occasion of a severe accident on the Versailles railway, caused by the breaking of an axle. And yet this subject appears to be still open to further researches and experiments. No definite conclusions have been arrived at. On the contrary, the longer the question remains unsolved, the greater appears to be the mystery in which it is apparently shrouded.

All molecular forces are transmitted by waves, vibrations, or undulations. A telegraphic message is communicated over a wire by virtue of the molecular waves, which propel each other from end to end. The electro-magnetic force, applied to the wire in Cincinnati is almost instantaneously responded to at the other end in Pittsburgh or New York, in consequence of these molecular affections. The application of such a force involves a molecular change in the condition of the iron. What the true nature of these invisible conditions is remains a mystery. We know the outer manifestation of the force, while its inner nature remains hidden to the human sense. The light of the sun is transmitted to the planets by vibrations, communicated through the medium of the ether which fills planetary space, and the sonorous sounds of a bell travel by vibra-

tions through the medium of the air. The web of nature's life is woven and unwoven by invisible undulations; without these motions nature would be a blank. Even in death they continue, because death involves only another kind of motion, which is chemical action.

It is currently believed that suspension bridges are exposed to great vibrations, and that these vibrations have a tendency to crystallise or to granulate (as some prefer) the wire, and that by this process its strength will be gradually destroyed. Now, the fact that the strength of iron, or any other metal, may be impaired by repeated vibrations and concussions is so well established that no further arguments are needed to prove it. A bell may be readily broken by repeated concussions. A piano wire, although made of the best and strongest material which is known in the arts, may be broken by repeated vibrations under tension. Good steel springs may be used and abused many years, but will break at last from the same cause. Railway axles, particularly those of a coarse, crystallised texture, are easily broken by continual vibration and concussion. And so on through the whole chapter of accidents and failures which may occur, when iron or steel is exposed to extreme vibration under tension or torsion.

This subject has engaged my attention for many years. I have made numerous experiments myself, and have continued them for years, and I also know the experiments of others. I have likewise collected an interesting number of specimens of iron and steel, which have been exposed to all sorts of vibrations, and under the most various conditions. My aim was to discover whether iron will crystallise or not under the influence of vibration and tension. But to this day I have uniformly failed in this attempt. With or without the microscope, I have been unable to discern one single crystal which had formed under the influence of tension, torsion, and vibration. When a drop of oxalic acid is placed upon a glass plate and examined under the microscope, evaporation, and, in consequence, crystallisation, at once takes place, in beautiful lines, shooting out in all directions. Here is rendered visible a formative process, because crystallisation is but the first attempt of nature at organisation. The same process may be observed in the formation of the crystals of ice, or in the crystallisation of any chemical solution.

We must bear in mind that crystallisation is not a process of disintegration, but of formation, a step forward in the endeavour of nature to advance the condition of matter. I maintain that in no single instance has the crystallisation of iron or any other metal been proved, as resulting from vibration, torsion, or tension. Vibrations and other violent mechanical actions are processes which have a tendency to disintegrate, to destroy, to loosen, but they have no tendency to form geometrically or to organise. The simple shaking of a chemical solution may promote crystallisation, but this fact is no objection to my argument.

On the breaking of a bar of iron an apparently crystallised fracture may be discovered. But this appearance is only appearance, and nothing more. There are no crystals. The reflecting and shining metallic surfaces of the lacerated particles of iron which have been forcibly broken or torn apart appear like crystals without being crystals. Any bar of iron may experimentally be broken in such a manner as to exhibit a crystalline fracture, and again so as to show nothing but fibre. But why is it that a fine uniform steel cannot be broken so as to exhibit crystals? Because it is a purer metal, more granular, less laminated, and more homogeneous and uniform in its texture than wrought iron. On the other hand, tough, fibrous, laminar wrought iron, on being broken, will display shining surfaces, because they are forcibly drawn out and exposed by the rupture. Crystallographers have never succeeded yet in the measurement of those supposed crystals, and I expect they never will, simply because they exist only in imagination, but not in reality.

As this subject is one of great importance, and has a considerable scientific interest, I will, in order to guard against misapprehensions, explain further.

Wrought iron forms an alloy of pure iron, mixed with carbon and other elements. A certain quantity of impurities in the shape of good cinder appears to be necessary to impart strength and cohesion to this metal, and also to make it malleable, and to give it welding properties. The purer and denser the iron, the higher its welding heat; the impure and soft qualities require less. During the process of puddling, as well as blooming, the melted pig iron is mixed with cinder, and this mixing, which promotes adhesion, prevents the formation of crystals, which is the tendency of pure iron in a molten state. The puddled ball or bloom is a mixture of crystals of iron and of carbon and cinder. The subsequent squeezing, shingling, hammering, or rolling has the effect to condense, laminate, reduce, and elongate these metallic crystals, at the same time removing and squeezing out any superabundant cinder that may remain inside. The longer this process of hammering and rolling is continued, the more will the particles of pure iron be incorporated and consolidated with the cinder, and, thus combined, they will be drawn out, flattened, and elongated. By the rolling process fibre is formed, the hammer makes it more granular and solid.

After all these processes have been gone through, what has become of the original crystals which were formed in the puddling furnace under the influence of a melting heat? Is it possible that any sensible man, on reflection, can look for crystals in a bar of iron thus treated?

An entirely different condition of things takes place in a large forging, which remains highly heated for a great length of time, and whose centre may not be influenced by the mechanical action of a hammer. In this case the original fibrous bar, exposed to a long continuous heat, without being compressed by mechanical force, may undergo an entire change. Under the influence of heat, crystallisation may then take place. I do not deny this, but I doubt it, because the loss of fibrous appearance and the coarse condition of the inner part of a large sagot may be principally owing to the destruction of the cinder.

All wrought iron is a composition of laminæ and threads of pure iron, enveloped and shrouded by films of cinder. The more the iron and cinder are compressed and worked, interlaced and incorporated, the greater will be its cohesion. But the cohesion between the cinder and iron once destroyed, and its strength is

gone. Now keeping this process in view, it becomes plain why cohesion should be destroyed by an exposure to continuous vibration and concussion, under torsion or tension. There is no mystery whatever about this; it is a simple mechanical process. All cohesion may be destroyed by such action. The rupture of a bar of iron or steel, therefore, will take place because of the forces applied to weaken the cohesion of the particles, and not because these particles have become crystallised.

But whilst the fact is acknowledged, that iron may be fractured when exposed to great vibration, tension, and torsion another fact is equally well understood; the same material when exposed to moderate tension, with very slight or no vibration, will endure and be safe an indefinite length of time. Long experience has proved beyond any shadow of doubt, that good iron, if not exposed to a tension exceeding one-fifth of its ultimate strength, and not subjected to strong vibration or torsion, may be depended upon for one thousand years. Proofs of this kind are furnished by the iron fastenings which in former ages were put into roof trusses erected over some of the oldest Christian churches still preserved.

What in this connexion may be said of bar iron applies with still greater force to wire. This material, in consequence of the manufacturing process which it undergoes, acquires a maximum strength. Bar iron of 1 to 1½ in. square section, fit to make the best quality of wire, should bear at the rate of 60,000 lb. per square inch. But this same bar, when reduced to No. 9 wire, if well treated, will bear at the rate of 100,000 lb. per square inch; and when drawn to No. 20, its strength will be increased 20,000 to 30,000 lb. more, equal to common steel. Not only can this be accomplished experimentally, with a few select bars, but hundreds of tons may thus be supplied. It is also important to know that this great increase of strength is not ephemeral or passing away. On the contrary, it is enduring and lasting provided its power of strength is not overtaxed. In some of my former reports I have cited proofs of this durability, but I cannot repeat them here without swelling this paper unnecessarily.

Within the reach of the engineer no material can be found superior to good iron wire. Steel wire, it is true, possesses greater strength, but its manufacture is not yet sufficiently perfected to insure entire uniformity, such as can be had in iron wire. The time however will come when the same uniformity will be obtained. In making this statement I wish it to be understood that it does not apply to specimen trials, but to experience on a large scale. I am aware that steel wire is now manufactured which bears 300,000 lb. per square inch, but I have not been able yet to obtain from any source as much as one-half ton of such uniformity as I consider necessary and essential for the manufacture of good wire ropes and wire cables.

Social, Financial, and Commercial Question.

Bridging our western rivers is one of the great means of facilitating intercourse, commercially, as well as socially and politically. Bridging the Ohio between Cincinnati and Covington means to amalgamate the two communities into one, in sentiment as well as interest. The same relations will spring up here which now exist between New York and Brooklyn. The latter city constitutes a huge boarding-house, a healthy and delightful place of retirement and repose for the busy merchant of New York. The more facilities are offered to the mercantile and industrial population of Cincinnati, the cheaper and more pleasantly people will be accommodated, the more will that population flourish and increase.

On the 27th of May, 1857, after the completion of the foundations, I submitted to the Board my estimate of the probable cost of the bridge according to the designs which had been approved in the previous year. The amount of this estimate was \$1,136,209, based upon a wooden superstructure. The actual cost of construction, not including real estate, will be nearly one and one-half millions of dollars. Including real estate, taxes, interest, and discount on bonds, the aggregate expenditures will probably reach the sum of one million and eight hundred thousand, which embraces all the old stock paid in, amounting to about \$300,000. Considering the enormous advance in the rate of wages and in the prices of materials, also the greater cost of an iron over a wooden superstructure, the excess of the actual cost over the original estimate is easily accounted for. In 1857 we contracted for Buena Vista free-stone at the rate of 22 cents per cubic foot; in 1866, we had to pay 45 cents. The rates of common labour, stone-cutting, and the wages of masons have more than doubled. With these facts before us, we may congratulate ourselves that the work has cost no more.

Engineering and Superintendence.

When the foundations were commenced in 1856, I was assisted by Mr. A. G. Gower, civil engineer, whose connexion with the work continued until the year 1863, when he resigned. The services of Mr. George W. Fulton, civil engineer, were subsequently engaged to superintend the laying of the Covington anchorage, and the continuation of the masonry of the tower on that side during the year 1864. My eldest son, Col. Wash. A. Roebling, after a four years' service in the Army of the Potomac, was then engaged as my assistant, and he has taken a very active share in its superintendence ever since. As engineer-in-chief, I owe to all these gentlemen an acknowledgment for their valuable and faithful services. Without able and willing co-operation, no work of magnitude can be executed, and it gives me great pleasure here to testify to the efficient aid which these gentlemen have rendered with such cordiality and professional devotion.

Mr. T. Walthal, of Covington, had, as master carpenter, charge of the carpenter work during the laying of the foundations.

In 1857 the masonry of the towers was carried forward by the contracting firm of Messrs. Mattoon, Dawson, and Messer. On resuming work in 1863, no satisfactory arrangement could be made for prosecuting it by contract, and it was therefore decided to lay the masonry by the day under our own supervision. The company has reason to be satisfied with this course, which, indeed, was the only one left to pursue. The masonry has, in my opinion, cost less than it would have cost had the laying been done by contract. No contractors made acceptable offers, because none had experience in such work, to carry up heavy

masonry such a great height. We were, therefore, obliged to put up all the requisite machinery for hoisting and laying ourselves; but this once done and the rest was easy to accomplish. Instead of paying large profits to contractors, and transferring the responsibility of the work to other hands, we concluded on doing the laying by the day. The stone-cutting was, of course, done in contract, or by the foot, and all the materials were delivered by contract. This course of management enabled us to prosecute the work just as we wanted, and to do justice to the quality of masonry, with a due regard to economy.

The Buena Vista sandstone consumed in 1857 was delivered by Messrs. H. Worthington and Co. On resuming work in 1863, a contract was made with Mr. J. M. Mueller, who supplied the great bulk of this material. Large quantities of limestone were consumed for backing, both in the towers and anchor masonry, and these were delivered by Mr. George A. Smith, from the North Vernon quarries in Indiana.

The stone-cutting on the Cincinnati side was superintended by Mr. Adam Hoplar, and by Mr. Charles Ware on the Covington side. As superintendents of masonry the following gentlemen have served at various times and on different portions of the work:

Mr. John Knox, Mr. A. Gilmore, Mr. Charles Gillespie, Mr. A. H. Acken, Mr. George Tudd, Mr. John Bell, Mr. John Maloy.

The carpenter work of the superstructure has been superintended by Mr. F. Farrington; the wire shop was in charge of Mr. D. S. Rhule; the machine and blacksmith's shops in charge of Mr. William Apperly.

To all these gentlemen I hereby express, on the part of the Bridge Company, my sincere acknowledgment for faithful services rendered during the execution of the work.

Table of Quantities.

Main span from centre to centre of towers	1057 ft.
Side spans from abutment to centre of tower	281 "
Total length between abutments	1619 "
Elevation of floor above low water at tower	91 "
" " of Front-street, Cincinnati approach	103 "
" " of Second " Covington	60 "
Ascent of Cincinnati approach in 100 ft.	71 "
Length of Cincinnati approach from Front-street to abutment	5 "
Length of Covington approach from Second-street to abutment	841 "
Total length, including approaches	292 "
Number of cables	2252 "
Diameter of each	2 "
No. 9 wires in each cable	121 in.
" " both cables	5200 "
Average strength of one wire	10,400 "
Ultimate strength of one cable	1620 lb.
" " of both cables	4212 tns.
Number of stays in main span	8424 "
Strength of each	76 "
Aggregate strength of stays	90 tns.
United strength of cables and stays	6840 "
Weight of main span between towers	15,264 "
" " as far as supported by cables	1500 "
Deflection of cables in main span	1300 "
Permanent tension to strength	89 ft.
Ordinary working tension to strength	1-8 "
Maximum tension to strength	1-7 "
Section of each anchor chain in square inches	1-6 "
" two	190 "
Ultimate strength of two chains	880 "
Elevation of anchor plates above low water	9500 tns.
Greatest weight resting upon the foundation of each tower	25 ft.
Area of each foundation	32,000 tns.
Pressure upon each superficial foot	8250 s.ft.
Cubic content of masonry of each tower	3.88 tns.
	400,000 ft.

THE METROPOLITAN AND ST. JOHN'S WOOD LOCOMOTIVES.

SIR,—Permit me to call your attention to an error in your article of the 20th July, on "Locomotives for the St. John's Wood Railway," which I have just read.

The condensing apparatus and fittings of the tanks of these engines are precisely the same as those which were fixed by Messrs. Beyer, Peacock and Co., after a series of experiments, on the first engines constructed by them for the Metropolitan Railway, previous to their leaving their works.

The apparatus has from the first worked so perfectly that it has not been found necessary to make any alteration in the subsequent engines.

I beg leave to add that it is intended to fix the maximum steam pressure in the boilers at 140 lb., in place of 130 lb. as stated.

Yours truly,
Chapel-street-works,
Edgeware-road, N.W., August 12, 1867.
ROBERT H. BURNETT.

THE FLOATING DOCK AT ST. THOMAS'S.—Telegrams have been received from St. Thomas's, dated July 20th, communicating intelligence of the sinking of the St. Thomas's new iron graving floating dock. An attempt was being made to dock the Royal West India mail steamer Wye, when by some unexplained cause the dock filled and went down in 33 ft. of water. Her top-sides are just visible above water, and unless assistance is sent from England it is apprehended the dock will become a wreck.

COATING ARMOUR-PLATED VESSELS.—The Lords of the Admiralty have invited the principal shipbuilding firms in the United Kingdom to send in tenders for the construction of an armour-plated iron ship of about 2300 tons. This vessel is to be supplied with twin-screws, and her bottom is to be sheathed with wood, which is to be coppered.—Army and Navy Gazette.