

EAST INDIA STEEL AND IRON COMPANY.—II.

In 1849, sixteen years after this company commenced operations, there had been no surplus profits from their works, and not a rupee had been paid of either principal or interest of the large sums advanced by Government, and which by that date had amounted to 822,240 rupees. Seeing how hopeless was the prospect of ever getting repayment of the moneys already advanced, in June 1853 the East India Company accepted a cash payment of 10,000*l.* down in lieu of all claims; and, in consideration thereof, new leases for thirty years were granted, to a new company, of the districts held by the old iron company, with provisions for securing the due working of the iron ores on an enlarged scale.

In 1859, the company was in possession of four sets of works, viz., at Porto Novo, Beypoor, Poolamputtee, and Trinomalee. Mr. W. Sowerby, C.E., who visited these works about the date stated above, remarked of them as follows: "The Porto Novo works have been and must continue to be a losing concern, though ever so well managed. They are too far from any place to be easy of access; the iron-stone has to be brought from many miles in the interior of the country. The charcoal was once obtainable round Porto Novo, but it has been all cleared away, and the ground cultivated, and the charcoal is now brought from a distance of twenty-five miles. Shells are, I believe, used as flux. There are three very old, badly built, and ill-designed blast furnaces at Porto Novo—all in a very dilapidated state, and none of them at work during the time of my visit; but they were being repaired. There was formerly a forge-work, but all the machinery has been taken out; there is not in either shape of the furnace, or the plan of the work, anything worthy of a single sketch. The works have been, from first to last, used for turning out castings required in the Presidency, and a portion of pig has been sent to England to be converted into steel. A large quantity of it was used in the construction of the Britannia Tubular Bridge and the Menai Bridge. The iron is very good, and would always command a good price, were the supply regular; but it arrives in England by piecemeal, and is not, therefore, valued at its full value."

Great expectations had been entertained regarding the Beypoor works, and great expense incurred in sending out steam machinery and rolling-mills, but all to no purpose, as the whole of the machinery was afterwards put up for sale. Why they failed it would be difficult to say. According to some statements, it was want of fuel, supplies having had to be brought from Ceylon in vessels; but, according to Colonel Cotton, wood was very abundant there, but there were no roads to take it along to the works. Certain German workmen, who had been taken out from Styria to Beypoor, stated that it was too hot for them to work, and it was impossible to get naked savages to do such works as puddling, who, if left by themselves for only a few moments, neglected the furnace, and all went wrong, and, not unfrequently, they would fall asleep in front of the furnace.

The Trinomalee works consisted, at the date to which we are now alluding, of one blast furnace similar to the one described below, but using cold blast.

The blast-furnaces at Poolamputtee is situated on the river Cauvery, about thirty-five miles north-west of Salem, and was commenced about the year 1857, and is of the following dimensions: height, 35 ft.; height of dam, 19 in.; height of tuyeres, 21½ in.; height of hearth, 5 ft.; from top of hearth to boshes, 4 ft.; from top of boshes to top of furnace, 26 ft.; width at top, 3 ft.; width of boshes, 5 ft. 6 in., and width of hearth, 2 ft. The waste heat is conveyed under the boilers, and is nearly sufficient to heat them. There are three boilers, two always in use and an extra one in case of accidents. The engine is about 20 horse power. The blast apparatus is complicated and bad; there are two small oscillating blowing cylinders on a patent principle, having, instead of valves, a cylinder working within a cylinder, and the air passing out at the joint pipes, where it escapes considerably. The diameter of the cylinders is 2 ft. 6 in., and 2 ft. 6 in. length of stroke; they make 60 strokes per minute, giving 2900 cubic feet of air. The pressure of blast is 2½ lb. per square inch, which amount of pressure is absolutely necessary owing to the refractory character of the iron ore. The blast is heated to a degree sufficient to melt lead, and this is done in a separate stove by means of the small waste charcoal which accumulates on the works.

In the International Exhibition of 1862, this company exhibited specimens of its ores, and manufactured iron and steel, which possessed considerable interest.

In the present Paris Exhibition, however, the name of the company is not to be found, and so little do we now hear relating to its proceedings, that it is, with us, almost a question whether it yet survives. Chequered though its struggling existence has been, it has nevertheless managed to maintain a sort of vitality to a greater degree than some others which have started for like purposes in other parts of India, and to which we shall, at some future time, refer. We will not now stop to inquire as to the causes of such lamentable failures in attempting to establish ironworks in India; but may premise that the want of communications has, in every such case, been the principal obstacle to success.

ELECTRIC-DISTANCE METER.

THE collection of articles sent to the Paris Exhibition by the Austrian War Office contains an ingenious apparatus, invented by M. C. Cociczka, captain in the corps of engineers, for measuring the distances and indicating the movements of distant objects. This apparatus requires two points of observation placed at a certain measured distance from each other, and connected by a telegraph wire. At each of these stations a telescope is used for observing the object in view, and below the telescope a small table is placed in one of the stations, representing the map of the space in front of the observer. At one fixed point upon the table exactly below the axis of the telescope there is a long thin needle balanced upon a point, and connected to the telescope, so as to follow all movements of the latter and to be always parallel to its line of sight. Besides this, a second needle, which turns round a point which represents the second point of observation upon the small map, is placed upon the table, and this second needle is connected with the telescope of the other station by an electric arrangement. The movement of the distant telescope is made to cause this needle to turn to an equal angle with itself, in a somewhat similar manner to the magnetic needles of the electric telegraph. The distance between the centres of the two needles on the paper being made to scale, so as to represent the measured distance of the two places of observation, it follows that the position of the two needles will indicate the two lines of sight of the two telescopes both fixed upon the same distant object, and the point where the two needles cross each other (one of the needles being slightly below the other) will correspond to the exact position of the distant object. If the latter is in motion, and the two observers follow its movements so as to keep it constantly in sight, the two needles will constantly change their position, and their point of intersection will make the same movements upon the map, on a small scale, as the distant object makes in reality; the movements of the object and those of the point of intersection of the two needles being simultaneous. For purposes of warfare there are several applications of this instrument, which will readily suggest themselves; but similar instruments may be used with advantage for purposes of general surveys of land, and for similar operations where they are not unlikely to effect some considerable saving of time, if properly employed.

BESSEMER STEEL BOILER PLATES.

WE have before us a large photograph of one of the steel boilers to which we referred, May 17th last (vol. iii., p. 515), as giving way under a hydraulic test. This was some years ago, before proper attention had been given to the testing and selection of steel. One of the longitudinal seams gave way, the steel cracking between the rivet-holes. The next plate broke clean across through the solid, almost as short as glass; another cracked nearly across diagonally, and another for about 3 ft. circumferentially. The failure was most complete, and the makers of the boilers, who had made them to specification, and without taking any responsibility for the quality of the steel, lost no time in sending out a private circular to their friends warning them against steel boilers generally.

Hundreds of large steel boilers have, however, been since made and tested, and are now under steam, giving every satisfaction. And when we say steel, we mean Bessemer steel, which is now sold at the price of Lowmoor iron. We published the tests of Messrs. Charles Cammell and Co.'s plates, of both Bessemer and crucible steel, on page 519 of our last volume. The forge test (hot) for all Bessemer plates 1 in. thick and under is to bend 180°, either with or across the grain without cracking. Tested cold, the ½ in. plates are to bend 80° with the grain and 60° across the grain. The tensile strength of the steel to stand this test is 33 tons per square inch, or about one-half more than

that of Lowmoor iron. If the steel be made much stronger, it is correspondingly harder, and is apt to be brittle, whereas the 33-ton steel has none of the brittleness ordinarily associated with our ideas of steel.

Among the various makers of Bessemer steel plates, the Bolton Steel and Iron Company have gained a good name for the strength and toughness of their work. We saw at Bolton, this week, great numbers of tested samples, all of which had been bent much beyond the Admiralty requirement without the least sign of cracking. From every plate made the edges are sheared and tested, and cracking is hardly ever known. We saw a long shearing from a ½ in. plate, the width of the shearing being but ¼ in., the plate having been first sheared ½ in. too long. This was a surprising test, for the steel was as sound as if it had been planed to the same thickness.

It is admitted that the punch induces brittleness in steel plates, and it would be better were the drill used for all rivet holes. The full strength of the steel is restored, however, after punching, by annealing, and at the works of Messrs. Hick, Hargreaves and Co., of Bolton, who make many steel boilers, every plate is annealed along the edges after punching. Steel is used not only for the shell of the boiler, but for the flues as well, and indeed many steel flues are made for iron boilers. As at Messrs. Cammell and Co.'s works, so at those of the Bolton Iron and Steel Company, nearly all the boilers are of steel made on the premises. Mr. Webb, of the Bolton Company, and who is so well known as having been for a long time the principal assistant of Mr. Ramsbottom, at Crewe, has all his boilers double rivetted on all seams, the diameter and pitch of the rivets being somewhat less than for iron, the plates being correspondingly thinner. Besides the tests of the plates, all steel boilers are tested when made, and their superiority in strength over iron is such that in all first-class work it is certain that steel boilers must become the rule and iron the exception. Steel has a further advantage, also, over iron in being less liable to corrosion, a source of danger furnishing about forty cases every month to the inspectors of the Manchester Boiler Association, and which is the cause of a large proportion of the annual number of boiler explosions.

THE HUDSON-BISSELL BOGIE.

TO THE EDITOR OF ENGINEERING.

SIR,—I find in your journal, under date of July 12th, an article on the Hudson-Bissell bogie, in which you state that the introduction of the radius links leaves the truck in exactly the condition of Mr. Wm. Adams's truck, as employed by him on the North London Railway. If you examine the drawings, you will see that you are mistaken. The radius bar has only a limited play, so as to permit the truck to swivel on its own centre sufficiently to allow both the front and rear wheels of the truck to equally adjust themselves to the track, but no more. In this respect it differs from the Adams truck, as well as from the ordinary truck, and in this difference consists its chief merit. In case of an engine leaving the line, the radius bar, having limited freedom, prevents the truck swivelling so far as to carry all the wheels of the track off the rails before the engine can be stopped, thus preventing the serious damage which is sure to take place when an engine with an ordinary truck leaves the rails, as the check-chains generally break, and the truck swivels round at right angles to the track; and when this occurs serious damage results both to the engine and to the train. I have known of many such accidents. It is well known that the Smith swing truck (which is a modification of the Bissell truck) was originally made without radius bars, and that Bissell trucks have frequently been so made and used here; this was long before Mr. Wm. Adams's truck was brought out in England. The want of freedom of the Bissell truck on its own centre (when a fixed rear centre was used), and the absence of safety when the truck was used without a rear centre, led to the adoption of my device of limited freedom; we sometimes obtain the limited freedom by slotting the rear centre bar, in place of using a radius bar. Experiments were tried here, on the Central Railroad of New Jersey, to test the safety of the Bissell trucks by placing bars of iron and other obstructions diagonally across, the track, and running the engine over them, the result showing very conclusively the value of a rear centre, as the wheels landed on the rails every time, as if nothing had been in the way. I may name another case, showing more strongly the utility of a rear centre; it took place on one of our western roads.

An engine and train came one night into the station, and it was discovered that the engine truck had only three wheels, one of the front wheels having been lost on the road without the knowledge of the driver. The wheel was found some twelve miles back on the road, the axle broken off close to the wheel; the engine had a Bissell truck with rear centre. Mr. Smith, of the Hudson River Railroad, is so well satisfied as to the safety of a rear centre with limited freedom that he adopts it on all his swing trucks. You say, in conclusion, that it is almost surprising that engineers have not discovered that, as in Mr. Wm. Adams's arrangement, the truck can go without leading-strings and take care of itself.

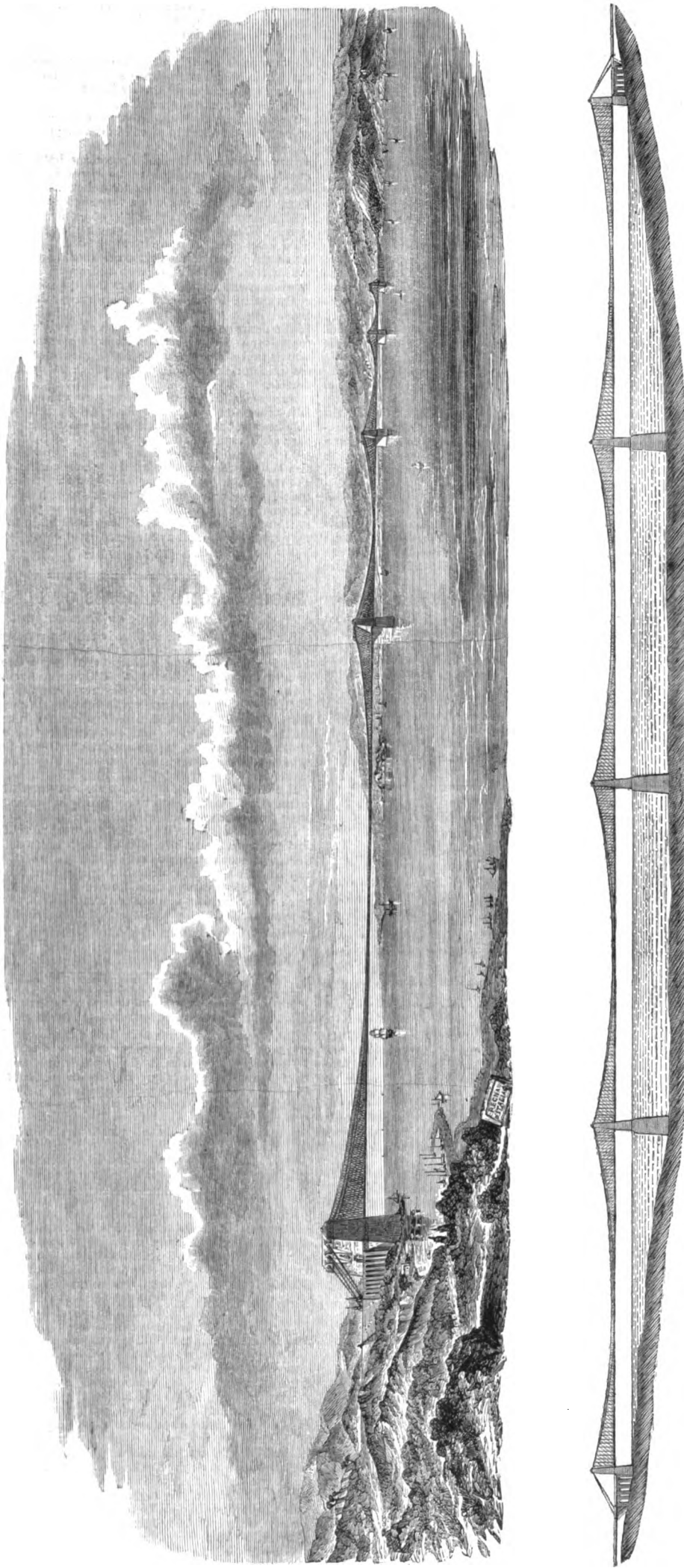
We find leading-strings in this case an improvement, and the fact that trucks on locomotives can go without them (but not as safely) is well known here.

It is possible that our imperfect roads may render the device of more importance here than with you, yet the greater safety is an element which no condition of track will be equivalent to.

WM. S. HUDSON.

Paterson, New Jersey, U. S. A., July 29, 1867.

PROPOSED BRIDGE OVER THE STRAITS OF MESSINA; FOUR SPANS, OF 3281 FT. EACH. M. OUDRY, ENGINEER.



ALTHOUGH the project for a suspension bridge of four spans of 1000 metres each, suitable for the passage of express trains, and not liable to injury by the most violent winds, proposed for the passage of the Straits of Messina, by M. Oudry, engineer of the Corps Impérial des Ponts-et-Chaussées, has already been referred to in English publications, we are not aware that any detailed description has yet appeared in print in this country, and we therefore give room to the following description, derived from the accounts published in Paris by M. Oudry himself in the year 1861:

Position of the Bridge.

On looking at the map of the Straits of Messina, it will be distinctly seen that the line of shortest distance between Calabria and Sicily is that from the point Pezzo on the Calabrian coast to the coast of Sicily at a point equally distant between Ganziri and the point Palazzo.

The width of the strait is here about 3200 metres. On observing the depth of water at the different points of the strait for the purpose of tracing the line of least depth, it will be found that that line lies between the point Pezzo and the

Sicilian coast somewhere between Ganziri and Santa-Agata. The width of the strait in that direction is about 4000 metres. If it be desired to construct a bridge on the line of greatest advantage as respects the depth of water, piers of 110 metres in height would be necessary; but if the shortest line be preferred, the piers must in that instance be sunk in 130 metres of water. Since the latter plan would necessarily largely increase the enormous difficulties that would have to be surmounted in making foundations in 110 metres of water, there appears but little necessity for hesitation in accepting the line of crossing 4000 metres in length in preference to that of 3200 metres.

In all the localities that we have studied for the construction of bridge piers, we have always found that the most favourable locality has been that which permitted their construction in the least possible depth.

In order fully to understand the effect on navigation which would follow the construction of a bridge, it will be necessary to enter somewhat into detail with respect to the natural phenomena of the Straits of Messina, and of the manner in which the navigation is affected by them.

The Currents.

The currents in the Straits of Messina are very variable, and sometimes attain a speed of five knots; so that it would be unwise, with a sailing ship, to attempt to enter the port without the assistance of a pilot.

These currents are tidal currents, and are, like the tides, influenced by changes of the moon. They vary every day about three-quarters of an hour, and attain their greater velocity at the periods of new or full moon.

The two principal directions of the current are to the north for flood tides and to the south for the ebb; but the configuration of the land, and other obstacles, at different points of the coast cause eddies and reverse currents which are necessary to be understood by all mariners navigating the straits.

These reverse currents, which generally begin to be felt about one or two hours after the principal current has appeared, are called by the pilots *refolo* when they are produced by the ebb, and *bastardo* when they are the result of the flood tide.

The principal *refolo* make themselves felt on the coast of Sicily, between the lower Palazzo and the Point Sottile, near to Faro, between the la Grotta and Fimmara della Guardia, be-

tween San Francisco di Paola and Salvatore dei Greci. The strength of these reverse currents increases in proportion to the duration of the general currents. The last is the most important in the marsh of Syrggia, and it extends about a mile along the coast.

On the Calabrian coast, at the entrance of the strait opposite to Messina, there is no reverse current with the ebb tide.

With the flood tide, or northern current, the only important reverse current, or *bastardo*, on the coast of Sicily, makes itself felt at the Point of Faro, between the lighthouse and the point Sottile; the other reverse currents are insignificant, and are of no use to ships.

There is no reverse current on the Calabrian coast until two hours after the flood, when the latter causes a backwater setting south between Cavallo, or rather Alta Fimmara, and Pointe Pezzo, and having its greatest strength in the direction of Canitello, where it is two or three cables' length in extent.

The ebb tide commences about 9 o'clock in the morning, and is first felt at the Pointe du Faro; at full and new moon it first runs towards Alta Fimmara, and from thence to the Pointe Pezzo, where it directs its course towards La Grotta, and

thence to Salvatore dei Greci, and towards the small light of Messina, where it arrives about 11 o'clock, and from thence it takes the direction of the open sea, and bears towards Reggio.

The current of flood tide is felt on the Calabrian coast at about 8 o'clock, at the point Coda di Volpe. Taking the direction of the reverse current already existing at that point, it gradually increases and unites itself with the northerly reverse current, extending itself from the Point Palazzo to the Point Sottile, and then the whole mass of water which it carries towards the north resembles a stream. Two hours after that direction changes, and the current bears towards Scilla; but at the same time there comes from the north a current called Rema di Baguara, which, uniting with that running towards Scilla, produces a current running out into the open sea.

At Messina the northerly current does not make itself felt until five o'clock. In the mean tides the southerly currents take the same direction as those at full and new moon; producing equally the same reverse currents, but having less speed. The current commences at the Pointe du Faro at 12 hours 48 min., and at the small light of Messina at 3 hours 45 min.

The rise of tide is but little more than 25 or 30 centimetres at Messina, and it is greatly influenced by the winds; at Pointe du Faro it is hardly perceptible.

The meeting of two opposite currents produces at different points of the Straits whirlpools accompanied by a great agitation of the sea, which is called in the country "*garofalo*." The principal of these are on the coast of Sicily, between the Pointe du Faro and the Pointe Sottile with the ebb tide, and at the Pointe Palazzo with the flood; this *garofalo* is very powerful, and it is the Charybdis of the ancients. Off the small light the *garofalo* is very strong; it is caused by the meeting of the southerly current with the reverse current which occurs at that point; it is dangerous with a south-east wind. On the coast of Calabria, at the Pointe Pezzo, there is also a very strong *garofalo* occasioned by the northern reverse current and the southern stream; it is very dangerous with a south-east wind. There are also at different points great agitations of the sea without whirlpools (caused by the dashing of the current against the high beach), which they call *scala di mare*.

The Winds.

In winter the most frequent and worst winds are those of the E.S.E. and W.S.W. coming after west, N.N.W., and E.N.E. winds. For ships wishing to enter from the north, the most to be feared are those from the W.S.W. and E.S.E., but principally the former, because they produce a very rough sea. The winds from the west last for a less period than those from the south-east. The south-west wind is sometimes very strong, but it does not last long; the S.E., on the contrary, increases in strength and blows sometimes for fifteen days together; a S.W. wind generally follows and lasts for a short time, it then passes gradually to the N. by the W., and restores fair weather. When the S.W. wind changes to the S.E., there is a continuance of bad weather; when the S.E. returns to the N. by the E., that is also a sign of foul weather; the wind from the S.W. soon returns. Fine weather is accompanied by wind from the N.W. and the N. When the wind blows from the N. or N.N.E., it is almost always calm at Faro, whilst at Messina and at Reggio the breeze is sometimes very fresh, but it generally falls at evening, and does not cause a heavy sea.

Navigation of the Strait between the Points du Faro and Messina.

Ships coming from the North.

1. With a fair wind, and running south with an ebbing tide, the centre of the channel should be taken, and passing opposite to Faro; the cape is made opposite to Messina; but on arriving before Salvatore dei Greci the course is changed a little in order to avoid the reverse current running north, and then the port is entered.

2. With a northern wind and current, or during a flood tide, if the wind is sufficiently strong, the ship's course should be directed along the Sicilian coast; but if the breeze is too light to enable it to double the Pointe du Faro, the Pointe de Calabria must be made in search of the reverse current running south, or *bastardo*, existing between Alta Fiumara and the Pointe Pezzo, the vessel there awaiting a favourable opportunity for anchoring, or for making short tacks.

3. With a southern wind and current. Arrived opposite the Pointe du Faro, or shaping a course past Alta Fiumara, or tacking the ship, and directing it towards a channel, or tacking again to bear up towards the Calabrian coast. Having arrived thus opposite Canitello, a fresh tack is made to Gaunzi; there a tack is made and an advance just in mid-channel in order to avoid the *réfolo* at the Pointe Pezzo, and a fresh broadside is presented towards the coast of Sicily. If the ship carries the wind as far as Gratta, it may continue as far as the coast of Sicily; but if not, a further tack must be made, so as altogether to avoid the *réfolo*, or reverse current; by continuing thus as far as Messina, the *réfolo* of Salvatore dei Greci is avoided.

4. When the wind and the current are contrary, it is necessary to anchor until the wind becomes favourable.

General Rule.

It is necessary to navigate a ship so as to avoid the *Réfoli*, or to make use of them, and to go from Messina to arrive at La Grotta, whence a course must be shaped for the port according to circumstances.

Ships coming from the South.

1. With a South Wind and Northerly Current.—Once arrived opposite to the little light, the vessel must be brought to if it is near the time for a favourable current; otherwise you must anchor, and pass a rope over one of the buoys established along the coast. It may be necessary to anchor again opposite Porto Salvo or San Francisco di Paola, or wherever a favourable current is waited for in order to enter the port. In beating up the current begins to be felt two hours after the commencement of the southern current at the Pointe du Faro.

2. With a Southern Wind and Current, the port can be easily entered at once, unless the southern current is reached.

3. With a North Wind and Southern Current.—In beating about in order to reach the Pointe Pezzo, the shore must be hugged opposite the coast of Calabria, and the vessel kept in mid-channel towards the coast of Sicily; once arrived opposite Pointe Pezzo, it is possible to bear towards the coast of

Sicily, and enter the port with a wind from behind, whatever may be the state of the current.

4. With a Northern Wind and Current.—Once the small light is rounded, the port can be entered with a fair wind.

When the wind is very strong, ships cannot enter the port of Messina, and must anchor either on the Fossa du Anigo, opposite Paradiza, or opposite La Grotta.

With very strong winds from the E.S.E. neither can they enter, but must anchor.

In the port of Messina ships at the quay are very badly situated with an E.N.E. wind; they knock one against the other, and often suffer damage. In rough weather, ships are in safety at one cable's length from the quay.

To leave Messina with the wind in the N.E., the ship must be hauled by ropes under the fort of Salvatore, inside the port, by the time that the water commences to flow out; the head of the ship must be set towards the lazaretto, where a tack is made; a second tack opposite the Pointe Salvatore as quickly as possible; a third tack brings the ship opposite to the bastion of Salvatore, continuing on that course so as to make a long tack along the coast of Calabria, as far as the Pointe Pezzo. Along the coast of Sicily it is necessary to maintain a mid-channel course, so as to avoid the *bastardo* or reverse current running south. If, however, Gaunzi can be reached, the ship must be pushed towards the shore. In the course, two other tacks must be made in mid-channel in order to reach the tower of Palazzo; at that point a short run out to sea is made in order to avoid the *bastardos* on the Calabrian coast. Once arrived to the north of Siana, sail may be made.

In order to leave the port of Messina with a S.W. wind, the ship must be brought over against the lazaretto with the assistance of a rope; and there a tack is made at once into the open sea, and the rest depends upon the wind. When the wind is fair the port may be left at will; and in order to reach the strait, the former rules must be observed.

Position of the Piers.

As a conclusion from the above may be advanced the possibility of erecting three piers in the straits, situated as follows: one in the middle of the strait, and the two others each one thousand metres distant from it, and consequently at a similar distance from the shore.

Height under the Spans.

It follows, from what has been already said, that ships must sometimes pass under the bridge at one point and sometimes at another, according as they are going in one direction or the other, whether the wind be fair or otherwise, and whether the tide be in flood or ebb; it is consequently necessary that the girders should be so erected as to admit of a free passage for ships for the entire width.

The highest masts are those of men-of-war; and it follows, therefore, that the full height to be adopted between the level of the sea and the bottom of the girders should be fixed with reference to such vessels. In order to ascertain exactly what would be the necessary height, a letter was addressed to Monsieur Pastoureaux, a qualified naval engineer, who, on the 15th November, 1860, replied as follows:

"Dear M. Oudry, I hasten to inform you as to the height which should be given to the bridge, a design for which you are preparing for the Straits of Messina."

"The height from the level of the water to the top of the mast of our largest vessels of war (three deckers) is 64.40 metres. If, therefore, these vessels had to pass under the bridge with all their masts raised, the under part of that bridge should be at least 64.40 metres in height above the level of the sea."

"But men-of-war are provided with a numerous crew with which they can easily, and whenever necessary, lower their top-gallant masts. That operation which sailors call 'striking their top-gallant masts,' can be effected in about ten minutes, and it would not, therefore, seriously affect the navigation. Supposing that to be done, the highest point of a ship's mast would not be much above 49.80 metres."

"Now if, instead of considering ships of exceptional dimensions, we pass to large frigates, it will be found that their masts are 55.20 metres in height, with top-gallant masts set, and 42.20 metres without top-gallant masts. In large military transports which correspond with large trading vessels, the respective heights are 50 and 40 metres."

"From the above considerations I should recommend that the height above water, from the under part of your proposed bridge across the Straits of Messina should be at least 50 metres in the centre."

"With that dimension of 50 metres, all ships might pass without difficulty—that is to say, ships of war and frigates with their top-gallant masts struck, and trading vessels with their top-gallants set."

"I must here add that since the introduction of steam navigation there has been a tendency to reduce the dimensions of masts, especially in height. Perhaps at no distant period a height of 50 metres will prove more than is necessary. But I repeat it, that with our present ships that height is indispensable."

"Yours, &c.,

(Signed)

"PASTOUREAU."

Profiting by the advice of M. Pastoureaux, we have fixed the height from below the girders to the sea level at 52 metres at the piers, which, rising in the centre about 2.50 metres, gives a clear height in the centre of about 55 metres.

Ships of war and frigates must lower their top-gallant masts on passing the bridge; but, as M. Pastoureaux has said, that operation is always possible and easy.

All other vessels would pass under full sail. The passage of frigates and three-deckers being an exceptional occurrence, it would seem that girders fixed at that height could cause no interference with the navigation.

Nature of the Spans.

After weighing for a long time the advantages and disadvantages of different kinds of spans, it appeared to us that those which were preferable for adoption for the Messina bridge were spans the stability of which depended upon the resistance of metal to a tensile strain, and of which the equilibrium was as firm as possible. Spans answering to this description are known

by the denomination of suspension bridges. These bridges have received but little consideration, especially in France; but that want of consideration has not affected the system itself, which is eminently reasonable and economical, and you must not therefore see in it anything but a consequence of the deplorable manner in which most bridges have been constructed. This adverse opinion is unfortunately justified, not only because very often improper materials and insufficient workmanship is employed, but because almost always an exaggerated idea of economy is permitted to prevail in drawing up designs for works of this character.

The suspension bridges of France are but little calculated to encourage the extended use of the suspension principle, for they offer but moderate securities for solidity, whilst, at the same time, they are in use only to a very small extent.

If a loaded wagon were to cross these bridges a little rapidly, if some people passed them marching in step, if the wind were to strike them with some force, they would be at once set in oscillation; if the first cause should continue, and should act in accordance with created oscillations, these will rapidly increase in extent and force, so as to cause not only the fracture of the chains, but also of the suspending-rods and of the platform.

The desire to economise, as much as possible, has pushed the contractor to too great a reduction in the suspended weight, and it follows that the very least overloading tends considerably to put out of form the whole system, which is by itself eminently flexible.

Suspension bridges which have been constructed in England follow the same system as in France, but, as they are considerably heavier, they favour much more the circumstances of ordinary oscillation.

In America there are found very good specimens of suspension bridges, constructed after the principle adopted in France, and there they are found applicable for the passage of railway trains. As a proof, there is the bridge of Niagara, which has a span of 250 metres, and which for many years has provided at the same time, by means of two platforms, passage for ordinary traffic and for that of trains.

(To be continued.)

RICHARDSON'S PROCESS OF PUDDLING.

TO THE EDITOR OF ENGINEERING.

SIR,—As considerable interest is felt in the above process, it may not be out of place to state that the use of blast in puddling furnaces is not new, and was tried even long before the process was patented by Mr. Bessemer. I have a memorandum in my possession of a trial made at Rhymney Ironworks, in March, 1841, in which blast was used by placing a tuyere iron between the door and the fire-bridge, about half an inch below the surface of the molten iron, in such a position as to throw the blast into the centre of the furnace. Its success was perfect as far as regards time in manipulation, quality, and yield, excepting the first and second heats after each fettling.

It was abandoned on account of the bottom of the puddling furnace not standing, and the necessity of fettling or relining being required so continuously.

Limestone being the only substance used at that period, the first and second heats after each fettling were so red short from the use of that substance as almost to be worthless. I have only the result of thirty-four heats; the iron was dark grey, coke made; the average time of each heat was 41 minutes; and when common cinder iron was put in, the time was reduced to 25 minutes. Had any non-injurious substance of fettling been tried, I have no doubt the process would have proved successful.

Yours, &c.,

Darlington, August 19, 1867.

FETTLING.

EXTRACTION OF SULPHUR FROM FUEL.

TO THE EDITOR OF ENGINEERING.

SIR,—Can any of your readers inform me of the best method of extracting sulphur from coal or coke?

There are very few coals obtainable, and especially north of the Tweed, in which this impurity does not exist in more or less quantity, and a good process for its removal is therefore of too general importance, I imagine, to be allowed to live long in obscurity.

Will you, therefore, kindly insert my question in your admirable journal?

Yours obediently,

August 16, 1867.

SCOTUS.

RAILWAY ACCIDENTS.—The third part of a series of reports upon certain accidents that have occurred on railways during the months of April, May, and June of the current year has been recently published. It gives details as to twelve accidents, one of which occurred on the Caledonian Railway, one on the Glasgow and South-Western, two on the Great Northern, one on the Great Western, two on the London, Brighton, and South Coast, one on the Midland, and four on the North-Eastern Railway. The nature of these accidents may be thus particularised: Six collisions, three in which, from various causes, trains left the rails, one in which a showman's van, carried on a truck, came into contact with the arch of a bridge; one in which a lifeboat, carried in the same way, came into collision with the carriage of a train travelling on the other line of rails; and one in which an engine came into collision with buffer stops at the end of a station. The most serious casualty appears to have been that on the Midland Railway, which occurred near the Methley station, on the 24th of April last, and which resulted in the death of the engine-driver and very severe injuries to the fireman. The engine left the rails when the speed of the train was about thirty-five miles per hour, and it is suggested in the report that this was caused by the worn state of the rails at this part of the line. Two accidents happened to trains in which it was discovered that no communication existed between the guard and the driver, and of the six collisions above mentioned, four took place at junctions, and all appear to have occurred for want of proper attention, or strict adherence to rules on the part of the companies' servants.

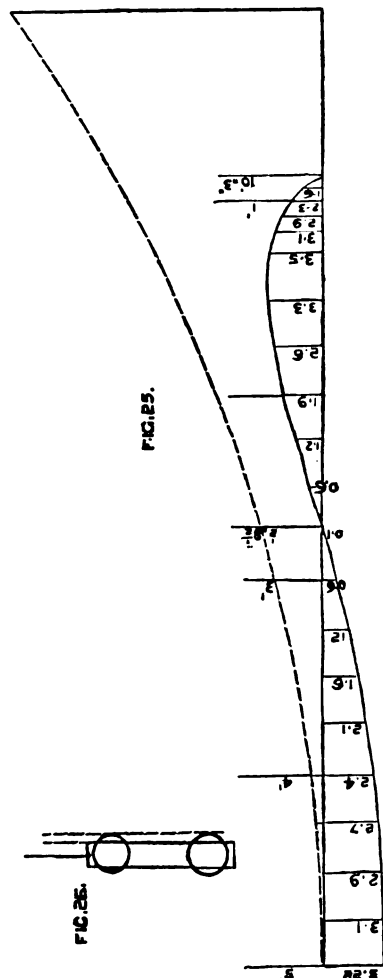
APPARATUS FOR MEASURING THE DISCHARGE OF WATER.

(Continued from page 125.)

It need scarcely be added that both the measuring sluice, conduit, and cistern contain the float must be arched over, or otherwise covered, a door being left for occasional access, but at all other times locked up. From the position of the shutter it will be evident that it will not be visible from outside, or capable of being interfered with through the conduit.

In Fig. 25, below, are given the offsets to the curve on either side of a perpendicular let fall from the top of the arc to the bed of the chamber. The curve is suited to a greatest depth of 5 ft., the length of radius being 10 ft., drawn from a centre 6 in. above the highest water mark, that is, 5 ft. 6 in. above the floor of the cistern and sill of the sluice.

In fixing the apparatus it is necessary to adjust the length of the chain (for the greater part of which an iron rod may be substituted) so as to give the desired opening of the shutter for different depths of water, as it would be necessary to be par-



ticular in testing the same for the greatest and least depths of water, viz., 3.22 in. for the former, if it were 5 ft., and 7.2 in. for the latter if 1 ft., the chain being shortened to increase the opening, and vice versa. If the curve should require correction in any part, it is obvious that the opening of the shutter may be reduced by cutting away a thin stratum from the surface of the curved ridge. If it requires to be increased, it is necessary to cut away from all the other parts of the ridge and shorten the chain.

It need only be further stated that in all cases where a rising and falling shutter is employed, it ought to be provided with side friction rollers running in grooves to prevent its face from absolutely touching the face of the plate in which the opening is cut; but otherwise, it should hang quite loosely and vertically, being only kept against the plate by the pressure of the water. These rollers are shown in Fig. 26. As before explained, the breadth of the slit or opening entirely regulates the quantity of water passed, and this would be 25 cubic yards per hour for 4 in. breadth, and 1000 cubic yards for 30 in.

Of the various contrivances which have been described in the foregoing paragraphs, it appears probable that several will be practically useful on large scale, and therefore worthy of trial. It must be remembered, however, that as some of them are new, it is not likely they will at first succeed, unless pains are taken to insure strict attention to all the essential points in their action. They have been tried in models, and the accuracy of their principles proved by severe tests. There can be no doubt, therefore, that if skilful endeavours be made on a large scale, they will not fail to be rewarded with success.

TEN YEARS' INDIAN COINAGE. The value of the gold, silver, and copper money coined at the mints of the respective provinces of British India in the ten years ending April 30, 1866, was as follows: 1856, 7,177,589*l.*; 1857, 10,969,034*l.*; 1858, 12,733,790*l.*; 1859, 6,792,196*l.*; 1860, 10,911,776*l.*; 1861, 5,508,568*l.*; 1862, 7,279,699*l.*; 1863, 9,532,416*l.*; 1864, 11,623,140*l.*; and 1865, 10,811,397*l.*

WORKING MEN'S HOUSES.

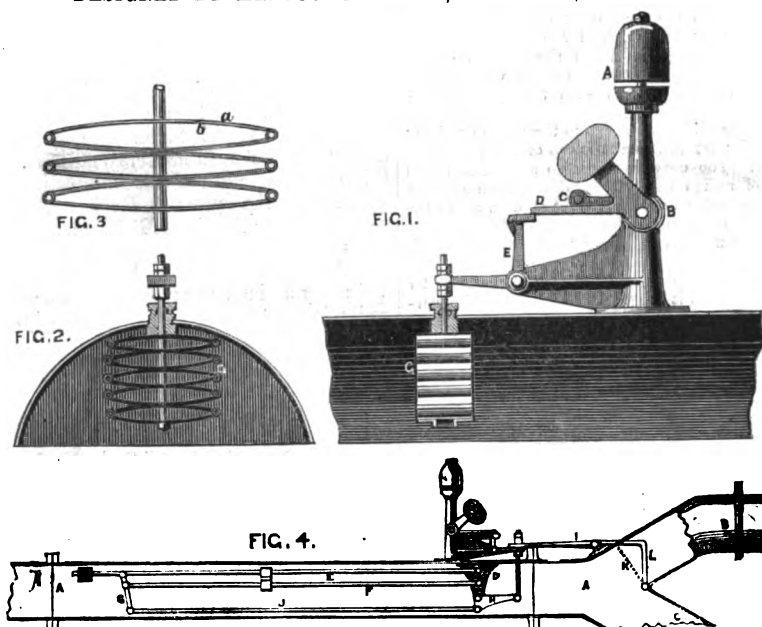
We have in our previous accounts of the Paris Exhibition noted some of the most important facts relating to the mutual relations between masters and men in different Continental manufacturing districts, as brought before the public through the competition for the so-called "new prize." This new prize was offered by the Imperial Commission to those who have most contributed to the physical and moral benefit of the working classes and to the improvement of the mutual understanding between masters and men. We consider this subject one of the most interesting and important features of the present Exhibition, and one most worthy of the attention of British manufacturers. The Paris Exhibition is remarkably rich in specimens, descriptions, and models bearing upon this subject, and many an important lesson is to be learnt from the collection. Amongst some dozens of different model houses exhibited in one form or other, as constructed for working men in different localities, we select the working men's houses of the town of Mulhouse, in France, for a special notice, as these houses, from the mode of their erection and the general management of the large number of them, which now forms the "*cité ouvrière*," or working men's town, in Mulhouse, are justly considered to be one of the most successful and most beneficial philanthropic undertakings which has ever been carried out. The *cité ouvrière*, at Mulhouse, has to thank British example for its origin. At the Exhibition of 1851, the late Prince Consort exhibited a model house for working men, constructed from the plans of Mr. Henry Roberts, and a description of this model cottage, together with plans and other information, was published, under the auspices of the Prince, by Mr. Roberts. The Emperor Napoleon, then President of the French Republic, ordered Mr. Roberts's useful treatise on the dwellings of the labouring classes to be translated into French, and in that form it appeared before the Society of Arts at Mulhouse. The society accepted a proposal made by some of its members to execute on a large scale what had been so ably indicated by a single model at the London Exhibition, and capital was subscribed for forming a society for the improvement of the dwellings of the labouring classes at Mulhouse. So far, the manufacturers of Mulhouse were mere imitators of what they had seen in this country, and their society was no more than a copy of the institution in London which bears the same name. The Mulhouse society has, however, taken an independent course, and it has now, in its turn, become the teacher of this country and others. The Mulhouse Building Society has made it its aim not only to provide comfortable, healthy, and well-arranged dwellings for the working classes at a comparatively low rent, but also to give to the inhabitants of these dwellings great facilities and a sufficient inducement to become proprietors of their houses after a certain time of occupation. In France the practice of leasehold does not exist, and the working men, in acquiring possession of their own dwelling-houses, become freeholders of the buildings and of the land upon which they are placed. The working men's town at Mulhouse at the present time comprises 800 houses, each inhabited by one family, and out of this number 684 houses are the property of their respective inhabitants, all being working men who have acquired the property out of their systematically accumulated savings. The society who created this town and erected the buildings has prospered, and increased its funds, and draws an interest at the rate of 4 per cent. upon the capital which is employed in augmenting the number of these houses and enlarging the general sphere of action of the institution. The whole scheme was commenced in the year 1853, with a capital of 12,000*l.*, subscribed by twelve of the principal manufacturers of the town, under the presidency of Mr. Jean Dollfus, who is still the chairman of the society. The Government subsequently aided the undertaking by granting to this society an equally large amount, 12,000*l.*, for the purpose of constructing public buildings, streets, drainage works and fountains, and this grant was made subject to the condition that the founders or shareholders of this society should never draw any profits from this undertaking beyond the interest at the rate of 4 per cent. upon the capital originally subscribed by them, and that all houses built by the society should be sold to working men inhabiting them at cost price, and on terms which should be regulated by the general rules of the society. The houses were built from different designs, but all on the cottage system advocated by Prince Albert, and exemplified by the plans in Mr. Roberts's treatise. Modifications of course were introduced to suit the habits and customs of the inhabitants of the Mul-

house district, and those types of cottages which after a few years' experience had been found most successful were generally adopted and multiplied in numbers according to the increasing demand and available means of the society. The houses are of a very superior character as compared with the general style of working men's dwellings in the district and in most other localities, and the cost price of a house for one family, including the freehold of the ground on which it is built and of the garden surrounding it—a total area of about 160 square yards—is 120*l.* The inhabitants have the choice of living in these houses as tenants, paying a rent of about 9*l.* 10*s.* per annum, i. e., 8 per cent. upon the total value of the house, or of becoming purchasers of the house by paying down a sum of 10*l.* or 12*l.*, and keeping the rest as a mortgage debt upon the property, which is paid off by monthly instalments extending over a maximum of fifteen years. The practical result is this, that the purchasers of these houses pay a rent of about 12*l.* per annum, which, although it includes the instalments for the purchase of the house, is below the usual rents of similar dwellings in the town of Mulhouse. At this rate a house is liberated from its debt, and becomes the free property of the inhabitant after thirteen years. Comparing this with the rents paid in the same time by an inhabitant of the same house at the rate of 9*l.* 10*s.*, there is only a difference of about 35*l.* actually paid by the inhabitant for acquiring the free property of a house and garden, the original cost price of which is 120*l.*, and the value of which rises in that space of time with the natural increase of the value of land in every rapidly growing manufacturing town. It is obvious, therefore, that the advantages offered to the working men in the purchase of these houses are very great, and the practical result is that the greater part of this working men's town consists of houses already purchased by their respective inhabitants, some being as yet with a more or less rapidly decreasing mortgage debt upon them, but a considerable number being already the freehold property of the families who live in them. Experience has shown that the men are extremely anxious to arrive at the ultimate release of their houses from the mortgage debts, so that as a rule they pay larger instalments than those necessary for the release in thirteen years. There are, of course, cases of death or unforeseen difficulties, which occasionally prevent some families from completing their purchase, thus necessitating the inhabitants leaving their partly acquired property. In all these cases the society gives up all legal claims upon the forfeit of the instalments already paid. The parties are treated as if they had been tenants during the whole past period, and their accounts are made out anew upon the usual scale of rents, at, say, 9*l.* 10*s.* per annum. All the surplus money paid by them at first, and in subsequent instalments, is refunded to them, deducting only the amounts necessary for repairing the property formerly occupied by them. In this manner the purely philanthropic character of the institution is preserved under all circumstances. The working population receives all the advantages which this system of operation is capable of affording, without under any circumstances being in danger of losing anything by the engagements they are obliged to make. The rents and instalments are paid with an extraordinary regularity and promptness. The statistics of the society show that up to the close of the last quarter no more than 2*l.* of rents remained unpaid from the whole number of 800 houses. All funds returning to the hands of the society are immediately employed for the erection of new houses, and the society has also raised further sums upon mortgage of some of the houses from bankers at Mulhouse and at Bâle. The beneficial influence of that undertaking, not only upon the working population of Mulhouse, but but upon all the inhabitants of the town, is incalculable. It has raised the general standard of dwellings for all classes of the population; it has improved the sanitary state of the town, and raised the moral and social condition of the labourers. It has created an attachment of the working men to their homes and to their places of employment, prevented discords between masters and men by giving to the latter increased comforts and a more agreeable existence, without, at the same time, necessitating a corresponding increase of wages for acquiring these benefits. That the morals of the whole population have been improved by the improvement in their physical condition, by the stimulation of their sense of order, foresight, and economy, by the provision of public schools and literary institutions, is a self-evident consequence of natural laws. But the power of the society over the special conduct

of the working population is still greater and more direct than through the agency of these general laws. The society makes it a condition for the inhabitants of their houses to send all children between seven and twelve years of age to school; it also grants annual prizes to those who keep their houses in the best state of order and neatness both internally and in the outward appearance, and particularly with regard to the cultivation of the small garden in front of each house. The competition for these prizes is voluntary, as the society does not intrude its visits of inspection upon the inhabitants except at their own desire; but in reality the competition for the prizes of the society is almost general, and the visits of strangers, who come to this town in great numbers, are much coveted by the inhabitants of the *cité ouvrière*, who are very proud of their "own" houses and gardens, and very fond of showing off their property in all its beauty. One of the most useful amongst the public institutions of Mulhouse is the public bath and laundry. The baths are very comfortably arranged in a style somewhat similar to the public baths in most of the towns in this country; but they are offered to the people at a remarkably low price, viz., 1½d. for a warm bath, including towels. There are about 9000 bathers per annum. The laundry is used by the wives of the workmen, and the number of admissions is about 40,000 per annum out of a population of 6000 inhabitants of the 800 houses which at present form the working men's town of Mulhouse. This entire town is situated outside of the town of Mulhouse proper, in the vicinity of the principal factories. It has been built upon a large open space, which was, originally, cheaply acquired by the society, but the value of which is rapidly rising. The houses are built with much uniformity, and grouped symmetrically, sometimes in single rows, like the cottages in England, sometimes in groups of two or four, placed back to back, and surrounded by a garden on all four sides. The groups of these houses are again placed in straight lines, like detached cottages, forming streets, which cross each other at right angles. At each crossing a well, with a pump, or a public fountain, is constructed, and the broader streets are planted with rows of trees in the style of "boulevards." There are co-operative stores for supplying the workmen's town with cheap provisions of all kinds, and also with articles of clothing, which are manufactured on a large scale, and sold at remarkably low figures. The society, although formed by manufacturers, does not follow any purpose of class interest. Its rules and by-laws refer to nothing but the maintenance of order in the town itself, and to the proper management of the property of the society. There are certain conditions imposed upon each purchaser of a house built by the society. For instance, a house, when purchased, cannot be resold before the expiration of ten years from the date of purchase, except with the special permission of the administration, or a house occupied by a tenant cannot be sublet, either wholly or in part, without such a permission. These provisions are made, however, with no other view than that of keeping speculators from purchasing the houses in the name of working men, and depriving the latter of the benefits afforded by the arrangements of this society, and also of preventing the accumulation of too many persons in one house, a matter which would interfere with the sanitary condition of the dwellings and of the town at large. In this *cité ouvrière* of Mulhouse we, therefore, see a practical model on the largest scale of one of the greatest desiderata in the manufacturing districts of this country, and one carried out under circumstances which most closely resemble those under which our own manufacturing towns are placed. The Mulhouse workmen do not belong to one single establishment, and are not obliged to remain in the employment of any special firm in order to be entitled to the benefits of this building society. The houses are built in the style most suitable to the wants of their inhabitants, and, although they are not in every respect suitable models for imitation in England, they afford ample proof that, by means of the general management and the mode of action adopted at Mulhouse, good dwellings can be provided which, with their moderate rents, will combine the possibility of the inhabitants becoming the proprietors of their houses, either by acquiring the freehold or a lease, according to the custom of the locality, or according to the special views and intentions pursued by the founders of such building societies at the outset. That such things are desiderata at a time when the increasing vigour of foreign competition and the growing acuteness of the suicidal quarrels between masters and men are endangering the position hitherto held, and, in spite of all that may be said to the contrary, still maintained by this country, requires no

TEMPERATURE INDICATOR FOR SUPERHEATERS.

DESIGNED BY MR. JOSHUA FIELD, ENGINEER, LAMBETH.



further demonstration. What has been doubtful was the practicability of such schemes, and this, we believe, has been fully established by Mr. Dollfus and his able cooperators of Mulhouse. We expect great and lasting benefits from institutions of this kind, particularly if created by master manufacturers, and maintained by their exertions, and under the supervision of committees formed amongst them. In the first instance, the fact of lowering the rent of the dwellings is equivalent in its effect upon the labourer to a rise in his wages; the position of the men will be improved without at the same time enhancing the price of the manufactures produced by them, and one of the causes of their disputes will in this way be lessened in power and acuteness. Besides this, the men will be more closely attached to the place in which they live, and where they have obtained a hope of acquiring some fixed property. This forms a strong tie between the "shop" and the "hands," and makes them unwilling to change except for very urgent reasons. There is also a source of mutual goodwill in every such association of masters and men for the direct improvement of the physical and social condition of the latter, which has a most powerful and beneficial influence upon their mutual relation in the long run of friendly cooperation.

Benevolence, forbearance, and generosity, which in these transactions are constantly claimed on the part of the men, and constantly practised on the part of those who represent the employers or the wealthier classes in general, create a feeling very different from that which we deplore, but cannot deny to exist at present. Let us hope that the great collection of information on this important subject, which we find concentrated at the present Exhibition, will not be lost upon the employers of labour in this country, and that they will be as quick to learn from and improve upon the example of their foreign competitors as the manufacturers of Mulhouse have been in making use of a useful and noble lesson given to them in this country at a former international Exhibition.

FIELD'S PYROMETER FOR SUPERHEATERS.

It not unfrequently happens that in marine engines fitted with superheaters, the steam becomes heated too highly, and damage is consequently done to the valve faces, pistons, packing, &c., giving rise to much trouble and annoyance. This overheating may be caused by the gases in the uptake taking fire in the neighbourhood of the superheater, or from other causes, and under ordinary circumstances there is no means of knowing that it has taken place until after the damage has been done by it. To avoid this, Mr. Joshua Field, of the well-known firm of Maudslayi, Sons, and Field, has designed and recently patented the form of indicator of which we give engravings above, this instrument being so arranged that, when the steam in the superheater is raised to too high a temperature, an alarm-whistle is put in action, and warning thus given to the engineer. In another form of the apparatus, in addition to the alarm-whistle being sounded, a throttle-valve placed at the junction with the main steam pipe, of the pipe leading to the superheater, is actuated and the supply of steam cut off from the superheater, a direct communication from the boiler to the engine being at the same time opened.

In our engraving, Figs. 1 and 2 show the simpler form of the apparatus as applied to an alarm-whistle, the various parts

being as follows: A is a steam-whistle of the ordinary construction mounted on a long hollow stem with a shut-off cock at B. This whistle is shown as placed on the top of the steam pipe, with which it communicates through the hollow stem and cock, B; C is the lever of the cock, with a projecting pin fixed in its end; and D D is a tumbling weight, with lever attached, fitting loosely on a pin on the end of the plug of the cock, B. This lever and weight are kept in position, as shown, by one arm of a bell-crank lever, E, the other arm of which is actuated by the pyrometer, G, placed within the steam pipe in the full current of the steam as it passes to the engines. The pyrometer, G, consists of a series of flat bars of copper and iron attached together by brazing or other suitable means, as shown in the enlarged view at Fig. 3, in which a represents the copper, and b the iron. It will be readily understood that when these bars become heated they will, from the unequal expansion of the metals of which they are composed, assume a more curved form, and draw down the horizontal arm of the bell-crank lever, E, so as to cause the other arm, when the horizontal arm has been drawn down a regulated distance, to release the tumbling lever and weight, D D, which latter falling on the pin in the cock lever, C, will cause it to open the cock, B, and thus allow the steam to pass from the steam pipe to the whistle, A, and give notice to the engineer that the steam has become too highly superheated. The apparatus should be so adjusted as to release the tumbling weight when the steam arrives at the temperature of about 340°, and the same apparatus may be equally well employed for releasing a bell or spring alarm.

Fig. 4 shows another form of apparatus which may be employed where there is a long length of steam pipe available, and also shows how the apparatus may be made to actuate a throttle valve, so as to shut off the communication with the superheated steam, and open the communication with the common steam. A is the steam pipe with two branch pipes, B and C, the pipe B leading the steam direct from the boiler, and the other, C, from the superheater. D is a bracket fixed in the interior of the steam pipe, and having the ends of two rods, E and F, attached to it. The rod, E, is made of iron, which may be tinned or galvanized so as to preserve it from the action of the steam, and the rod, F, is made of copper; and the opposite ends of these rods carry a lever, G. Attached to the end of this lever is another iron rod, J, returning to a bell-crank lever, H, which is also carried by the fixed bracket, D. It will be readily understood that when these rods, E and F, become heated they will by their unequal expansion cause the lever, G, to move away from the fork in the pipes, and by the connecting-rod also cause the bell-crank lever, H, to move, as shown by the dotted line, and draw down the horizontal arm of the releasing lever, as before described. I is a second releasing lever, for the purpose of releasing the throttle valve, shown by the dotted lines. K L is a lever on the end of the spindle of the throttle-valve K; and it will be seen that when the one end of the releasing lever, I, is drawn down by the action of the heat on the iron and copper rods, the other end will be raised so as to release the valve lever, L, and allow the throttle valve, K, to fall down so as to shut off the communication with the superheated steam, and open the communication with the common steam. The arrangement of the various parts of the apparatus may, of course, be modified to suit special cases.

RAILWAYS IN RUSSIA.—A great line from Moscow to Toula, Orel, Koarsk, and Kiev is being constructed at present at the charge of the state, which has let the works to private contractors. The first section from Moscow to Serpoukhoff was opened in November, 1866, the length being ninety versts. The second section from Serpoukhoff to Toula is now on the point of being opened for traffic. Between Toula and Orel the works are now in a very advanced state, and the administration hopes to complete the line to Orel in the course of 1868. Surveys are being made of a line which would unite Orel to the Wittepsk, Dunaburg, and Riga line. Riga would by this means be placed in direct communication with districts which now dispose of their products with difficulty. The Russian government appears to be now fully alive to the importance of establishing railways throughout the vast dominions of the Czar.

DOUBLE-CYLINDER MARINE ENGINES.

DESIGNED BY MR JOSHUA FIELD, ENGINEER, LONDON.

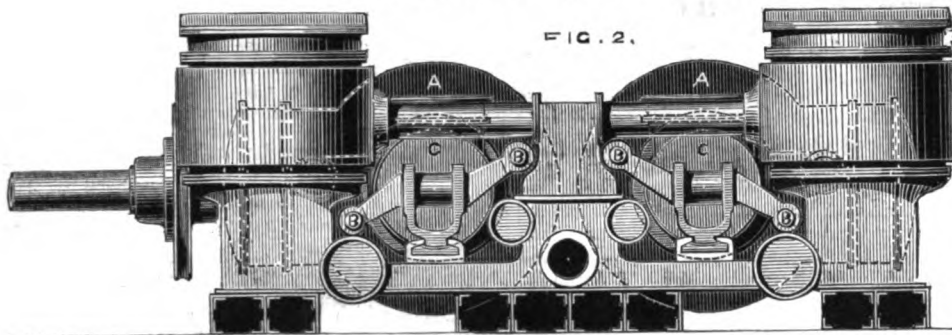
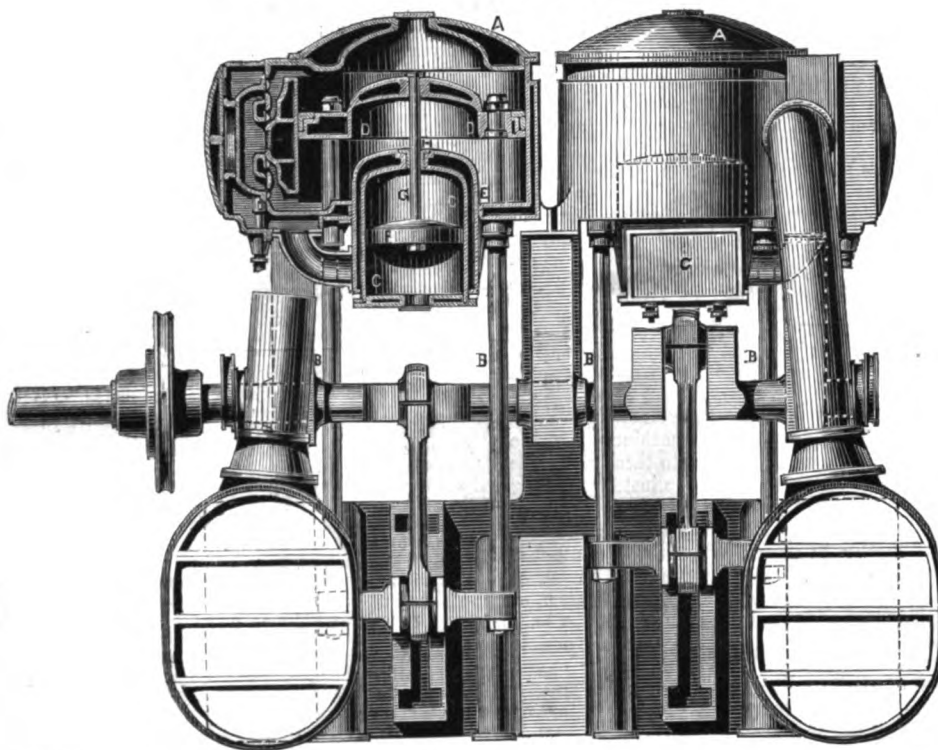


FIG. 1.



We give above engravings showing an arrangement of double-cylinder marine engine which has been designed and patented by Mr. Joshua Field, of the firm of Maudslay, Sons and Field, of Lambeth, Fig. 1 of our illustrations being a plan (partly in section), and Fig. 2 an elevation, of a pair of screw engines constructed on this principle. According to Mr. Field's plans, the small or high-pressure cylinder, instead of being placed altogether at the end of and outside the large or low-pressure cylinder, as usual, is to a great extent recessed into it, only projecting outside of it sufficiently to enable its valves to be readily got at; and by this means a considerable saving of space is effected. Mr. Field prefers to recess the small cylinder into the front of the large one, or at the end next the crank-shaft, so as to allow the covers of both cylinders to be readily removed, but when more desirable, it may be recessed into the back of the large cylinder. The piston and cylinder covers of the large cylinder have corresponding recesses in them, and the piston of the small cylinder is connected to the large piston by a rod passing through a steam-tight joint in the back of the small cylinder in the ordinary way. For ordinary working it is preferred to shut off the steam in the small cylinder at about half the stroke of the piston.

In the engravings, A A are the two large or low-pressure cylinders of the engine, with double piston-rods, B B; C C are two high-pressure cylinders on Woolf's system, which, instead of being placed at the end of and outside the cylinders, A A, are recessed into them at their front ends, the cylinders, C C, only projecting sufficiently to enable their valves to be readily got at. The pistons, D, and covers, E, of the large cylinders, A A, are recessed, as shown, to receive the small cylinders, and the piston, F, of each small cylinder is connected to the piston, D, of the corresponding large cylinder by a rod, G, passing through a steam-tight joint, H.

Messrs. Maudslay, Sons and Field are about to construct a pair of engines for the Government on the plans we have described.

SOUTH AUSTRIAN, LOMBARDO-VENETIAN, AND CENTRAL ITALY RAILWAY.—This undertaking having opened its Brenner line, which will greatly improve and facilitate the traffic between Austria and Italy, the directors have issued to the larger shareholders free passes to enable them to visit the works with their families. The delivery of these passes was commenced on Tuesday (August 20), and they will be available until September 30. The passes have been issued at a favourable season.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

The Ocean Fishery Company's Steamers.—An exhibition of implements for and produce of fisheries has just been held at the Hague, and Messrs. Randolph, Elder, and Co., the eminent engineers and shipbuilders of this city, have been informed by the exhibition committee that the silver medal has been awarded to a model of a small fishing steamer exhibited by them. There have been built by the firm just named three small steamers for the Ocean Fishery Company of Bordeaux—the *Cormorant*, *Heron*, and *Pelican*; and it is a model of these which has been exhibited at the Hague. As these steamers have proved to be a great success, and as they have not received any public notice in this country, we may here give a few details regarding them. The following are their dimensions: length between perpendiculars 90 ft., breadth 16 ft., depth of hold 8 ft. 6 in., and the tonnage is 109 $\frac{1}{2}$ B.M. They are fitted with double-cylinder expansion engines of 30 horse power nominal (geared). They are employed in the ocean fishery in the Bay of Biscay, and hail from the small fishing town of Arcachon, near Bordeaux. In summer they fish for sardines and other near-shore fish, and in winter for deep-sea fish—in both cases using the trawl net. The net is sometimes as far as two miles in rear of the vessels when engaged in their work. Sailing fishing smacks are employed in connexion with the steamers, taking the fish from them into the harbour, and otherwise assisting them. The steamers have a speed of 9 knots per hour, and the consumption of coal when employed at their ordinary work is 1 $\frac{1}{2}$ tons per day. A peculiarity of their construction is the wells formed by bulkheads, and into which the fish are put and kept alive, a constant flow of water being maintained through the wells by the motion of the vessel. On deck the steamers are fitted with steam-worked capstans, by means of which the nets are drawn in and lifted out of the water. The steamers are rigged as schooners, with fore and aft sails, and square sail on the foremast. During the short time these steamers have been in use they have been very successful, and it was a knowledge of this circumstance that led the committee of the Hague Exhibition to request of Messrs. Randolph, Elder, and Company that the model referred to should be exposed in the Exhibition. The information regarding the medal being awarded to the firm comes quite unexpectedly.

Fishing by Steam on the East Coast.—The idea of using steamboats in the deep-sea fishery trade has extended to the

east coast of Scotland. There has within the last few days been brought into notice such a steamer on the fishing-ground at North Berwick, the property of Mr. Jameson, fishmonger, Edinburgh, built for him by Messrs. Dickie and Sons, Tayport. Her dimensions are as follows: length, 61 ft.; breadth of beam, 18 ft.; depth, about 8 ft.; gross tonnage, 40. The engines are horizontal, high-pressure, of 20 horse power (nominal). She is a composite steamer, and is so constructed that she can be used either as a sailing or steam vessel. She has been built as an experiment, and if the experiment is attended with success, it is very probable many boats of a similar kind will be constructed forthwith. One advantage of such fishing-boats is that deep-sea fish can be brought a distance of sixty miles in time to catch the early trains for the great inland towns, where fresh fish can be eaten the same day that they are caught. Another advantage is that fishing may be carried on in almost all sorts of weather, which is impossible by the ordinary boats; and instead of having to return home on account of stormy weather, they may "lie to" for days together, as, in this case, there is excellent sleeping accommodation on board, and that will also be possible in any other steamers that may be built. It is not common for the workmen who are connected with any industry to look favourably on innovations, especially the application of steam; in this instance, however, the fishermen on the North Berwick shore seem to be quite in love with the idea, as they feel satisfied that they will thereby materially improve their condition.

The First Iron Ship Built.—There is at present lying in the west harbour of Greenock a vessel of some 60 or 70 tons, to which there is attached some classical interest, as she can lay claim to being the first iron vessel built. She is appropriately named the *Vulcan*, and was built on the Clyde in the year 1818, so that she is now nearly half a century old. When she was launched, crowds of people came from all parts of the country to witness the then extraordinary and novel sight of an iron vessel actually floating. Readers of *ENGINEERING* do not require to be informed that the building of iron ships has attained an eminent position among the industries of this country. It is now a somewhat novel spectacle to witness the launch of a wooden ship. Notwithstanding the great progress made in the science and art of naval architecture since the *Vulcan* was built, it is probable that the strength and durability of her hull are not surpassed in any vessel of similar dimensions built at the present time. The *Vulcan* appears to be as tough as ever, and almost fit to begin her career over again.

Loch Katrine Waterworks.—Last Thursday the lord-provost and other members of the Water Commission of this city made an inspection of the new works at various points between the city and Loch Katrine. The object of these new works is the laying of such additional pipes as will increase the supply by 10,000,000 gallons daily, and so make the total supply of water 30,000,000 gallons. In all the three valleys where the works are going on—the Blane, Endrick, and Duchray—the commissioners were much pleased with the progress making by the several contractors, Messrs. Charles Tough, Robert Craig, and James Manwell. The contractors for the pipes are Messrs. D. Y. Stewart and Co., of this city, and the whole cost of pipes and works will be about 45,000*l*. The aqueduct planned by Mr. J. F. Bateman, C.E., was constructed to carry 50,000,000 gallons of water daily, so that we have still 20,000,000 gallons to come and go upon. By next summer it is expected that the new works will be completed.

Termination of the Miners' Strike at Wishaw.—This strike, which has lasted some ten weeks or so, has now been brought to an amicable and satisfactory termination, the employers—Mr. Russell, and Messrs. Scott and Gilmour—having offered such terms to the miners as they could scarcely fail to accept. The struggle has been of a most unusually determined character, embracing a lock-out and the forced idleness of six or seven hundred workmen, and the ejection of about two hundred families from their houses at Sunnyside. A week ago it was said that not more than one hundred and thirty-seven of the miners were out of work in the district, the others either having secured employment in other collieries, or having gone to other districts; and at that time, too, there was no apparent probability of an immediate termination of the dispute. Strangely enough, the "white flag" was sent from the employers' camp. Perhaps, in this instance, the "last feather that broke the camel's back," and caused the employers to make overtures to the men, was the fact that a number of Cornish miners, who had just been brought into the district, were induced by the colliers to return home again, which they did on Thursday last, while they only arrived in the district on the Tuesday evening previous. On Friday Mr. Russell sent for those of his "locked-out" men who were still idle, and offered very favourable terms to them; and on Saturday Messrs. Scott and Gilmour were glad to offer to take back their "strikers" on the same terms as had been accepted by Mr. Russell's men. As an example to other mining districts, we cannot forbear to give the minute of agreement on which the strike and lock-out have terminated.

"Proposed minute of agreement between the following coalmasters and the workmen employed by them in their respective collieries:

"To prevent so frequent misunderstandings between the workmen and their employers, we, the following employers, agree to the underwritten resolutions:

"1st. To pay four shillings and sixpence per day from 1st October to 1st April, and four shillings per day from 1st April to 1st October in each year.

"2nd. In the event of any unusual depression or activity taking place in the trade to such an extent as may seem to warrant a change in the above rates, we agree that a meeting shall be called of representatives from the employers and workmen to consider the circumstances that demand such alteration; and that before a strike or lock-out be resorted to on either side, that the matter in dispute shall be submitted to a neutral party to adjudicate between the two.

"3rd. We further agree to furnish our workmen with a copy of these resolutions, and to ask their concurrence with them by Wednesday, the 26th inst.

"Wishaw, August 19, 1867."

It is to be hoped that no unpleasant or humiliating conditions will be brought out for signature by the employers. They should let bygones be bygones, and strive to fall upon some

plan whereby they can gain the respect and esteem of their workmen, and not their hatred and enmity.

Shipbuilding News.—The past week has been unusually busy in the launching of vessels of various sizes—none very large—from yards on the banks of the Clyde; but as our column of "Notes" is already filled to overflowing, the details must be withheld for the present, more especially as they may be included in the next monthly summary.

THE ST. PANCRAS STATION.

MORE than a year and a half ago we gave, in the first number of this journal, an engraving and some general particulars of the roof of the St. Pancras Station—a station which will, when completed, form the London terminus of the Midland Railway; and we this week publish a two-page engraving, showing a perspective view of the interior. The St. Pancras Station with the hotel and buildings connected with it, will occupy a site of nearly ten acres—the frontage being in the Euston-road, not far from the existing King's Cross Station—and it will, when completed, undoubtedly be the finest terminus in the metropolis. The constructive details of the station embrace many points of interest to engineers, the main one being the roof, which will, as we stated in our former notice, be of greater span than any yet erected.

As will be seen from our engraving, the roof springs from the platform level, and the principal ribs each have the form of a four-centred arch, the radii of the curves being 57 ft. and 160 ft. respectively. The two central curves of each rib—those of 160 ft. radius—meet at an angle in the centre at a height of 96 ft. above platform level. The roof is 690 ft. long, and has a clear span of 240 ft., covering five platforms, ten lines of rails, and a cabstand 25 ft. wide between the arrival platforms, the clear area within the station walls being thus 165,600 square feet. The ribs are 8 ft. deep, and are made with lattice bracing, except for a short portion of their length at the springing, where they have plate webs, the junction of the lattice and solid web portions of each rib being marked by ornamental castings. Castings are also placed at the springing of the ribs from the platform level, and handsome spandril fillings are introduced in the spaces between the ribs and the side walls. The main ribs are placed at a distance apart of 29 ft. 4 in. from centre to centre, there being three intermediate ribs between each pair of main ribs, and these intermediate ribs being carried by trussed purlins, which are so constructed that they also stiffen the bottom flanges of the main ribs laterally. The intermediate ribs are of rolled iron of I section 10½ in. deep. The roof is glazed for a distance of about 70 ft. on each side of the centre, the remainder being covered with slates on boarding.

The thrust of the roof is taken by the transverse girders which support the floor of the station. The rail level in the station is about 17½ ft. above that of the adjoining streets, and this fact has been taken advantage of to form extensive cellars. The floor of the station is supported by ranges of cast-iron columns, these columns being placed at a distance apart of 14 ft. 8 in. from centre to centre. The height of the basement story, from ground level to the top of the columns, is 13 ft. 6 in. The transverse girders extending across the station rest on these columns, and the ends of each alternate girder are firmly secured to the feet of the main ribs. The girders are so proportioned as to be capable both of carrying the rails and platforms, and of resisting the tensile strain put upon them by the thrust of the ribs. The main transverse girders are about 2 ft. deep, and then have cross girders between them, the main and cross girders being connected by Mallet's buckled plates, which form the flooring.

The transverse girders are connected so as to form continuous girders across the station. In addition to being tied by the transverse girders in the manner just explained, the feet of the ribs are each secured by four 8 in. bolts to an anchor-plate built into the wall, the bolts having enlarged ends where the screws are cut on them. About one-third of the flooring plates, girders, columns, &c., have been erected, and about one-half of the springings of the arched ribs set up. The great travelling platform, by the aid of which the remaining portion of the ribs is to be erected, is also in progress.

The weights of some of the principal portions of the ironwork of the roof, &c., are approximately as follows:

Main floor girders	...	...	...	tons.
Intermediate "	...	...	...	500
Cross girders of floor	...	...	...	390
Buckled plates	...	...	...	1020
Main roof ribs and spandril framing	...	...	...	820
Intermediate ribs	...	...	...	1270
Purlins and connexions between ribs	...	...	...	320
Cast-iron columns and caps below flooring	...	...	...	230
				1080

The hotel will be situated at the south end of the station. The architect of the hotel and station buildings is Mr. Gilbert Scott, Mr. W. H. Barlow being the engineer-in-chief of the whole work. Mr. Barlow has entrusted Messrs. Ordish and Le Feuvre with the design of the details of the roof, and the work is being carried on under the direction of Mr. F. Campion, the resident engineer of the metropolitan portion of the Midland Railway extension works. The general contractors are Messrs. Waring Brothers, who are carrying out the work in an excellent manner, and the ironwork for the station is being made by the Butterley Company. We have in this present notice merely remarked upon some of the principal features of the St. Pancras station, but we shall probably at some future time enter into further details.

STEAM CULTIVATING COMPANIES.—In noticing Mr. Phillips Smith's improvements in traction and cultivating engines in our last impression, referring to the success of the Herefordshire Steam Cultivating Company, we say, "the reports show a net revenue over all expenses of 26½ per cent. since its formation two or three years ago." We should have said 26½ per cent. *per annum* profit after deducting all expenses. With 26 millions of bullion lying idle and money at 2 per cent., such a result as the Herefordshire Company should tempt the employment of capital in the improvement of agriculture, which, of all our great industries, has been hitherto most neglected.

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. 3291, 1s. 10d.) Thomas Berney, of Bracon Hall, Norfolk, patents machinery for bending plates and angle-irons, &c. The arrangements—which could scarcely be clearly described without the aid of drawings—are such that the plates, &c., can be bent to curves of varying radius.

(No. 3292, 10d.) Thomas Vaughan Morgan, of Chelsea, and Edwin Hyles, of Battersea, patent improvements in machinery for manufacturing crucibles and other hollow ware from plastic materials. According to these plans, the plastic material is placed in a horizontally revolving mould, as usual, and the "former," for shaping the interior of the article, is adjustable horizontally, and is carried by a crossbar, which can be raised and lowered between two up-rights. Arrangements are also provided for keeping the frame by which the "former" is carried steady, whilst the "former" is acting on the plastic material.

(No. 3295, 1s. 4d.) Charles Randolph, of Glasgow, patents an arrangement of machinery for propelling vessels on the water-jet principle. We shall give a full description of Mr. Randolph's plans in an early number.

(No. 3297, 1s.) Samuel Chatwood, of Bolton, and John Sturgeon, of Burley, near Leeds, patent improvements in steam-hammers. The plan proposed includes arrangements for raising and lowering the hammer cylinder, so that the full length of stroke may be obtained on forgings of various thicknesses; and also means for shifting the cylinder laterally, so that the hammer may be brought to bear upon one of two or more anvils at pleasure. One of the plans proposed was illustrated on page 679 of the last volume of *ENGINEERING*.

(No. 3299, 1s. 2d.) George Bertram, of Edinburgh, patents improvements in machinery for the manufacture of paper. According to these plans the "half-stuff" to be converted into pulp instead of being treated by the ordinary beating engine, is passed through a machine consisting of a truncated conical casing, the interior of which is fitted with a number of knives or cutters, this casing having revolving within it a conical "grinder," the circumference of which is also fitted with knives or cutters. The half-stuff is admitted at the top of the machine, and is ground or beaten between the cutters of the casing and those of the revolving "grinder," the spindle carrying the latter being capable of being raised or lowered, so that the distance between the two sets of cutters can be adjusted.

(No. 3304, 6d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Asa R. Reynolds, of Auburn, U.S., a method of welding steel to iron, and tempering the steel simultaneously, the process being stated to be applicable to the welding of the cutting edges of tools to the iron backs. According to the methods proposed, the welding is effected by placing the steel and iron portions of the article on an anvil mounted on an elastic bed, and then subjecting them to a blow from a heavy "drop die," this die being of great weight, and having only a very short stroke. It is stated that the "shivering" or vibrating blow thus given, combined with the coolness of the anvil and die, effects the proper tempering of the steel. We should have some doubts about the certainty of the process.

(No. 3320, 8d.) Frederick Nicholas Meixner, of Manchester, patents a method of regulating the supply of water to those turbines of the "Foureyron" class in which the depth of the guides and buckets is divided into a series of spaces to suit varying quantities of water. Mr. Meixner brings the outer edges of the guide-vanes as close as possible to the inner edge of the buckets, and makes the inner diameter of the guide-vanes the same as that of the pipe by which water is supplied to the turbine; and he fits the bore of this latter pipe with a cylindrical regulator, which can be raised or lowered so as to cover the openings between the guide-vanes more or less, and thus govern the quantity of water admitted to the wheel.

(No. 3321, 2s. 8d.) John McFarlane Gray, of the Vauxhall Foundry, Liverpool, patents an arrangement of steering apparatus, this comprising a steering telegraph and rudder indicator, and a steam steering-engine. This steering apparatus, as applied by Messrs. George Forrester and Co. to the Great Eastern, was fully illustrated and described in the last volume of *ENGINEERING* (*vide* pages 579, 580, and 581).

(No. 3336, 1s. 6d.) Michael Henry, of 68, Fleet-street, patents, as the agent of Louis Coignard, of 33, Boulevard Saint Martin, Paris, some forms of centrifugal pumps, the peculiarities of these pumps, which could not be clearly described without reference to drawings, consisting in the shape and arrangement of the valves, and in the construction of some of the other details. The centrifugal pumps are in some cases provided with an air-pump, which can be used for producing a vacuum in the centrifugal pumps when the latter are first set to work.

(No. 3338, 8d.) Michael Hodge Simpson, of 127, Milk-street, Boston, U.S., patents an apparatus for the prevention of sea-sickness. Mr. Simpson states that his own experience has convinced him that sea-sickness is produced by the motion of the vessel causing the stomach to rub against the diaphragm and the inferior organs, and he therefore proposes an apparatus by means of which the rubbing action may be prevented, the traveller connecting "his body as rigidly" "as possible with the ship"—a comfortable suggestion, certainly. The apparatus consists of a kind of chair, in which, by means of arms, straps, &c., a person can be firmly secured; the chair itself being, in its turn, rigidly fixed to the vessel. The sheet of drawings accompanying Mr. Simpson's specification has several views, representing a man secured to the chair in various positions; but the agonies depicted on this individual's countenance, and the general tendency to "bust up" which his appearance suggests, cannot be said to be favourable testimonials as to the ease and comfort to be obtained by the use of the apparatus. Whether or not the engravings represent Mr. Simpson trying experiments we cannot say.

THE INDIAN TELEGRAPH.—A telegram from Bombay states that the telegraph line is greatly improved in its working during the last fortnight, but five miles of the Indian line between Bombay and Kurrachee have been destroyed by a storm. Double rates are in future to be charged on all messages from Kurrachee to Great Britain and France containing groups of figures when the commodity to which they refer is not specified.

AUSTRALIAN RAILWAY LOAN.—It appears from the Sydney advices that the colony of New South Wales contemplates another railway loan in London of 3,000,000 sterling.

PROPOSED ROAD FROM INDIA TO CHINA.—The result of explorations which have been made proves the practicability of a road to China through Burmah. The investigations beyond the frontier are to commence.

THE MILLWALL DOCKS.—The report of the Millwall Freehold Land and Docks Company, to be submitted on Tuesday, states that the docks, which we fully described the week before last, will be ready for the admission of water by the 29th inst., and will be shortly afterward fit for the reception of vessels. The stagnation of business has temporarily checked the great increase in demand for waterside premises, which was anticipated when the works were commenced, and the Board therefore recommend the appropriation of part of the docks for import and export trade, as well as for all the general purposes of commerce. This will necessitate the erection of warehouses and sheds, and, in order to raise the money for the purpose, it is proposed to put forth such portion of the preference shares as remain unissued, and as the proprietors may think fit to sanction. Mr. G. R. Birt, who for ten years was superintendent of the Victoria Docks, has been appointed general manager. The total paid-up share capital of the company is 584,622l.

THE BRINDISI ROUTE TO THE EAST.—Captain Tyler, R.E., has left London for Paris to negotiate with the French Post Office authorities respecting the transmission of the Eastern mails through France and Italy to Brindisi. Captain Tyler will subsequently proceed to inspect the works of the Mont Cenis Railway, the opening of which for traffic is expected to take place next month.

PERU.—According to a recent report from Islay, in Peru, by Mr. Consul Wiltheu, the parties who obtained the concession for a railroad from the coast to the city of Arequipa have not been able to comply with their contract, the time having expired at which they were to have commenced the works. They had been ordered to pay the fine, and the Government had declared themselves open to fresh proposals. A telegraphic line to Arequipa had been recently finished, and was now in full operation.

DOVETAILING MACHINE.—A new machine for cutting dovetails in wood planks or boards, such as required in the manufacture of packing-boxes and other joiners' work, has been recently brought over from America, and patented in England and France. Messrs. Robinson and Son, of Rochdale, have purchased this American machine and the sole right of making it in England, and they are now commencing the construction of such machines. The American original has been sent to the Paris Exhibition, and is about to be started there very shortly. The machine cuts both kinds of dovetails by the application of a peculiarly shaped saw, this being the only cutter employed, and its operation finishing the entire dovetails of both kinds. The same machine can be set to cut dovetails of very different sizes, and it is so simple and light that it can be worked by hand without difficulty. It is, however, constructed for working by steam power. Its rate of production is very rapid, and the cost of repairs is said to be very trifling, as the saw is not likely to get out of order. The machine is not large, and it is said that its price complete will be less than 100l., including royalty in England.

A NEW INDIAN RAILWAY.—A railway has been proposed between Calcutta and Darjeeling, and the scheme is approved by the Bengal and India Governments.

FORMULAS AND TABLES FOR THE
SHAFTING OF MILLS AND FACTORIES.*

By JAMES B. FRANCIS, Civil Engineer.

The following investigation was undertaken at the request of General John C. Palfrey, the agent of the Merrimack Manufacturing Company, of Lowell, Massachusetts, for the purpose of ascertaining the relative fitness of wrought iron and steel for the shafting of a cotton factory now erecting by that company.

Samples of steel, all of American manufacture, were obtained from different makers, and, together with several samples of iron, were subjected to experiment.

The constant expressing the resistance of cylindrical bars to torsion I deduce from Navier's formula,†

$$T = \frac{16WR}{\pi d^3} \quad (1)$$

in which

T = a constant for the same material.

W = the weight, in pounds, which, if applied at the distance R, in inches, from the axis, will just fracture the bar.

π = the ratio of the circumference of a circle to its diameter.

d = the diameter, in inches, of the bar at the place of fracture.

The bars subjected to torsion were finished in the form of the annexed diagram, the ends being 2 in. square, and the middle turned down to a diameter of $\frac{1}{2}$ in., in order to ensure the fracture taking place in that part of the bar.

The weight producing the torsion was applied at the end of a lever, of the effective length of 35.975 in., fitted to the square boss at one end of the bar. The tendency of the bar to revolve under the action of the weight was controlled by a worm-wheel about 15 in. in diameter and 138 teeth, fitted to the square boss at the other end of the bar. This wheel could be moved through any arc by means of a worm. As the bar became twisted by the torsional strain, the worm-wheel was moved through an arc sufficient to bring the lever to an horizontal position.

A graduated circle on one face of the worm-wheel furnished the means of measuring the arc of torsion.

The effective weight of the lever and scale at 35.975 in. from the axis, where the scale was hung on a knife edge, was 48.5 pounds, and was the least effective weight which could be applied to produce torsion.



EXPERIMENTS ON TORSION.

Description of the Bar.	Mean diameter of the reduced part of the bar, in inches.	Arc of torsion just before fracture, in degrees.	Weight producing fracture, in pounds.	Mean temperature of the air.	Value of T
English refined wrought iron, from a bar 2 in. in diameter, marked A 18 ...	0.750	416.8°	113.17	58.8°	49,148
Same, marked 13 ...	0.750	596.0°	125.69	66.0°	54,585
Wrought iron, from the Pembroke Ironworks, Maine, marked 14 ...	0.753	641.3°	143.72	62.3°	61,673
Decarbonised steel, from the Farist Steel Company, Windsor Locks, Conn., from a bar 2 in. square, marked B 6 ...	0.752	390.5°	192.48	70.2°	82,926
Spindle steel, from the same, from a bar 2 in. square, marked A 5 ...	0.750	284.3°	235.17	68.3°	102,131
Steel, from the Nashua Iron Company, Nashua, N. H., from a bar 2 in. square, marked 2 ...	0.751	611.3°	198.73	65.5°	85,961
Same, marked d 2 ...	0.752	557.0°	203.23	63.7°	87,557
Steel, from same, from 1 1/2 in. octagonal bar, marked 4 ...	0.752	475.0°	221.0	67.5°	95,218
Same, marked 3 ...	0.751	508.3°	217.25	61.2°	93,972
Steel, from the works of Hussey, Wells, & Co., Pittsburgh, from a bar 2 in. square, marked E 1 ...	0.751	308.0°	202.66	63.6°	87,661
Same, marked 1 ...	0.748	297.3°	196.50	68.0°	86,023
Bessemer steel, from the works of Messrs. Winslow & Griswold, Troy, N. Y., from a bar 2 in. square, marked 16 ...	0.748	215.5°	181.97	66.0°	79,662
Same, marked 16 x ...	0.748	268.5°	174.50	67.0°	76,392

The experiments on deflection were made on round bars turned to a diameter of about 1 in. The distance between the points of support was 48 in. Observations were made of the deflections produced by a weight of 150 lb. suspended at the middle point between the supports. This weight was not sufficient to cause any sensible set in the bar after the weight was removed; and no sensible increase in the deflection was produced by allowing the weight to remain suspended on the bar for several days.

The constant, E, for deflection has been computed by Navier's formula,‡

$$E = \frac{pW}{6\pi d^4} \quad (2)$$

* From the Journal of the Franklin Institute.

† Résumé des Leçons sur l'Application de la Mécanique.

‡ See Journal of the Franklin Institute for February, 1862.

in which

l = the distance between the points of support, in inches.

W = the weight at the middle point, between the supports, in pounds.

π = the ratio of the circumference of a circle to its diameter.

d = the diameter of the bar, in inches.

δ = the deflection at the middle point between the supports, in inches.

EXPERIMENTS ON DEFLECTION.

Description of the Bar.	Diameter of bar at the middle, in inches.	Deflection, in inches.	Mean temperature of the air.	Value of E.
Spindle steel, from the Farist Steel Co., Windsor Locks, Conn., from a bar 1 1/2 in. in diameter, marked A 7 ...	0.995	0.2380	48.0°	3,853,590
Same, marked A x 7 ...	0.977	0.2315	53.5°	3,847,530
Decarbonised steel, extra, from the Farist Steel Co., from a bar 1 1/2 in. in diameter, marked A A x ...	0.993	0.2310	53.0°	3,918,360
Same, marked A A 8 ...	0.995	0.2327	53.7°	3,858,557
Decarbonised steel, from the Farist Steel Co., from a bar 1 1/2 in. in diameter, marked 9 x B ...	0.992	0.2330	54.2°	3,900,420
Same, marked 9 B ...	0.995	0.2307	53.3°	3,892,008
Steel, from the works of Hussey, Wells, and Co., Pittsburgh, from a bar 1 1/2 in. in diameter, marked 15 ...	0.998	0.2337	52.2°	3,796,060
Same, marked 15 x ...	0.996	0.2337	49.8°	3,826,641
Bessemer steel, from the works of Messrs. Winslow and Griswold, Troy, New York, from a bar 1 1/2 in. in diameter, marked 17 x ...	1.000	0.2330	49.4°	3,777,095
Same, marked 17 ...	1.000	0.2315	52.0°	3,801,566

Several specimens of the steel have been tested for tensile strength, at the works of the South Boston Iron Company, by Mr. F. Alger, in the apparatus designed by Major W. Wade, for testing metals for cannon, a description of which may be found in "Reports of Experiments on the Strength and other Properties of Metals for Cannon," published in 1854, by authority of the Secretary of War.

EXPERIMENTS ON TENSILE STRENGTH.

Description of the Specimen.	Diameter at the place of fracture, in inches.	Weight producing fracture, in pounds.	Tensile strength per square inch in pounds.	Specific gravity.
Spindle steel, from the Farist Steel Co., Windsor Locks, Conn., marked A 10 A 1 ...	0.597	40,800	145,754	7.8401
Same, marked A 10 A 2 ...	0.598	39,500	140,639	7.8287
Decarbonised steel, from the same, marked B 11 B 1 ...	0.596	34,500	123,662	7.8583
Same, marked B 11 B 2 ...	0.597	35,200	125,750	7.8514
Decarbonised steel, extra, from the same, marked A A x 1 ...	0.600	30,500	107,862	7.8417
Same, marked A A x 2 ...	0.600	30,900	109,271	7.8579
Same, marked A A x; ends upset in order to form the specimen ...	0.600	30,800	108,901	7.8484
Same as next preceding specimen, marked A A x 2 ...	0.600	29,700	105,053	7.8534
Steel, from the works of Hussey, Wells, and Co., Pittsburgh, marked c 12, 1 ...	0.694	40,400	145,790	7.8530
Same, marked c 12, 2 ...	0.694	40,200	145,070	7.8496

I find on record many experiments on the fracture of iron and steel by torsion, from which I deduce the following values of T; using the above formula for cylindrical bars, and Navier's formula,

$$T = \frac{3\sqrt{2}WR}{\delta^2} \quad (3)$$

for square bars, in which b = the side of the square in inches, and W and R the weight, in pounds, producing fracture, and the distance from the axis, in inches, at which it is applied.

Experiments by Rennie, given in the *Philosophical Transactions of the Royal Society*, for 1818.

Bar of English wrought iron, 0.25 in. square ... T = 65,982
Bar of Swedish " 0.25 in. " ... T = 61,909
Bar of shear steel " 0.25 in. " ... T = 111,191
Average of 3 bars of iron cast horizontally, 0.25 in. sq., T = 64,776

Experiments given in the fifth edition of *Hassell's Engineers' and Mechanics' Pocket-book*.

Bar of Ulster Iron Co.'s wrought iron, 1 in. diameter, T = 87,090
Bar of Swedish " " " T = 93,965

Experiments made at the "Royal Gun Factories, Woolwich, England, on many varieties of cast iron. (Parliamentary document ordered to be printed July 30, 1858.)

Experiments are given on fifty-one varieties of British cast iron, besides several varieties from other countries. I select the experiments on four varieties of British iron, viz., the strongest, two of medium strength, and the weakest; each result being deduced from a mean of several experiments on bars about 1.8 inch in diameter.

From West Hallam Ironworks, Ilkeston ... T = 38,217
" Netherton Ironworks " ... T = 34,490
" Butterley " " ... T = 33,949
" Haematite Iron Company " ... T = 22,132

Experiments made at the Fort Pitt Foundry, in 1846, on bars of different forms and dimensions of common foundry iron, given in Reports of Experiments, &c., above cited.

Bar about one inch square ... T = 36,946
" 1.45 inch square ... T = 34,443
" about 1.749 inch square ... T = 42,821
" 1.135 inch in diameter ... T = 37,445
" 1.506 " " " " T = 42,047
" 1.955 " " " " T = 38,851

Experiments made at the West Point Foundry, in 1851, on Greenwood iron of different grades, mixtures and fusions, given in Reports of Experiments, &c. above cited.

Mean deduced from eighteen experiments on bars about 1.9 inches diameter ... T = 44,957

The value of E, for wrought iron, I have previously deduced from English experiments, and tested by a single experiment on a shaft two inches in diameter and about 180 inches between bearings.* From these experiments I find E = 3,492,539

There being such great irregularities in the values of T, it will not be safe, in practice, to take a mean value, but one near the lowest value.

The values for wrought iron vary from 49,148 to 93,965. For safety, I take for wrought iron ... T = 50,000

The values for steel vary from 76,392 to 111,191. For safety, I take for steel ... T = 80,000

The values for cast iron vary from 22,132 to 64,776. For safety, I take for cast iron ... T = 30,000

I also take for wrought iron ... E = 3,500,000
And for untempered steel ... E = 3,800,000

Shafts for transmitting power are subject to two forces, viz., transverse strain and torsion. In shafts of wrought iron or steel, in which the bearings are not very near to each other, a transverse strain, too small to cause fracture, will produce sensible deflection; if this is too great, it will produce sensible irregularities in the motion, and tend towards the rapid destruction of the shaft and its bearings. This limits the distance between the bearings, as the weight of the shaft itself will produce an inadmissible amount of deflection whenever this distance exceeds a certain amount, which varies with the material and diameter of the shaft.

The deflection of a cylindrical shaft from its own weight, supported at each end, but disconnected from other shafts, is given by the formula (4), which is deduced from Navier's formula for the deflection of a cylindrical bar. (See Journal of the Franklin Institute for February, 1862.)

$$\delta = 0.007318 \frac{W l^3}{d^4 E} \quad (4)$$

If the several parts are so connected as to be equivalent to one continuous shaft, it will correspond to the case of a beam fixed at both ends, for which case Barlow gives δ equal to two-thirds of its value in the case of a beam supported at both ends, given by formula 4. Navier, taking into account the effect of the deflection in the adjacent divisions, finds δ equal to one-fourth of its value by formula 4. In order to decide which of these eminent authorities to follow, I have appealed to experiment.

(To be continued.)

THE ATLANTIC CABLE.—It must have appeared extraordinary to those who have watched the condition of the submarine telegraphic lines connecting Europe with America, that while the 1865 cable, which was picked up from the depths of the ocean after it was thought it had been irretrievably lost, has since its junction with America remained intact, that of 1866 has been ruptured twice. The explanation of this is, however, exceedingly simple. It appears that when the shore end of the 1866 cable was being laid from the Great Eastern the vessel was in a fog, and unfortunately this part of the line was laid over a shoal patch, about forty fathoms in depth, so that the icebergs which so constantly occur in that region, reaching, as they often do, to the bottom, cut the cable. The wire has been completely repaired, but it has been resolved upon to raise the shore end of it as soon as possible from its present bed and remove it to a deeper channel. Meanwhile, with a view to more perfect communication between Europe and the United States, the ship Chiltern, which had been commissioned by the Telegraph Construction and Maintenance Company, sailed on Tuesday last with the telegraphic wires, of the material of which we gave an account some time ago, which are to be laid from Placentia, in Newfoundland, to the island of St. Pierre, on the Gulf of St. Lawrence. She carries 320 miles of wire which is packed in new water-tight tanks. There is no doubt that until perfect telegraphic communication is established between Europe and the United States in such a manner as to avoid adopting the assistance of the land lines in New Brunswick, Nova Scotia, and Newfoundland our correspondence will be subjected to the interruptions by which it has been so often retarded during the past year. With a view, however, to temporarily remedying the evil, it is contemplated to establish throughout Nova Scotia a series of land lines from Sydney, via Halifax, to the United States and Canada; should these fail during the winter, and there is no doubt that they will have to bear the brunt of snow-storms and sustain the weight of superincumbent ice, it will become absolutely necessary to lay submarine lines between Halifax and Boston in 1868. A Franco-American company is, we understand, in course of formation, with the object of laying a submarine cable from Ushant to Boston, so that it will be advisable for us to take such measures as will obviate the necessity of availing ourselves of the new projected line. This is not a subject, however, in which Englishmen alone are interested, the whole world will doubtless have more or less anxiety for its success.

THE OAKS COLLIERY.—The work of opening out the colliery has been suspended, as the men have got close to the bottom, and nothing further can be done until there is a meeting of the mining engineers to decide upon what course will have to be adopted in entering the workings.

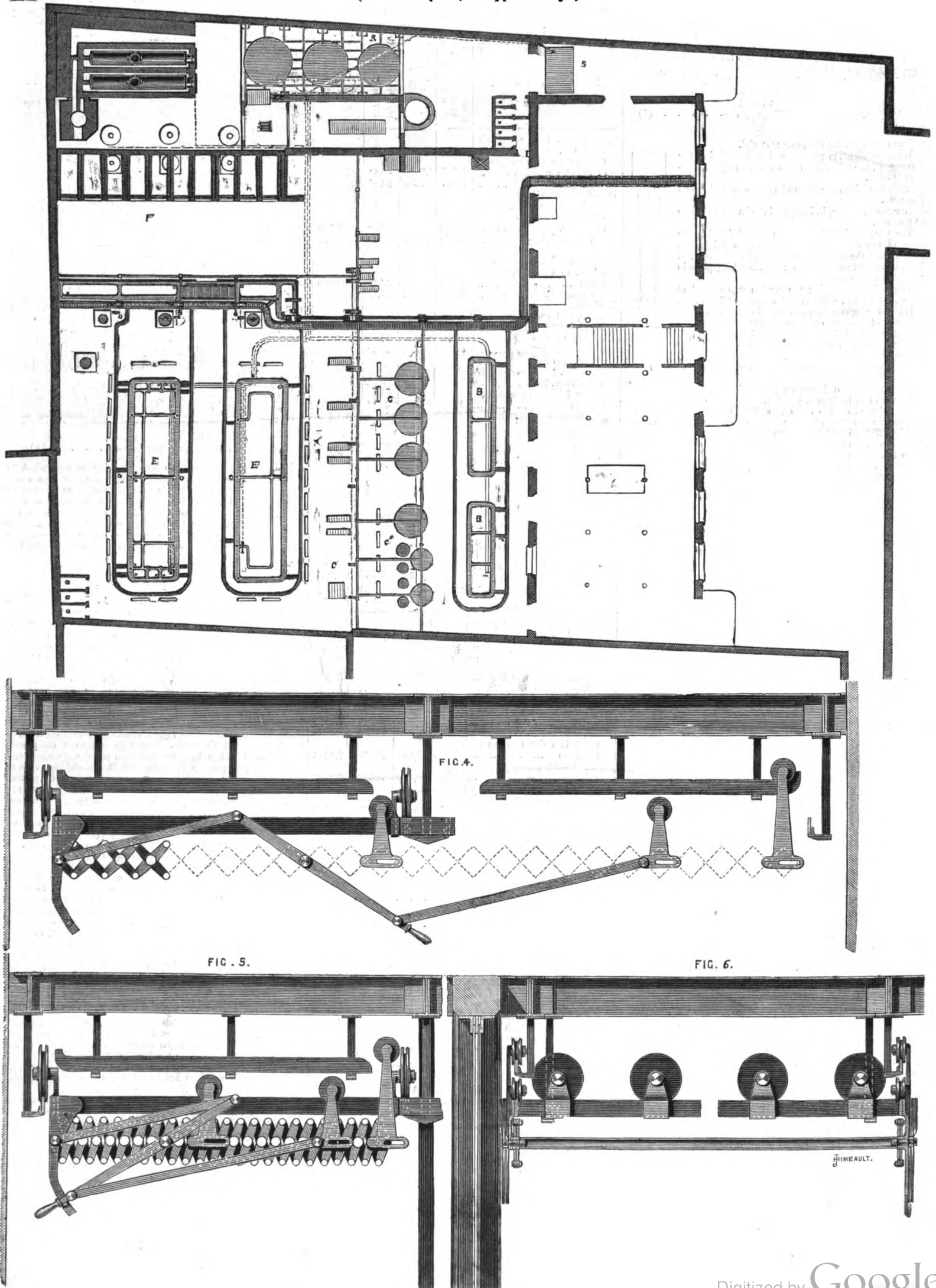
* See the number of the Franklin Institute Journal for February, 1862.

† Report of the third meeting of the British Association for the Advancement of Science.

‡ Résumé des Leçons sur l'Application de la Mécanique.

THE LAUNDRY OF THE GRAND HOTEL, AND HOTEL DU LOUVRE, PARIS.

M. EUGENE FLACHAT, ENGINEER.

(For Description, see opposite Page.)

THE LAUNDRY OF THE GRAND HOTEL, PARIS.

M. EUGENE FLACHAT, ENGINEER,

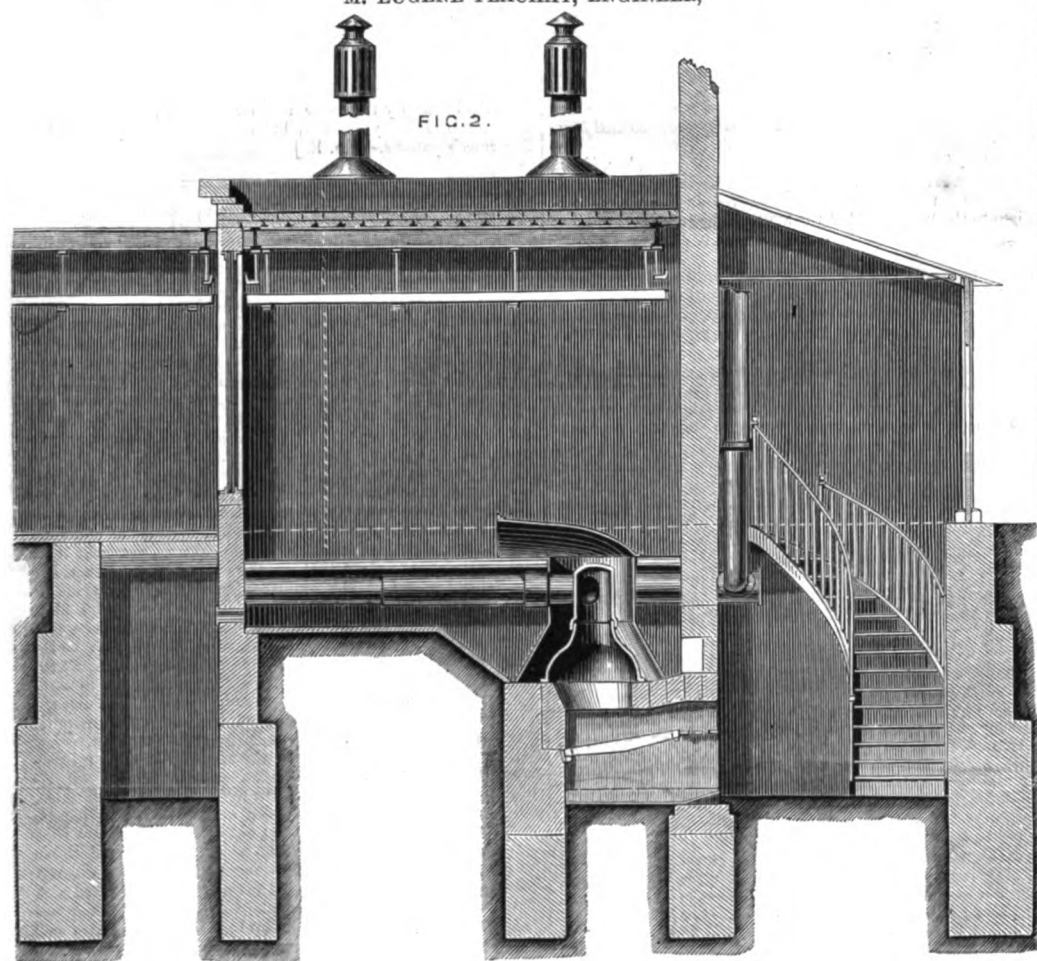


FIG. 2.

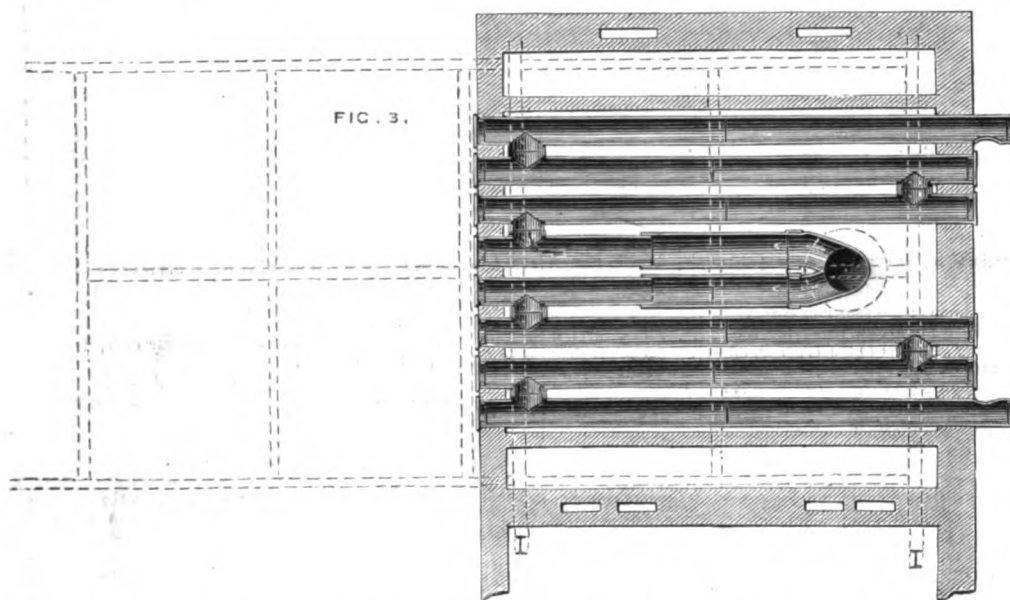


FIG. 3.

It may appear strange, at first sight, to find the washing of dirty linen considered amongst the objects of scientific engineering; yet the account which we propose giving of a laundry established several years ago in Paris, and now in regular and very satisfactory operation, will prove to our readers how much engineering science and practice, and how great an amount of skill and ingenuity, may be brought to bear upon the performance, on a large scale, of those simple operations which usually form the business of a laundress. The Compagnie Immobilière, of Paris, being the proprietors of the two largest hotels in that town, viz., the Grand Hôtel and the Hôtel du Louvre, found it necessary to establish a special laundry for the vast quantities of washing required by these two hotels, quantities which reach the enormous amount of 4 tons of linen per day. The company consulted M. Flachat on the best mode of laying out an establishment on such a large scale, and the result was the construction of the present great laundry, from the designs and under the supervision of that celebrated engineer. The resident engineer of this laundry is M. Fellot. The laundry was commenced in 1863, and since that date it has been considerably enlarged and its business increased. It is now not only employed by the two great hotels of the company, but also by the Jockey Club, the Transatlantic steamboats, and other large institutions. The laundry also possesses a large stock of linen, which has been bought on speculation, and which is lent to the different

hotels and public-houses in Paris for a fixed rate of hire, including the charge of washing, so that hotel-keepers and private parties are saved the necessity of purchasing their own stock of linen, and have no other payments to make but the washing bills. This business has proved highly profitable to the company, as the purchase and management of such large stores of linen as those now employed in this business offer advantages with regard to economy and quality of goods which cannot be obtained in any other manner, and are, therefore, inaccessible to parties employing limited quantities. The present capability of the great laundry amounts to the washing of 6 tons of clothes per day, this weight being that of the linen in a dry state. For this quantity the laundry consumes 180 cubic metres, or 39,600 gallons, of water, of which 100 cubic metres, or 22,000 gallons, are supplied by the waterworks from the river Seine, and the rest is furnished by a well on the spot. The consumption of fuel is about 2 tons of coal and 1 ton of coke per day, the former being burnt under the steam boilers and the latter in the drying-stoves of the laundry.

On the opposite page, we give a general plan of the establishment, which is situated in the Rue de Courcelles, near Auteuil, Paris, and forms a large building several stories high in some of its parts. The plan represents the ground floor, which contains all the machinery, the rooms overhead being used for hand-labour, store-rooms, and air-drying sheds only. The

clothes are brought into the laundry in carts belonging to the company, and are discharged on the floor of a large room, A, where they are separated and removed to the washing-tubs in small three-wheeled barrows. The tubs, or basins, are made of bricks and Portland cement. They form two extensive reservoirs, each divided into smaller compartments by partition walls; their inner surfaces are covered with Portland cement, and the supply of water from the reservoirs, R and S, is effected by the pipes indicated in single lines. The linen is left in these basins from 10 to 15 minutes, after which it is transferred to the reservoirs, C, containing alkaline solutions. Each of these vessels is filled with cold water at the beginning of the operation, and afterwards heated by steam, which is supplied through a central pipe having an injector-pozzle at the bottom of the reservoir, a constant supply of fresh water being drawn in with the steam. This heated water rises up through the central pipe, and ultimately escapes through two horizontal branch pipes, which are perforated with numerous holes at their sides, so that the escaping water drives them slowly round in a circle by reaction, the branch pipes spinning round the upright vertical pipe, while the hot water escapes through their openings in thin small jets. There are four large vessels of this kind, each containing 1 ton of clothes (weighed dry), and the corresponding quantity of water, to which 46 lb. of carbonate of soda are added for each operation. The time occupied by this process is about five hours, the supply of hot water by means of the injector being kept constant during this whole time, so that towards the end of the operation the water is at its boiling point. The surplus of water is let off by waste pipes. The boiling vessels are made of cast iron covered inside with zinc, and they are of a cylindrical form. Besides the four large vessels, two smaller ones, each containing 660 lb. of linen, are in use; some still smaller vessels, which had been originally provided, have since been discarded. They are indicated on the plan at C'. The next operation is of a mechanical nature, and it consists in passing the clothes through a washing-machine proper. This latter consists of a large cask or cylinder made of wood, and mounted upon pairs of rollers in an inclined position. It is kept in motion by means of the rollers, which make it revolve round its own axis at a slow and uniform rate. In the interior, the cylinder is provided with rows of shelves or boards placed parallel to its axis, and both ends are open at the centre. At the upper end, the linen is thrown into this cylinder, and it is tumbled and tossed over in each revolution of the latter, gradually descending at the same time on the incline formed by the position of the axis of rotation, so that it is ultimately discharged at the lower end of the washing-machine. The linen then only requires to be passed through cold water once more, an operation performed by hand, in large basins provided for this purpose, and represented at E. For smaller pieces of linen, which require a different treatment, some special machines are provided. There is a large drum or wheel of copper mounted on a horizontal axle, and made to revolve rapidly. This drum is divided by partitions into four compartments, each having a door on the face of the drum for charging and removing the clothes. The sides and partitions of the drum are everywhere perforated with small holes, and the whole is enclosed in a chamber filled with an alkaline solution nearly up to the level of the bearings in which the drum revolves. A constant current of steam is passed through this liquid from the boilers during the operation of washing, and the linen is thus exposed to the action of the alkaline solution at a boiling heat, being at the same time agitated very forcibly by the quick rotation of the drum. This apparatus serves for washing the linen of the visitors at the great hotels, and the whole process is completed in the short time of two or three hours, this time including all the subsequent operations of drying, &c.

The process of drying the linen is carried out by centrifugal machines. There are at present three large machines of this kind at work. One made by Messrs. Ducommun, of Mulhouse, is 3 ft. 3½ in. in diameter, and its gearing is placed entirely underneath the floor, so that the box is left clear for charging and removing the articles. The two other centrifugal machines were made by Messrs. Buffand and Co., of Lyons, and they are each 2 ft. 7½ in. in diameter. The work performed by these drying-machines is very important. The wet linen, when taken from the washing-tub, contains a quantity of water fully equal to its own weight. After having passed the centrifugal machine, there is only 40 per cent. of this water left in the linen, and this quantity must be removed by evaporation. In seasons permitting of a successful air-drying process, a great part of this process is effected in the drying-sheds by means of the natural action of the atmosphere, but at most seasons a considerable part of the work, and in winter almost the whole of it, has to be done by stoves. The stoves are represented at F, in the plan. They were constructed by Messrs. Bouillon and Muller, and consist of large chambers divided into compartments, and heated by means of flues of wrought iron, which pass underneath the perforated floor. The flues are traversed by the products of combustion passing from a fire maintained upon a grate under a cast-iron dome which is heated to redness by the fire. The fuel used for this purpose is coke. The linen is suspended in these chambers on copper tubes sliding in and out upon iron bars. The process of drying in these stoves shows a comparatively wasteful application of heat. The quantity of linen dried per pound of coke consumed on the grate only corresponds to an evaporation of 1.8 pounds of water, a result which, although nobody expects it to compare with the effect obtained in a steam boiler, is very low. There have been for this reason other drying stoves constructed more recently at this laundry, and of these we give an illustration on the present page, Fig. 2 being a vertical section, and Fig. 3 a horizontal section through the flue tubes. These stoves are also heated by a coke fire burnt under a cast-iron dome, and the products of combustion pass through a series of zigzag iron tubes, each 10½ in. in diameter, at the bottom of the chamber.

The new stoves have better proportions than those first made, and they are better arranged for utilising the heat radiated from the dome and pipes. Their effect is consequently much better, amounting to an evaporation of 2.4 pounds of water per pound of coke. There is also a more convenient apparatus provided for the suspension of the cloth within the chambers, which we

have illustrated on page 151, Figs. 4, 5, and 6. It consists of a series of tubes moved in and out by an arrangement, on the "lazy tongs" principle, and which will be readily understood from the engravings. These new stoves are placed in an annex not shown in the plan. There are now five stoves in all, three on the old and two on the new plan. The further processes passed through by the linen are different according to the nature of the articles. There are some calendering rolls of large size provided, and driven by steam power, also several hydraulic presses for folding and pressing napkins, sheets, and other articles of that kind. The small linen is finished by hand, there being about 150 women employed for that purpose in this establishment. Division of labour is very carefully carried throughout the manual operations, each kind of work being executed in a special room, and by hands employed at this one kind of work only. A very complete system of statistics is being compiled by the clerks of this laundry, for the purpose of collecting experience and information with regard to the relative durability of different fabrics, and to the most advantageous modes of treatment for each kind. The purchase of large quantities of linen has given rise to comparative tests of the strength of different kinds of textile fabrics. A testing machine has been provided for this purpose at the laundry, and in this the tensile strength of the fabrics is ascertained both in the direction of the warp and of the weft. These tests have shown that in many instances the strength of the fabric was insufficient, and very different in the two directions, and orders were accordingly given to the manufacturers for articles of such strength as to resist a greater wear. By these means the durability of the linen has been increased more than 100 per cent., and a corresponding economy and gain have been the natural result.

THE RICHARDSON PROCESS.

TO THE EDITOR OF ENGINEERING.

SIR,—With reference to a leader in *ENGINEERING* of the 9th inst., criticising a paper in the *Practical Mechanic's Journal*, of August 1st, entitled "The Richardson Process," I, as the writer of that paper, feel myself called upon to ask space to comment on the remarks in your paper.

From what source you obtained the information to enable you to say that the experiments were made "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," I do not know; it is, therefore, right for me to dissipate from your mind and those of your readers the grave error into which you have fallen, as it appears to me, inadvertently. The fact is that not only does Mr. Richardson use the tubular rabble as an instrument whereby to inject oxygen into the mass of the charge, so as to reduce it to the metallic state as rapidly as possible, but at the same time the puddler manipulates the charge with it in precisely the same way he has hitherto been accustomed to work the old fashioned rabble, thus constantly exposing fresh portions of crude metal to the surface of the charge. You will thus easily comprehend that the tool used in the "Richardson process" is something more than a "blast-pipe," as you term it. It is, in fact, an instrument adapted to perform the common work of the old fashioned rabble, and the injection of oxygen as well.

It may be as well that I should here explain the essential feature that Mr. Richardson has kept in view.

In the first place, he set himself to avoid altogether the use of any separate process for refining the crude metal. As to his success on this point, I need only refer you to the table of experiments which I compiled, in which you will find that in using the proportion of "plate" or refined metal commonly employed in the Scotch ironworks, the time of working the charge is longer than with the very commonest brands of pig that could be got.

In the second place, one of the objects was to produce in the puddling-furnace a metal combining some of the properties of the best malleable iron and some of those belonging to Bessemer metal, of which properties I may briefly mention, as belonging to the former, a high range of tenacity, high ductility, and freedom from cold and red shortness; as belonging to the latter, the more thoroughly cohering state of the metal believed to be caused by the more complete elimination of carbon and some silica and slag, since it appears extremely probable, indeed, if I err not, it has in some cases been shown, that the weakness of some puddled irons is caused by the presence of these substances in the state of minute and highly attenuated plates, separating the fibres (more strictly speaking, the atoms) of metallic iron, thus intercepting their intimate cohesion.

In a word, the second object was to produce iron in a state that, commercially, we have not yet been able to obtain.

The third object sought was to reduce as much as possible the time of bringing the crude or pig iron into the state of the best malleable metal: this already the experiments show may be lessened over one-third with the very lowest brands; I may, therefore, be excused for looking forward to still greater reductions where a better quality of crude metal is used.

From what has now been shown, I conceive it will, at least, be apparent that there is something more in this process than had occurred to you when writing the leader under reference. I have, therefore, good grounds for taking up an argument opposed to that which has been published in your columns. I, therefore, combat the conclusion at which you have, certainly, in too much haste, arrived, namely, that in your opinion "The Richardson Process" is an infringement of Bessemer's patent, No. 2768, A.D. 1855.

To discuss this rather serious expression of your views, it is necessary, first of all, to consider the real subject matter of Mr. Bessemer's patent, to enable me to do which I must refer at length to your own principal extracts, at the same time asking permission to supplement them with further extracts of my own, in order to illustrate the truth, the elucidation of which is all I aim at.

Now, in the first place, in his *provisional* specification (and this is the document from which you chiefly quote) Mr. Bessemer states: "The object of the first stage of my improved process of manufacturing iron consists in refining the iron after it leaves 'the blast furnace, and while still in a fluid state;' the mode of which may be expressed by saying that, in place of running

the crude metal into sand beds, there to consolidate into pigs, he causes it to flow direct from the blast furnace into a refining vessel, which vessel Mr. Bessemer describes as an improvement on the ordinary "finery;" nevertheless, a "finery" in another shape it still is. He next describes his process of refining iron by blowing air or steam, or air and steam, into the molten metal in this refining vessel, by means of a pipe dipping into it. Mr. Bessemer then observes that "when the workman judges the process has been carried far enough, he will turn the vessel on its axes, and discharge the contents of it into a suitable iron mould, having compartments of such dimensions as will form 'ingots suitable for the puddling process.'"

Now, Sir, I merely ask you if thus far a "finery," or, if you like it better, a *separate refining process*, is dispensed with? Is not the metal most unmistakably prepared by a process intermediate to the "tapping" of the blast furnace and its treatment in the puddling furnace, so as to more completely fit it for being operated upon in the latter?

I now proceed to consider your first quotation, which runs thus: "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."

Now, you will allow me to state that the latter part of this process of Bessemer's is nothing else than the use of a puddling furnace to complete the work which could not be done, for obvious reasons, in the refining vessel. Indeed, had you given a veritably complete quotation, you ought, in strict justice, to have commenced at the beginning of the paragraph from which you extract, in which Mr. Bessemer specifies that, "For the purpose of completing the refinement of the iron," he uses a reverberatory or puddling furnace, &c., the remainder of the sentence being as you have it. Why should you have omitted these few words, which at once convey a different and, let me add, the true meaning to the paragraph, I cannot divine. It is thus far evident that Mr. Bessemer does not convert crude into malleable iron by a direct process in the puddling furnace, finishing it at once by the ordinary operations of shingling and rolling as malleable iron. Mr. Richardson does!

You next try to show an infringement by the following quotation, from which (being only a fraction of the whole thing expressed) a very one-sided and imperfect view is liable to be formed: "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 be more readily 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," which sentence, allow me to add, continues thus: "for which purpose I construct an air-furnace, in which I place a fireclay or blacklead crucible capable of holding several hundredweight of iron. The interior of the furnace I construct of a circular form, having a number of buttresses or projecting parts jutting out from its interior; these projecting parts stand out further at the firegrate than at the top, and are of such a shape as to come in contact with the exterior of the crucible, and thus form a series of supports to the crucible, and assist in preventing the pressure of the metal from breaking it when it becomes softened by the great heat to which it is exposed."

Now in these very words Mr. Bessemer ties himself to convert crude into malleable iron. I ask you does he use a "puddling" furnace? or does he use a "tubular rabble," for injecting oxygen into the mass of metal, at the same time stirring and exposing the charge as with a common rabble? or does he even ball up the metal in his crucible, and work it in any way akin to the conclusion of the puddling process? None but a negative reply can be given to such questions; and a little further reading from the specification will show that "the iron (so treated) is allowed to flow into an ingot mould, the ingots so produced may then be rolled or hammered into any of the forms usually given to bar iron." As to the unmistakable distinction between the Bessemer and Richardson processes, I need not say more; but merely ask you if Mr. Bessemer's is identical with Richardson's, or, to put it more broadly, is the latter in any way an imitation of the former? Why has the former not produced such metal as the samples the latter has obtained, which, having been shown to some only as yet of the first judges on both sides of the border, are admitted superior to anything hitherto brought under their notice? Or how is it Mr. Bessemer failed to produce bar iron by his process at Govan and elsewhere? The truth, as I and many others believe it to be, is that no such metal as that which Mr. Richardson produced has hitherto made its appearance, and, what is more, such metal never could be produced by the processes specified under the patent of Mr. Bessemer's, under consideration, which in large part is impracticable on a full working scale.

For the great part Mr. Bessemer has played in revolutionising certain branches of the world's "iron industry"—for I do not admit it to be a revolution *in toto*, as some would have it to be—the greatest reward possible is due; and I am the last man who would seek, by the least extolling of another's doings, to diminish that fame in the least. At the same time you must allow me to say that, knowing what I do of both processes, and bearing in mind the strong attempt you have made to build up an unfounded argument by merely half stating whole facts, and so

that the truth concerning what appears to promise so much for the iron trade of this and other countries may not be given to the world half suppressed, I have deemed it right to trouble you with this rather long letter, which I beg publication of in your next issue.

Very truly yours,
ST. JOHN VINCENT DAY.

Glasgow, August 20, 1867.

[The so-called "Richardson process" was carried out at Dowlais, in exactly the same manner as now practised by Mr. Richardson, some years ago, but we believe subsequent to Mr. Bessemer's patents.—Ed. E.]

SOLID AND LAMINATED ARMOUR.

TO THE EDITOR OF ENGINEERING.

SIR.—In the discussion which took place upon my paper "On Ships of War," read at the Institution of Civil Engineers at the beginning of this year, it was objected by some of the speakers that as the American monitors were plated, not with solid, but with laminated armour, and as it was known that laminated was much weaker than solid armour, such a model could not be an eligible one for us to imitate. I replied that the monitors were not in every case protected solely by laminated armour, as some of them were plated with thick slabs below the laminated armour; and I further said that laminated armour constituted no essential part of the monitor system, but had been adopted by the Americans merely because none other was at the moment within their reach. At the same time I stated that the assumed great inferiority of laminated armour had been by no means proved; for that, although in the case of spherical or punching shot lamination implied weakness, yet that there was no evidence to show that in the case of clearing shot, like the Palliser projectile, any similar inferiority to solid would be found to exist. As the Palliser projectile pierced solid plate more easily than any other yet discovered, the measure of weakness now existing in armour, I stated, would therefore be the penetrating power of this projectile, and if—as I anticipated the fact would be found to be—laminated armour was able to withstand it as effectually, or nearly as effectually, as solid, the hypothesis of the great inferiority of laminated armour must therefore be discarded.

Experiment has now confirmed the accuracy of this anticipation. The *Times* of to-day gives an account of some experiments lately made at Shoeburyness to illustrate this question, and with the following results, which I will give in that paper's own words:

"Three masses of iron, each 7 in. thick, were exposed to the fire of the 7 in. muzzle-loading rifled gun. Nothing was put behind the iron as a backing. The thinner plates backed each other. The first target was a solid 7 in. plate, the second was formed of two 3½ in. plates, the third of three 2½ in. plates well bolted together. Had the empirical rule of the squares of the thicknesses been applicable under the conditions of the case, the ratios of resistance, taking the inch as a unit, ought to have been, for the solid plate 49, for the 3½ in. plates about 24, and for the three 2½ in. plates about 16. But what really declared itself as the result of the day's work may be shown very simply as follows:

"To pass an ogival-head Palliser shot through the solid plate required 15½ lb. of powder in the new 7 in. gun; to perform the same upon the two 3½ in. plates 14 lb.; upon the three 2½ in. plates, 13 lb. The energy of the projectile was in the first case 61 foot-tons per inch of the shot's circumference; in the second, 57; and in the third, 52."

It turns out, therefore, as I anticipated, that solid and laminated armour are pierced by the Palliser projectile with much the same facility; and, in fact, as I pointed out, penetration will be promoted either by laminating the armour or by pointing the projectile. But where one of these things has been already done, it is of no use to do the other, as the effect cannot be obtained twice over. The action lies in making the ruptured area a minimum; but where that has been already done, there is very little more to be effected.

August 20, 1867.

I am, &c.,
JOHN BOURNE.

ROAD LOCOMOTIVES.

TO THE EDITOR OF ENGINEERING.

SIR,—For the information of those concerned in the working of steam-engines on common roads, I beg to inform you that on Monday last I ran a small locomotive road engine, constructed by Mr. L. W. Boulton, of this town, from here through Manchester, Eccles, Warrington, and Preston Brook, to Chester, paraded the principal streets of Chester, and returned home, the distance being over 90 miles in one day, without a single mishap or stoppage for anything except to take in water. I believe this to be the longest continuous run on record ever accomplished by any road locomotive engine within twenty-four hours. If any one should have performed a similar journey, I shall be most happy to exchange particulars with them. I may add, the engine has only one 4½ in. cylinder, 9 in. stroke, 130 lb. pressure, 5 ft. wheels. I trust you will give publicity to this, and thus oblige,

Yours respectfully,
T. BOULTON.

Ashton-under-Lyne, August 21, 1867.

P.S.—The engine carried six persons throughout the greater part of the road; in some places eight and ten. When you take into consideration that eighty miles of the road was perfectly strange to all concerned, and consequently that we had to look out for water as we travelled along, it makes the journey more remarkable.—T. B.

SHEFFIELD.—Business affairs do not improve at Sheffield. During the past fortnight several furnaces at the large iron-works on the railway side have been put out, and the men employed at them have been discharged. At other furnaces the men are on short time, and the plate mills are not doing a great deal. The steel works continue, however, to be well supplied with orders.

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[Illegible text in left margin]

INTERIOR OF THE ST. PANCRAS

MR. W. H. BARLOW

(For Description)



ENGINEERING, August 23, 1867.

STATION: MIDLAND RAILWAY.

LOW, ENGINEER.

(see Page 148.)



PUBLISHER'S ANNOUNCEMENT.

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ENGINEERING.

FRIDAY, AUGUST 23, 1867.

NEW MODES OF MAKING STEEL.

THE Paris Exhibition is particularly rich in specimens of steel obtained direct from pig iron or iron ore by certain new methods of conversion, recently invented, partly with an intention of avoiding Mr. Bessemer's patents, and partly also with an idea of removing from the iron the noxious admixtures of sulphur, phosphorus, and other elements which have proved unassailable by the Bessemer process, and by most of the other methods adopted for making steel. We have already noticed Mr. Siemens's new plan of making steel direct from the ore in a regenerative gas furnace, and we have noted other applications of the Siemens furnace to the manufacture of cast steel direct. There are two inventions of this kind in the French department, both represented by some very fine specimens of steel, made by a direct process in the Siemens furnace, and without crucibles. The two inventors, we believe, are now involved in a lawsuit for infringement of patents, although it is difficult to see how either of the two can substantiate any claims, with the exception of more or less unimportant details.

The two inventors are M. Berard, of Paris, whose operations are carried out at Montataire, and Messrs. Emile and Pierre Martin, of Paris, the well-known proprietors of the forge at Sireuil, France. M. Berard has the idea of exposing his pig iron to a protracted series of alternative decarburisations and recarburisations. He works a quantity of molten pig iron in a Siemens furnace, through which an oxidising current of heated gases, or a flame containing a surplus of air, is passed. The oxygen of the air is thus enabled to act upon the impurities contained in the iron in the same manner as it does in the Bessemer process. After continuing this action for a certain time, M. Berard reverses the process, that is, he introduces a flame which contains a surplus of gas, and is, therefore, capable of parting with some of its carbon, so as to restore it to the liquid iron. By this alternating process M. Berard believes that he is in a position to protract the process of conversion to any desired length of time, and to give the oxygen an opportunity of removing from the mass a greater quantity of impurities than can be got rid of by the Bessemer process. M. Berard makes use of the changes of current required for working the regenerators of the Siemens furnace for effecting his alternating operations. He divides the furnace into two halves, each forming a receptacle for a quantity of molten pigs, the two compartments being separated by a bridge made of fire-bricks. The flame entering the furnace at one side must pass over one mass of iron before it can reach the bridge, and after that it passes over the second charge of iron. The oxygen of the flame is taken up by the carbon contained in the first bath of iron, and the flame is thereby made a reducing one before it passes the bridge; the latter is sometimes also covered with pieces of coke or charcoal, so as to add still more carbon to the composition of the flame before it passes over the second bath of molten iron. The process is usually carried on so as to have fresh pig iron on one side, while a nearly decarburised material is contained in the second compartment, one change of currents only being made. The fresh flame,

therefore, always passes over the crude pig iron first, and afterwards reaches the decarburised mass, which it converts into steel. M. Berard is very far from having as yet got his process into anything like a practical working condition. The small quantity of good steel he has produced hitherto is the pick of a disproportionate amount of failures, and to all those who are acquainted with the difficulty which exists in removing sulphur and phosphorus from the iron by the oxidising influence of the air, it must appear extremely unlikely that the means resorted to by M. Berard, however protracted their action may be, can effectively serve the purpose for which they are intended. M. Berard also intends to add mixtures of wrought iron, steel scrap, and other similar matter to his pig iron, but for this he has no special claim as an inventor, the process of mixing pig iron with decarburised iron, or with iron ore, being very old and universally known. Messrs. Emile and Pierre Martin have introduced a system of steel manufacture which is of far greater practical value and importance, although it contains no more novelty in its abstract principle than the first-named process. Messrs. Martin, however, have succeeded in making their process a commercial success. The Martin process is now in operation at the works of Messrs. Schneider and Co., at Creusot, at Messrs. Verdier's, at Firmini, and in three or four other French steel-works, and its results are very satisfactory, both with regard to the quality of steel produced and to its economical production. Messrs. Martin's mode of operation consists in the following process: A quantity of pig iron, say a charge of 3 or 5 tons, is melted in a Siemens furnace with a dish-shaped bottom, or it is run into the furnace from a cupola or blast furnace. It is then exposed for about half an hour to a very high temperature, care being taken to keep the flame slightly overcharged with gas, by which means the burning of the fire-bricks of the furnace-top is said to be avoided or lessened. After that time a quantity of wrought iron, scrap steel, scrap or iron ore, or a mixture of these substances, is added to the mass. These additions are repeated in intervals of about thirty minutes, and they are made at charges of about 2 cwt. at each time. The articles charged into the furnace are all previously heated to redness, so as to avoid any cooling influence upon the liquid mass. The process continues in this manner for about six hours. Towards the end of the operation the temperature of the furnace is raised as far as the nature of the combustion will permit. The quality of the metal produced is carefully tested from time to time by removing a small quantity of metal from the furnace, and casting it into a small ingot mould, the ingot being afterwards tried under the hammer. The operator has thereby, at all times complete control over the course of the process. He can judge how near the product obtained at any given moment comes to the desired quality of steel, and he can adjust his operations and additions accordingly. Messrs. Martin have found it advisable, in the production of steel, to follow the same course as has been adopted in the Bessemer process, viz., to decarburise the iron completely at first, and then to add a sufficient quantity of spiegeleisen to effect the desired combination of iron and carbon. In M. Martin's process the facility for working up old iron and steel scrap is a very important point. The conversion of old iron rails and of similar articles into steel has become a great desideratum in our recent practice. In the Bessemer process this is feasible, but the proportion of wrought iron which can be added to the pig iron in the converter is comparatively small, and any excess endangers the proper fluidity of the charge. The largest proportion of wrought iron that has, to our knowledge, been added to a charge in the Bessemer converter was 30 per cent. of old rails mixed with very grey hematite; but then the rails were thrown into the converter at a welding heat, and the pig iron run upon them immediately. M. Martin says that he can use two-thirds of old rails with one-third of pig iron without difficulty, only the rails must be of good iron, free from sulphur and phosphorus, since the Martin process will no more remove these elements from the iron than the Bessemer process will. Messrs. Martin have produced the same graduation of metals containing more or less carbon, in proportion as has been obtained by the Bessemer process. They make a "mixed metal," half cast iron, half steel, the same as Mr. Bessemer uses for his hammer heads and anvils. They produce tool steel of remarkably good quality, also soft steel, or homogeneous metal, and ultimately the very softest kinds of decarburised iron, to which they have given the name *fer fondue*, or "cast wrought iron." This latter substance is somewhat similar in its nature and appearance of fracture to the homo-

geneous iron shown in the exhibitions of several iron-works in the British section. Messrs. Martin's process seems to be worthy the attention of British steel-makers, and it is very likely to come in as a very useful addition to the Bessemer process for working up scraps and old materials into marketable steel.

THE DOWLAIS IRONWORKS.—No. I.

DOWLAIS! The name of no other place in Britain so strongly and fully expresses the tremendous power of British iron and British coal—a power which has made our country the first among the nations of the earth. France has its Creusot, with its fourteen blast-furnaces, and giving employment to ten thousand men; Belgium has its Seraing, with five furnaces and extensive workshops, never again, however, to be what they once were when John Cockerill, an Englishman, too, and having the King of Holland for his partner, was living. We will not dispute the greatness of Essen; nor need we refer to the comparatively insignificant centres of the iron industry of America—Phoenixville and Johnstown. But where France, and Belgium, and Prussia may have large individual works, Dowlais, with its seventeen blast-furnaces and its 9000 workpeople, making 150,000 tons of pig iron and raising almost a million tons of coal yearly, nevertheless makes but one-thirtieth of all our iron, and raises less than the one-hundredth part of all our coal. Great in itself—indeed, the largest ironworks in the whole world—its loss, were Dowlais swept from existence, would be hardly apparent in the vast totals of our national production. For all the coal raised upon the Dowlais property in a year forms but a slice, less than 15 ft. thick, from one side of the enormous cube, more than 1500 ft. square, brought up yearly from the coal mines of the kingdom.

And who has not heard of Sir John Guest? What a Wellington was he in the war of industry against nature, before nature had surrendered, as it has long since surrendered, so many of its treasures to man! Were titles dispensed in England after the manner in which Napoleon rewards his foremost men, Sir John would have been the Duke of Dowlais—an iron duke, indeed—and the title would have been honoured over the whole world, even had the blue blood of all lord-dom turned bluer than ever at the thought:

For since the birth of time, throughout all ages and nations
Has the craft of the smith been held in repute by the people.

And the ironmaster ranks above the smith. And how often have we all heard of Lady Charlotte, her splendid company in Spring-gardens, and how the courier, "booted and spurred," rode all the way from Dowlais, breaking the wind of a dozen horses one after the other, to bring the balance-sheet to my lady; and how the countesses expired in astonishment when they were told that it had been "a very fair year," the balance being a little affair of a couple of hundred thousand pounds! Alas for the romance of this pretty fiction! for, it has little or no foundation, and Walkinshaw, the reputed courier, was by no means distinguished for his equestrian attainments, his equitation or, more correctly, asitation being chiefly confined to an occasional donkey ride. Still, Sir John *did* make money, and even the highest society is apt to hear of such things, and it is not impossible that that remarkable lady, now Lady Charlotte Schreiber, may have at some time given certain noble friends a hasty peep at the footing of a Dowlais balance-sheet. She was a wife worthy her husband, and after Sir John's death, in 1852, she managed all his vast business for a time, calling in, however, all manner of professional assistance, for Nicholas Wood was once at Dowlais, and upset, for a space, the whole system of coal-mining pursued there, working down the dip instead of up, and drowning the pitmen up to their necks in water; and there was Sir (then Mr.) William Armstrong, and other great but unprofitable lights, until at last Lady Charlotte would have no more of them, and called to her aid one of her mill-managers, William Menelaus (not boasting Hellenic blood, however, but that of Ayrshire), and installed him in office as the manager of the greatest ironworks in Christendom. Since then all has gone on smoothly enough; and if more than 5l. 10s. could be got for rails, the works would be again making money. Sir Ivor Berti Guest, of Canford Park, Dorsetshire, is the sole inheritor of the property, although it is managed by trustees under Sir John's will, and under the style of the Dowlais Iron Company. Sir Ivor, however, has little occasion to trouble himself about the works, and we have even heard it said that, like a sensible man, he never goes near them, but contents himself with the annual profits paid in to his account.

Somewhere about the middle of the last century, the Marquis of Bute granted a lease for ninety-nine years,

at 90%. a year, of all the Dowlais estate, some 6000 acres, with right to all above and all beneath the ground. It was under this lease that John Guest, afterwards created a baronet, held the property for nearly half a century, until 1848, when the late marquis, determined to divide the profits with his tenant, refused to renew the lease, and, but for his sudden death, and the business-like conduct of the trustees of the present marquis, then an infant, Sir John would have blown out his furnaces, and taken the whole population of Dowlais along with him to some other scene of operations. The lapse of this lease made a difference of quite 25,000%. a year to the "Dowlais Company," for the royalties on iron stone and coal are now somewhere about 6d. a ton. And what must be the extent and elasticity of a business which could thus meet this great addition to its yearly outgoings? A fair selling price of the property would be, perhaps, a million and a half, and it requires certainly 300,000%. of floating capital to keep it going.

Merthyr Tydvil, in Glamorganshire, lies on the Taff, 24 miles north of Cardiff, and about 550 ft. above the sea. Dowlais, a suburb of Merthyr, is two miles further up; and nearly 550 ft. higher still, the "old" Dowlais works being 1078 ft. above Cardiff, while the newer Ivor works are at a somewhat higher level. If any other ironworks in the kingdom are at a higher altitude, we forget which they are. Most of those in Wales, such as Ebbw Vale, and Rhymney, and Tredgar, and Sirhowy, and Pontypool, lie in valleys; and some of these, like that of the Ebbw and Pontypool, are of rare beauty, and although they have not become classical in romance or in song, are scarcely less lovely than the Vale of Avoca, or those beautiful wooded uplands the famous "birks of Aberfeldy." But there is no natural beauty about Dowlais, except glimpses of green hills and the "Brecon beacons" beyond. Up, up a long, long road from Merthyr, higher and higher, till we seem nearly at the hill-top, and yet the works are much below it, and the outcrop of the coal glowers in a broad black belt, some hundreds of feet above. The coal is worked to the east of the hill, in Gellygair parish, towards Rhymney, and there are eight pits in all on the estate. The dip to the east is very great, and although the outcrop near Dowlais is some 1200 ft. above the sea, the bottom of the deepest of the Vochrhiw pits, four miles away, is 444 yards below the surface, and 77 ft. below the sea. Three seams are worked, locally known as the 9 ft., the 6 ft., and the 4 ft. veins, although the actual thickness at Vochrhiw is but 5 ft., 3 ft. 6 in., and 2 ft. 6 in., respectively. This coal is splendid stuff, containing about 90 per cent. of carbon, and both at Dowlais and at Rhymney it is used in the blast furnaces without being coked, being unlike any other coal in Wales in this respect, with the exception only of the anthracite. It weathers well, too, a big block—the first touched at the bottom of the Vochrhiw pits when it was opened six years ago—having lain since that time on the lawn in front of Mr. Menelaus's house, and that without losing scarcely any weight at all. The coal is also tolerably free from sulphur. As might be expected, it is an excellent steam coal, and the Dowlais, like many of the other iron companies in the district, now raise large quantities for sale, screening it and sending only the large coal to Cardiff, while the small is all used at the works, a fan-blast being employed under the firebars of the puddling furnaces to give sufficient draught. The seams are tolerably free from water, although the Cornish pumping engine at Vochrhiw has an 85 in. cylinder and 10 ft. stroke. The workings hold a considerable quantity of gas, but the ventilation is very effective, over 100,000 cubic feet of air per minute, and the men work with naked lights. We believe the cost of getting is not much above 18d. per ton to the men, and the coal is, we should say, laid down at the works at about 5s. the long ton of 2520 lb. The present coal seams on the Dowlais estate will be worked out in from thirty to fifty years, but there is plenty more to be had elsewhere. Mr. Bedlington, of Rhymney, now the president of the South Wales Institute of Engineers, estimates that the South Wales and Monmouthshire coal-fields contain 21,000,000,000 tons of coal yet unworked, there being 8 ft. in thickness over the 242 square miles of the upper series of veins, and 41 ft. in thickness over the 624 square miles of the lower series, no seams under 2 ft. thickness being counted.

The ironstone is not so plentiful, and the seams are thin and scattered. It is an argillaceous ore, and will readily correct the effect of siliceous cinder from the puddling furnaces, all of which, calcined or uncalcined, together with every ounce of the mill-scales, is charged again into the blast furnaces, so that none of the iron

is lost. This use of cinder was first practised by Sir John Guest himself; at least, he convinced the lawyers of his prior use, in the famous patent lawsuit brought against him by that clever but not highly successful ironmaster, Sir Anthony Hill, of the Plymouth Iron-works, who had patented the use of cinder in the blast furnace. The yield of the Welsh stone is about 27 per cent., and we have reason to believe that its cost at the works is as much as 10s. the long ton of 2400 lb. (The miner's coal ton is 21 cwt. of 120 lb. each, and the iron ton 20 cwt. of 120 lb.)

Few, out of Wales, have any conception of the amount of "foreign" ore used there, all ores brought from other districts or from abroad being alike termed "foreign." We should say, speaking roughly, that nearly or quite three-fourths of the ore used at Dowlais comes from other districts. Much of it is red hematite from North Lancashire, which makes very red short iron unless corrected by the argillaceous ores of the principality. Red shortness is, indeed, the sin of Welsh iron, and we fear that sometimes a little of it gets into the market which would not bear the crucial test, that of bending a $\frac{3}{4}$ in. rod, heated to a cherry-red, close home around the beak of an anvil. Other ores come from the West of England, and much from Spain, about Santander, and other yet from Elba. These ores carry nearly 50 per cent. of iron, and although they cost, at least, twice as much at the tunnel head as the Welsh ores, they are not much dearer when their superior yield of iron is considered.

So much for the coal and ironstone; and there is plenty of limestone to be had almost anywhere in the iron district of South Wales. If we have not, in description at least, brought the materials to the blast-furnaces, it will be understood that they come by the Dowlais railways, of which there are many, although their aggregate length is not great. Indeed, the Merthyr district is tolerably well off in means of communication, and the Taff Vale Railway managers are civil and attentive, where they were once the most bumptious and conceited functionaries to be found anywhere. The Dowlais Company, in sending their coal to Cardiff, have quite given the Taff Vale people the slip, the Vochrhiw pits having a junction line with the Rhymney Railway, which joins the Taff Vale a few miles above Cardiff; and the former is now being extended, through a longish tunnel, directly into that town. In a year or more, also, the Great Western, the Rhymney, and, of all companies, that great ramifying concern, the London and North-Western, will have extended their lines right into the Dowlais works; and the line of the Brecon and Merthyr is already close at hand, Pant Station being less than a mile from the manager's house. There are actually four railway routes from Dowlais to London, although we will defy any one to learn from "Bradshaw" the hours of the respective trains.

Come with me and stand upon the stage of one of the furnaces at the "old" works. You have only to walk upon it, for it is at the level of the great plain, which some would term a yard, whereon the iron stone, and the coal, and the limestone are unladen from locomotive-drawn trucks. Look down into that vast amphitheatre of Tubal Cain's great laboratory. You have never seen anything like *that*. You may have seen all the other ironworks in the kingdom, or, if you like, nine-tenths of all in the world, but, I tell you, you have seen nothing like *that*. It is impossible to describe it. It must be *seen*, and we pity the man who can behold it and feel no sense of that nobler feeling, wherein the soul of man worships a higher power than his own. Here are God's grandest forces of nature at work for the advantage of man—heat, gravity, and chemical affinity. What is the amphitheatre of the Coliseum to the great plain fifty feet below us, and aglow with long ranks and files of scarlet iron, running, in vulgar phrase, into sows and pigs, aglow too with refinery fires, and brightened, even at night into day, by the towering flames of the blast furnaces? for even at Dowlais there is, we grieve to say, a waste of much gas. The amphitheatre of the blast furnace department of the "old" works might, in the Isle of Wight, be described as a "chine;" but the wildness of Blackgang bears no relation to its mystic wonder. Nor would the idea of the great red pipe stone quarry of Hiawatha assist the mind of one who had not seen it. It is a scene rather for Dante, and could *he* have seen it, his *Inferno* would have been enriched in its terrible description, and the pencil of our own Gustave Doré would have found new and nobler material to work upon. Here are volcanoes all around us; thirteen blast furnaces, not actually named, but which we may call Vesuvius, and Etna, and Hecla, and Tomboro, and Stromboli, and Hawaii, and Cotopaxi, and Papanday, and Teneriffe, and Wunzendake, and Gualatieri,

Atacama, and Chipicani, after the greatest volcanoes of the world. The flaming chasm below is clouded with wreathing volumes of steam, here as white as snow, there purpled by the blaze of the fires behind; and then there is the dull roar of the blast, and, clear above this, a whistling, rushing sound, like that of the storm-wind through the rigging of a ship, a sound denoting the escape of blast or of steam, for all these fires and all this sound represents a loss, a waste of mechanical power, tolerated at Dowlais because of its might of abundant fuel.

THE CHALMERS TARGET.

THE competition between armour and ordnance is still continuing in its full vigour. The Palliser shot has been the last step arrived at in the one branch of our national defences, and it seems to have surprised even its own inventor by its superior penetrating power as now actually proved by experiment. Mr. Chalmers, who, in spite of the success obtained by the Palliser shot against armour plates of all kinds, considers his target fully equal to the task of resisting it, has recently been brought into a controversy with Major Palliser, in consequence of some trials made at Vincennes by the French Government, where a Palliser shot had penetrated a target made on Mr. Chalmers's plan. It was a wooden structure, with a $\frac{5}{8}$ in. plate, and a compound backing of wood and iron. Mr. Chalmers states that the Palliser shot, both at Shoeburyness and at Vincennes, was fired against his target only after the latter had withstood a heavy fire from steel shot and other projectiles, which had very much shaken the whole structure, and also that his invention has never yet had a fair trial on account of some inferiorities in the details of construction which had crept in, partly without his knowledge. Mr. Chalmers has now designed a target expressly destined to withstand the effect of Palliser shot, and he has offered to Major Palliser to bear the cost of the construction of this target in case of its being penetrated by the chilled shot, on condition that Major Palliser will undertake to pay the cost of this target, which is not to exceed 1000%, in case of his failing to penetrate it with his projectiles. The target is not to exceed the weight of materials or depth of structure of the 8 in. Warrior target, which has been penetrated by the 9 in. Palliser shot, and the new Chalmers target is to be fired at under the same conditions as those under which the above-named target failed. The outer plate is to be 5 in. thick, the backing being 13 $\frac{1}{2}$ in. deep, and consisting of rolled steel plates of $\frac{1}{2}$ in. thickness, placed on and between the wooden backing, and of $\frac{1}{2}$ in. steel plates behind, placed parallel with the outer armour. The whole depth of the structure will come to 26 in.

THE TRIAL OF BURGLAR-PROOF SAFES AT PARIS.

PARIS, August 21, 1867.
THE proceedings of the jury selected by Messrs. Chatwood and Herring for the trial of their burglar-proof safes were protracted for several days after the trial last reported in our columns had been completed. It appears that the unsatisfactory mode of conducting the whole experiments showed itself more and more clearly as the jurors advanced towards a final conclusion upon which to found their verdict. The calculations of the American jurors seem to have been so far different from those of the English that the figures arrived at by the different parties were vitally different, and produced conclusions which were diametrically opposite to each other. Under these circumstances there remained nothing to be looked to except the final vote of the chairman, which would have decided the whole in favour of one side or the other upon the sole authority of this one juror. It was agreed that the two parties should each send a report to the chairman in writing, stating their views of the case, and that the chairman should then decide between them. The reports were sent in accordingly, one by Mr. R. F. Fairlie and by Mr. Mallet, giving the verdict of these two jurors in favour of Mr. Chatwood's safe, and a second report by Mr. Holmes and Mr. Pickering, arguing in favour of Mr. Herring's safe. At a subsequent meeting, however, and before the chairman had completed his report or given his verdict, it was found that there had been other communications besides the reports in question addressed to the chairman—communications which, according to the opinion of the English jurors, and according to that of the chairman himself, ought not to have been made. Under these circumstances Mr. R. F. Fairlie and Mr. Mallet considered it their duty to withdraw from the jury and to take no further part in its proceedings. There has been therefore no verdict given, and it appears to be impossible that any proper decision can be arrived at. The further course of this question will refer entirely to personal matters, and not to points of engineering or safe construction, and it will therefore have very little professional interest or value. As far as the public is concerned the trials are over, and the verdict has been given in favour of Chatwood by the unanimous opinion of the press, and by the conclusions which no impartial engineer can fail to arrive at on examining the two safes in their present mutilated condition. There is, however, a still more important fact elicited by these trials, and one which will benefit both parties engaged in this contest. The public may rest

assured that, for all practical purposes, both Mr. Chatwood's and Mr. Herring's "burglar-proof" safes are perfectly reliable. The comparatively short time occupied in breaking into both of the two safes has nothing to do with the question at issue. We have carefully pointed out that the tools used were not such as burglars could bring to bear under ordinary circumstances, and it must also be remembered that the workmen employed on either side (whatever may be said of their relative measure of knowledge and skill) were superior to the most expert burglars in any country. The trial, moreover, very forcibly points out the great value of the precaution usually taken of building Chatwood's safes into a strong wall so as to have all the sides covered by masonry, and leave nothing but the door open to an attack. In such a position, Chatwood's safe has been proved by the trial absolutely invulnerable, and therein lies its great superiority over Herring's, which has been opened through the door proper, and would have been opened just as well if it had been built into a wall. Against this Mr. Herring's plan of building a burglar-proof safe within a fireproof one, provided that the public is duly informed of the relative weakness of the outer safe against burglars, is very sensible and useful, since there are generally two kinds of valuables to be protected by safes. Books, papers, and other articles, which are of value only to the proprietors, require protection from fire only, and may be safely deposited in the outer fireproof compartment, although they are then not inaccessible to burglars. On the other hand, those articles which require protection both against fire and burglars are deposited within a strong box enclosed in a fireproof safe. Both Mr. Chatwood and Mr. Herring make larger and even stronger safes than those which have been tried. In Chatwood's large safes there is a piece of angle steel below the dovetailing of the outer plates all round each corner, and this makes this only assailable point considerably superior in strength and power of resistance. Mr. Herring's mode of applying the spiegelstein between soft plates placed on end, and his plan of tapering the bolts which connect the outer and inner plate of his structure all the way through, are very good. The former arrangement compensates for the brittleness of the franklinite, and prevents it from being crumbled off when exposed at any place, and the latter prevents the bolts from being drawn through the plate when a strain is brought to bear upon the latter. Mr. Herring has now received his large burglar-proof safe, which had been detained in Havre, and he has placed it alongside of the broken safe in his stand at the Exhibition. This new safe looks very well, and seems to be a much superior article to that which was tried. It is of about the same size as the Chatwood safe operated upon, but it seems to be heavier, and, we understand, is also dearer than the latter. The construction of Chatwood's bolts for fastening the door when the safe is locked is unquestionably superior to Herring's, or to any other safemaker's construction hitherto brought before the public.

THE SOCIETY OF ENGINEERS.

WITH reference to the recent application of the Society of Engineers for a royal charter, and, subsequently, for registration under the Companies Act, and as bearing upon the opposition of the Institution of Civil Engineers, we subjoin the following extracts from the Companies Act of 1862:

"Companies Act (1862) Amendment" Act, as passed this Session.

"Associations not for Profit."

"23. Where any association is about to be formed under the Principal Act as a limited company, if it proves to the Board of Trade that it is formed for the purpose of promoting commerce, art, science, religion, charity, or any other useful object, and that it is the intention of such association to apply the profits, if any, or other income of the association, in promoting its objects and to prohibit the payment of any dividend to the members of the association, the Board of Trade may, by license under the hand of one of the secretaries or assistant secretaries, direct such association to be registered with limited liability without the addition of the word 'limited' to its name, and such association may be registered accordingly, and upon registration shall enjoy all the privileges and be subject to the obligations by this Act imposed on limited companies, with the exceptions that none of the provisions of this Act that require a limited company to use the word 'limited' as any part of its name, or to publish its name, or to send a list of its members, directors, or managers to the registrar, shall apply to an association so registered.

"The license by the Board of Trade may be granted upon such conditions, and subject to such regulations, as the Board think fit to impose, and such conditions and regulations shall be binding on the association, and may, at the option of the said Board, be inserted in the memorandum and articles of association, or in both or one of such documents."

25 and 26 Vic., cap. 89.

"Companies, &c., Part VII., Registration of existing Companies" Act.

"180. With the above exceptions and subject to the foregoing regulations, every company existing at the time of the commencement of this Act including any company registered under the said Joint Stock Companies Acts, consisting of seven or more members, and any company hereafter formed in pursuance of any Act of Parliament other than this Act or of Letters Patent, or being a company engaged in working mines within and subject to the jurisdiction of the Stannaries, or being otherwise duly constituted by law, and consisting of seven or more members, may at any time hereafter register itself under this Act as an unlimited company, or a company limited by shares, or a company limited by guarantee, and no such registration shall be invalid by reason that it has taken place with a view to the company being wound up.

SIR JOHN BROWN.—Mr. John Brown, of the Atlas Works Sheffield, has received the honour of knighthood.

BELGIUM.—The victory of Cleveland firms in connexion with the late adjudication for rails required for the Dutch state railways has greatly depressed the spirits of the Belgian industrialists, who had hoped to obtain the orders carried off by English competitors. The Belgian iron trade continues dull.

RUSSIAN ARMOUR-PLATED FORTS.

THE Russian defences of Cronstadt are just at present held up for our imitation, and an idea seems to prevail that whole forts are faced with 15 in. armour-plates, backed by a further layer of 6 in. or 7 in. armour-plates. It is not so. The batteries are constructed in several different ways, which have been varied from time to time as the work proceeded. The 28-gun battery at Fort Constantine, for instance, illustrates no less than three different methods of construction. One of them shows in succession from the front first a 9 in. plate, then 6 in. teak let into an angular frame of 1 in. thickness, backed by a plate of 1 in. in rear of all. The face has a slope of 22°. Another has a 7 in. plate in front, and also slopes back at an angle of 22°. The third is perpendicular, and built up of Thornycroft's bars, which were rolled at Millwall. The plates on the first-named battery, certainly, and some of the others were made by Petin and Gaudet. The battery which is most frequently quoted as an example to Englishmen, or rather the three shields for three guns each, may, perhaps, be understood by the following rough description:—A number of bars 18 ft. 4 in. long by 12 in. thick, and 12 in. high, are laid horizontally one upon another, fitting together along their lengths by grooves and projections. At the back of each bar is another projection 3 in. in length, in the form of the frustum of a cone. This dovetails into perpendicular supports of considerable thickness placed behind it. And because the Russians found that this mass of metal had little structural cohesion, two 1½ inch plates have been placed in front of the bars and bent over the top. The great advantage claimed for Thornycroft's bars was their cheapness compared with other forms of plating, and this is true enough, as far as they are concerned. But when it was found necessary to back them so strongly, and to wrap other iron plates round them, the aspect of the case was considerably changed. Such erections as these cost over 3000l. per gun for the shield alone, the dimensions being 14½ ft. long by 8 ft. high. Our English shields cost less than 1000l. per gun, their dimensions being 12 ft. by 8 ft. The English case-mate costs for its ironwork a total of under 8000l. per gun. If built on the Russian model, its cost would be 6800l. per gun nearly.—Times.

H.M. GUN-VESSEL BEACON.

THE Beacon, launched on Saturday last from Chatham Dockyard, is a twin-screw gun-vessel, and is the first of the squadron of vessels designed by the Chief Constructor of the Navy on what is known as the composite principle, her frames, keel, deck beams, and stringers being of iron, while her planking is of wood, in two layers, the inner being 8 in. and the outer 2 in. in thickness. She was commenced in February last, and has been built in the short space of six months, in addition to which the iron frames for the Dwarf, a sister ship building at Woolwich, have also been prepared at Chatham Dockyard. The Beacon is one of the squadron of ten double-screw gun-vessels ordered by the present Board of Admiralty to be constructed for special service in China. She is built on perfectly flat midship sections, which will give her a light draught of water, not exceeding at her deep-load line 7 ft. 6 in., enabling her to operate in rivers, harbours, and along the coast. The whole of these vessels will mount an armament of one 7 in. 64 ton and one 64-pounder pivot gun, arranged to fire either ahead, astern, or at the broadside. The engines of the Beacon are in preparation at the steam factory, and are collectively of 120 horse power (nominal), each driving its independent set of shafting for the port and starboard screw. The engines have been taken out of two of the gunboats built during the Crimean war. There will be three boilers, which will be new, and, considering her light draught of water, the Beacon is expected to attain a very fair rate of speed.

THE PROPOSED BRIDGE AT LOUISVILLE.—The bridge which it is proposed to construct across the river Ohio, at Louisville, will be a grand structure. Its entire length will be about 3650 ft., with a pivot bridge across the canal of 280 ft. The exact location is not yet established, but it will be between what is called the Elm Tree Garden and Rock Island. It will be reached by a grade of about 78 ft. to the mile on each side, for the distance of nearly 350 yards. There will be twelve spans of 250 ft. each, with one large span of 400 ft. across the Indiana chute. The bridge will have an elevation of 90 ft. above low-water mark, and 49 ft. above high-water mark. The superstructure, which will be entirely of iron, will be 152 ft. above the foundation, and 82 ft. above the floor. The cost of the bridge will be but little over half as much as that of the suspension bridge at Cincinnati. The Louisville and Nashville and Jeffersonville railroads have each \$300,000 stock in it, and private parties have \$400,000. Hands are now at work quarrying the stone for the bridge, and it is proposed to have it completed by the year 1870. The progress of the enterprise has, perhaps, been somewhat retarded by the opposition of certain parties in that city, who claim it will be an injury to Louisville, because freight and passengers will pass through the city without paying their re-shipping duties to commission merchants, hotel-keepers, &c. It is barely possible that the business of a certain class will be injured, but there is not the least doubt that the city will be amply compensated for such injury by the influx of trade from the other side of the river.—The Journal of the Franklin Institute.

OPENING OF NEW WELSH RAILWAYS.—During last week two new lines of railway—one of considerable length and importance—were opened in Wales. The first, the Manchester and Milford, runs from Aberystwith to Carmarthen, and, by completing a link in the western chain of railways running through the principality, opens a new route between the manufacturing districts of South Lancashire and the mineral districts of South Wales. The length of the line is 41½ miles. Last Wednesday week the long-deferred opening of the deviation line of the Cambrian Railway, near Aberdovey, took place. It affords an unbroken route between Aberystwith and Carnarvon. The Dinas Mawddwy Railway, running through portions of Merionethshire and Montgomeryshire, and forming a junction with the Cambrian system at Emmel's-road, will be opened for traffic early in next month.

THE CORLISS ENGINE.

TO THE EDITOR OF ENGINEERING.

SIR.—Several of your correspondents express a desire to have additional facts respecting the working of the Corliss engine compared with the working of engines on the ordinary plan. As one interested in the introduction of this engine, I have not been in any way alarmed for its safety on account of the declamation of "Observer" and his friends.

"Observer" now makes the confession that he has no facts, and does not pretend to furnish facts in support of his opinions, but agrees in thinking that statements of facts are wanted from those who can give them. With your permission, therefore, I will give a few facts and results of the working of some of the Corliss engines erected in this country.

To make a fair comparison between any two engines, it is necessary and important that the conditions should be as nearly as possible the same in any trials that are made, and I will give the facts respecting one or two examples where I believe all the conditions for a fair comparative trial exist. At the Royal Arsenal, Woolwich, there is a Corliss engine and a horizontal engine of the usual construction, fitted with slide-valves, with cut-off slides working on the back of the main slides, the cut-off variable to any point of the stroke. Both engines are new, and in good order, and are supplied with steam from the same boilers. They were erected expressly to drive the same work, for which one of the engines is sufficient, and arranged so that either engine can be disconnected in a few minutes, and the other set to do the work. A trial was recently made, by the officials connected with the department, to ascertain the relative economy of the two systems. The steam was supplied from the same boilers, the coal used was the same in quality, and carefully weighed during the trials; the water used for the boilers was carefully measured, and the same men fired the boilers. Indicator diagrams were taken at stated intervals, to ascertain the power developed, and the trial with each engine was carried on for one week. The result was that the coal used with the Corliss engine was thirty-eight per cent. less than what was required to do the same work with the slide-valve engine.

I can give another example of an engine in London, at Messrs. Berger and Co.'s works at Bow. Here there are a pair of engines, fitted to drive on the same shaft, but at present only one engine is used to drive the works, and, by simply disconnecting the connecting-rod of one, and connecting the other, either engine can be used. They are both the same size, one on the Corliss principle, recently fitted by Mr. Douglas, the other fitted with a slide-valve variable to cut off at any point of the stroke; and when the engine is working can be varied by hand. Steam is supplied to either engine from the same boiler. With the slide-valve engine 26 cwt. of coal is used per day, and with the Corliss engine, doing the same work, 17 cwt. per day. These are the results of some trials at which I was present recently. I mention these cases because all the conditions, except the principle of the engines, happen to be the same—the same boilers fired by the same men, the same quality of coal, and the same work. The results of these trials are much the same as what is usual in my experience.

I have now before me several letters from gentlemen of the highest standing in England and Scotland referring to the working of Corliss engines with which they have been supplied, compared with engines working on the ordinary plan. Some of these letters have been addressed to myself, but most of them to Mr. Douglas, and as they all contain facts referring to the Corliss engine, I propose to give a few extracts from them.

Messrs. James Normand and Sons, of Dysart, Fifeshire, in a letter written Feb. 8, 1867, say with reference to a Corliss engine which they have had at work for eighteen months past, driving their factory: "Its economy is giving us entire satisfaction. In comparison with our other engines, which are modern and of the slide-valve construction, we consider it uses little more than half the fuel to do the same work."

The following is an extract from a letter, dated 5th March last, from R. Calvert Clapham, Esq., of the Walker Alkali Company, referring to a Corliss valve engine with 24 in. cylinder, started about eighteen months ago, which works stone-breaking machines and an incline railway at the above works. He says: "The load on the engine is necessarily variable from the work to do, and it is thrown on and off very suddenly, yet the engine works at a perfectly uniform speed. The engine does about the same amount of work as our former one, with about one-half the quantity of coals."

Messrs. Alex. Pirie and Sons, of Aberdeen, who have a great number of engines at their extensive works, writing to me in November, 1865, after they had had some years' trial of the Corliss engine, say: "We believe this principle to be the most perfect that has as yet been invented for regulating the speed of the steam engine, and we may inform you also that, if we have ever to put up additional engines, we shall certainly apply this principle."

In a letter dated 25th January of this year, Henry Bruce, Esq., of Kinlusk Paper Mills, near Edinburgh, referring to a 24 in. cylinder Corliss valve engine erected at his works, says: "I continue perfectly satisfied with the Corliss engine. Mine has now been working night and day for nearly three years, and it is doing its work well and economically, and the regularity of its speed is as near perfection as possible. If I had to put up another large engine, I would rather pay a good price for a Corliss than accept one on any other principle for nothing."

In 1865 the late J. G. Stuart, Esq., of Balgouie Works, Markinch, N.B., had an engine with ordinary slide valve (which worked the mill in connexion with a turbine) removed, and a Corliss engine substituted, and connected with the same turbine; and in a letter dated September of that year, referring to some experiments to test the steadiness of the engine when the water was suddenly shut off from the turbine, he says: "I could not conceive of anything more perfect. I do not remember of the water ever being lower. Last summer, when it was about the same, we burned 45 tons of coal, or even more, per fortnight. We have never exceeded 30 tons per fortnight this year. We have averaged during the last two months about one thousand spindles per fortnight more yarn from our spinning than ever we did before.

On December 18th, 1866, James Stuart, Esq., M.A., Trinity

College, Cambridge, and Balgonie, wrote to Mr. Douglas, referring to the same engine, as follows: "Referring to my late father's letter to you of 1st September, 1865, as to the economy and steadiness of the Corliss engine you made for us, I have to say that our continued experience of it confirms the opinion then expressed. We have had an example lately of the perfect control of speed by this engine. A cogged wheel, which drives about two-thirds of the mill, was instantaneously *stripped*, bringing that portion of the work to a stand. When this happened before with the common engine, its motion was suddenly accelerated, and every thread in the spinning-frames was broken. When it happened with the Corliss valve engine, *not one thread was broken*, which showed that the engine had drawn the reduced quantity of steam the instant its load was diminished."

About two years ago, Messrs. Jas. Ewing and Co., of Glasgow, sent a Corliss engine from this country to Demerara, for driving a large pump for draining land. The cylinder was 24 in. diameter. Alex. Crum Ewing, Esq., of the above firm, writing on 25th April, last year, says, with reference to the working of the pump and engine: "The quantity of water discharged was enormous, and the coals used were greatly less than on a neighbouring estate, also belonging to my father, where there is a similar pump worked by an ordinary high-pressure engine."

D. Chalmers, Esq., of Kate's Mill, Edinburgh, says (after about three years' experience of a Corliss valve engine at his mills), in a letter, dated 16th February last, "I do not know of any kind of engine which is so economical in fuel."

I could give other proofs of the satisfactory working of the Corliss valve engine compared with other engines, if it was not that I have already occupied so much of your space; but I may say that there are Corliss engines at work in this district in larger mills, and, as far as I know, I am not aware of any case where they are excelled by other engines for economy of fuel, and I believe that they are not equalled.

I have during the last four years designed upwards of fifty of these engines. You have already published particulars of some of them, and I am prepared to give full information about them, and where they are at work, and I ask "Observer" to prove in any one case by the result of their working, that the hard names he has used in this discussion against the engine can with any propriety be applied to it.

The only argument "Observer" has used against the Corliss engine, and in favour of the system of regulating with the throttle-valve, is that the power lost from wire-drawing reappears in the shape of heat, and is not, therefore, an irrecoverable loss—which, of course, every engineer knows. His letters have no doubt received more attention than they would have done, had you not announced that he is one of our first authorities despite his professed ignorance of the Corliss engine. As I do not make any pretension to authority, I will close with an extract from the work on the steam-engine by Professor Rankine (the first authority in such matters), which is entirely opposed to "Observer's" argument and opinion. It is as follows, in the article on wire-drawn steam:

"Even supposing, however, that no energy is directly wasted when steam is wire-drawn, there is still an indirect waste of energy from the lowering of its pressure, which, by diminishing the forward pressure upon the piston as compared with the back pressure, and by diminishing the extent of expansive working of which the steam is capable, lowers its efficiency."

"When an engine, therefore, has to work against a diminished resistance, it is better to diminish the mean effective pressure by cutting off the admission earlier, and so working with a greater ratio of expansion, than by contracting the opening of the regulator, and so lowering the initial pressure by wire-drawing. The former method makes the engine more economical, the latter less."

This accords with my experience. Let "Observer" give us some proof that it is not so—if he can.

I am, yours truly,
WILLIAM INGLIS.

TO THE EDITOR OF ENGINEERING.

SIR,—It was my intention to give a detailed comparison of two engines—one a Corliss, the other a common engine—of equal sizes, and subject to the same variations in loads and speeds, to show that the former must, under any circumstances, do the same amount of work as the common engine, and that with a considerably less quantity of steam of equal pressures. This can be easily demonstrated, as can also the variations in speed, which must entirely depend, *ceteris paribus*, on the rapidity with which the steam admission-valves act, combined with the scope they give for variable expansion. But, Sir, I think it would be time thrown away, and, with your kind permission, I will review "Observer's" letters on the Corliss engine, with a view of seeing fairly on what grounds he puts forth the following assertions, which I extract from his letter in the last issue of ENGINEERING. And I strongly advise every person desirous of advancing the cause of truth, justice, and progress to read this last of "Observer's" lucubrations, and mark how transparently he exposes the real cause of his antagonism to the Corliss engine. He clearly states that with him it is merely a matter of opinion, or, in his own words, "it is his belief that that is this and this is that;" and because there is no private gentleman ready to employ one or more professional engineers to conduct a series of expensive experiments for his delectation and instruction, he, forsooth, will not surrender his faith to the Corliss engine. Having further already determined in his own mind that the cost of this beautiful automaton valve-gear must, for some reason hidden in the foggy caverns of his own mind, be greater than the slide-valve, with all its expensive wear-and-tear *addenda*, to obtain but a mere approximation to the perfection of the Corliss valve-gear, as an automaton variable expansion valve-gear. "Observer" jumps to the conclusion that, because the manufacturers of this valve-gear do not choose to parade the various items incurred in its construction, being contented with their growing trade in the Corliss engine, he has the hardihood to assert another of his, as he supposes, annihilating dicta, which I give *verbatim* from his last letter:

"Although, however, you have enumerated a *great many* 'Corliss 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 little* of evidence has been given to show that any unprecedented or remarkable economy is obtained by the adoption of this engine, and my belief that there is not." Mark his *belief*, on which he seems to think depends the future fate of the Corliss engine, and those who cling to it, all of which and every one of whom lie, some few weeks ago, kindly tolled to "the tombs of the Capulets," and just because of "his belief." I am constrained to assert that the mistake made by "Observer," when in Paris—I allude to him taking the Swiss engine to be a Corliss engine, although it is radically different in principle to the latter engine—must have some connexion with his blind, unreasonable, and apparent fixed determination to ignore whatever has been, or may in future be, adduced in favour of the Corliss engine. To him the published experience and statements of facts relative to the construction and working of the Corliss engine, as vouched for by Messrs. J. F. Spencer, Inglis, Douglas, Salt, and others, are but as many Machiavellian arts to delude the users of steam engines, and such firms as Messrs. Hick, Hargreave and Co., Bolton, are but mere dawdlers in practical mechanical engineering, and, therefore, the fact that *they* see the superiority of the Corliss engine counts for nothing in his estimation. What, Sir, can be done to convince your correspondent "Observer"? Must we all surrender at discretion to the *finesse* of his tactics and subtle logical (?) inferences, based on *theorems* which no one admits but himself; or must some disinterested gentleman expend a few paltry hundreds, or thousands, on experiments to settle the engineering *belief* of this mighty tactician, who looks upon provincialism in an engineer as the sure stamp of mediocrity? By logic, it has been said, we may prove anything, even as the most ugly man in France proved himself to be the most beautiful object in the world. We, however, know that the substantial world requires reason in logic, or at least a faint semblance of it, but it would puzzle a modern Argus to discover in "Observer's" letters the merest pretension to reason. I ask him would it not have been more seemly had he troubled himself to find just a few *data* to justify the sweeping arrogance with which he claims the pre-eminence on a subject of which he has had, according to his own showing, not the slightest practical experience? But, Sir, this is not the only characteristic of his prejudiced onslaught on the best of all ancient or modern machines for the control and development of the force generated from that mighty element, water, by that no less powerful force inherent to a more or less extent in all combustible matter, as any mathematician can easily demonstrate. We are willing to admit his opinions, and give them that attention and consideration which they merit; but we deny to any man, no matter what his position may be, the right to set up his *mere* opinions and *beliefs* as conclusive proof against the working, durability, &c., of any accomplished engineering work. Any tyro can prognosticate the *ultimate* failure of any piece of mechanism, only he must mind to put off the time for the accomplishment of his forecast to a sufficiently distant period, and he might possibly pass for a wise man and leading authority on engineering subjects. I beg most respectfully to submit to "Observer" that it will be quite early enough to supply him with the cost of the Corliss valve-gear, and proof of its durability (its automaton performances have, as yet, not been disputed) when he adduces *any evidence* to raise a doubt on that which has hitherto performed its functions to the satisfaction of those who have invested their capital in it. Were gentlemen, who are actively engaged in business, to spend the greater portion of their time, to say nothing of money, in answering the questions and trying to remove the doubts and change the "*beliefs*" of every self-styled "Observer," they would soon also become *me*, "Observers." When the rising reputation of the Corliss engine becomes jeopardised by the sophisms of quondam "Observers," then the tabulated *data* will be forthcoming; it may appear sooner, but not from fear of the Corliss engine losing its growing prestige. To return to our extract from the letter signed "Observer" in ENGINEERING of the 16th instant; we were quoting his "*belief*." Now I have a "*belief*," so have all men; but then I do not set up my "*belief*" to the condemnation of other men's practical experience and knowledge of facts. Sir, in "Observer's" "*belief*," there is no remarkable economy above common engines in the adoption of the Corliss engine; his experience must be widely different from many others, and he goes on to say, "This belief cannot be changed by anything short of attested facts; and if such facts are producible, why, 'allow me ('Observer') 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.' I do not think that it will be necessary to retrace our steps and wade through those cleverly indited letters against the Corliss engine which, since the 14th day of June last, have, from time to time, appeared in ENGINEERING, for the extract given above is a fair sample of the whole collection. From the first publishing of ENGINEERING the Editor has from time to time made his readers acquainted with what had and what was being done in the Corliss system, both in America and this country, and information in both able leaders and letters has been copiously supplied. Not a single statement contained in those articles and letters was ever contradicted, nor was ever doubt cast on the veracity of those interested in the manufacture of the Corliss engine up to the time of the appearance of "Observer's" letters. Surely, he must have read a little, if not all, which has already been made public relating to the performance of these engines; or if he has visited the various parts of the United Kingdom, and he be really an engineer, he cannot be so ignorant as he would have us believe. What is the use of knowledge, and the good of newspapers, journals, and other publications, if, when gentlemen of unblemished character, write the results of their personal experience and daily observation, another gentleman says, "Nay, but *my belief* is quite opposed to your experience, therefore you must either incur expense and loss of time, which is equivalent to money, to give me attested facts, or I do not believe your statements?" This

is now the point at which the discussion has arrived, and "Observer" must either have attested facts to change his belief or the benefits known to be derived from an engine, the principles of which are fairly summarised in Mr. Spencer's letter of last week, are all shams. Even when Mr. Salt says that within his own knowledge Corliss engines are giving excellent results, even this does not satisfy "Observer," although Mr. Salt, of Saltaire, is giving the very best testament of the truth of his statements that a man can give, by replacing the cylinders of their common engine with new cylinders fitted with the Corliss valve-year; these cylinders are 50 in. in diameter.

After all, "Observer" may be merely drawing out the supporters of the Corliss systems, and he himself is probably as ready to wield his pen in its favour as he has been to take the opposite side. Be that as it may, the Corliss engine has nothing to fear by comparison with any other class.

Of course we do not claim that it is the acme of perfection. For other engines may have separate steam and exhaust valves, with the shortest possible steam-passages correctly proportioned, and be provided with a variable cut-off motion; but up to the present time the Corliss engine is recognised by every one practically acquainted with it as the best in the field. That it gives the most uniform motion, which in itself is of the first importance, most especially in large factories, where the first cost of gearing alone will save the mill-owner a very handsome sum, and its durability of gearing and machinery will be largely increased. There are many other ways in which a steady working engine adds to the increase of its owner's income besides the saving of fuel, all too obvious to those professionally competent to need further notice here.

I am, Sir,
Your obedient Servant,
J. W.

TO THE EDITOR OF ENGINEERING.

SIR,—After all this mechanical cackle, don't you think it is about time we had the egg? I have been a reader of your journal for a good few months now, and I don't think I have ever been faced weekly with such an ever-recurring plague since I learned to read. It is really amusing to see how these courteous gentlemen conduct their arguments from week to week, and never either seem to approach mutual conviction or civility. They are all hammering industriously at one another, each trying to undo his neighbour very much in the manner of those scientific (1) safe-openers at the Paris Exhibition the other day, and I must say their method is very much in the same refined scale. Now perhaps I, having been intimately connected with the working of a certain Corliss engine, might be allowed a word more of narrative than argument, where such tools as the crow-bar of spite shall not be inserted, nor yet the sledge-hammer of professional chaff descend.

At the outset, there's our friend, "Observer," surnamed the "rattletrap" man; he comes in for all the abuse of these rapid "cut off" champions of this curious machine. Well, it is with him entirely that I beg to sympathise, and in harmony with whose previous argument my few remarks will be found to tally.

We have a Corliss engine (I say *we*, so inquire no further, pray), and it is one which never behaves half so well nor appears to half such advantage as when it is standing! A more elegant, neat, trim, continental-looking gimcrack contrivance could hardly be seen in its attitude of burnished repose, but once set it a-going and its beauties at once become a delightful burlesque. There's that sorry valve-gear, with its spasmodic snapping. What with its host of pins and straps, and slides and springs, peradventure "dash-pots," I can tell you we have had an awful time of it with this rattletrap gear. I will not weary you to tell of the nature of its frequent repairs, but you can conceive them easily when I say that we are thinking of hiring a mechanic in livery to be in constant attendance on this dignified contrivance.

True its cut-off and economic principles in result are really good, and that is why we got one; but, oh dear me, does the end in this case justify the means? As "Observer" and as you yourself have said, we have as good results on record from some old engines that were made thirty years ago. Take even the double-slide valve, as your paper showed the other week, by diagrams from an engine of this principle, sent you by Messrs. Sheppheard, Mulliner, and Garstang, of Blackburn, and common sense will show you that all the rattletraps in Christendom could not beat them.

The whole question lies in that thirst for novelty and love of the newfangled and fanciful that seems to pervade this progressive age, as "Observer" has wisely said. I had occasion lately to show an engine to a Yorkshire country mechanic, when it was with difficulty I could get him induced to enter the engine-house, he seemed so scared and terrified at the noise of the vehement "dash-pots!"

Let us not browbeat the Corliss engine, though we try to soothe its assumed majesty; and as the voice of an afflicted martyr to the rattletrap disorder, let me advise English manufacturers to stick to the staid calm dignity of an English engine.

Yours very truly,
A YARN-SPINNER.

P.S.—In case you may think me in league with the evil one, "Observer," I have never seen him, nor taken tea with any one who knows him.

TO THE EDITOR OF ENGINEERING.

SIR,—That "outsiders see most of the game" is a well-known proverb. I will not be so egotistical as to claim its application in the present instance to myself, but I put it on record as my title to a share in the discussion now going on in your columns relative to the merits or otherwise of the Corliss valve-gear, the only new and independent part of the engine. In the heat of controversy, writers are apt to get blinded by passion or prejudice, and so lose sight of what they meant to prove, or of the best means of answering their opponents. As "Observer" seems to be the leader of the opposition, and many of his coadjutors are supposed to have no personal existence apart from him, I shall confine my remarks chiefly to his letters, and endeavour to show him and your readers in what position he stands as far as his attacks have gone on the Corliss engine.

In your issue of June 14th, "Observer" objects to the rattle-trap nature of the gear, and to the statement of economy of fuel claimed for this engine. Mr. Douglas, a builder of the Corliss engine, and who ought to know as much about it as any one, says that the "results are most satisfactory," that "their economy in fuel is remarkable, and their speed regular and unvarying, their powers of self-adjustment to load as near perfection as possible, and that, working night and day, they give no trouble." To all this "Observer" only replies by most impertinently asking, "Who is Mr. Douglas?" It is as well Mr. Douglas is not so bellicose as his great namesake of old; were he, perhaps "Observer" would have been more cautious. He also says that Mr. Douglas would not be likely to cry stinking fish. An observer in the days of the Black Douglas would have told him "he lied in his throat." And where, I ask, is the difference between the open manly assertion and "Observer's" *insinuation*? None, except in the cowardice of the attack. Anything, I take it, is remarkable when it is out of the common run of things of like nature and species. "Economy in fuel is remarkable," is not perhaps the most definite term that could be used, but it shows that the advantage is on the side of the Corliss engine. And "J. W.," in your last issue, shows that the consumption of fuel in the Corliss is about half that in the common engine.

In a further letter, he complacently asserts that his anticipations as to proving rattletrap valve-gear futile have been confirmed, and adds that neither by argument nor evidence has any one point of superiority been proved. I should like "Observer" to favour your readers with what he requires as proof. The economy of fuel has been stated as a fact by those who know the working of the common and Corliss engines. That the self-adjusting valve-gear produces, as from the very nature of its construction "Observer," if he know anything of the gear, must be well aware it would, a greater rapidity, precision, and uniformity of motion than that of any other engine in existence is not denied.

The cost and complication are the only points remaining to "Observer." Cost, I need hardly say, is a relative term. All new things "Observer" ought to know, are dear for a very good reason. The Corliss valve-gear will become cheaper in time; of that there is not the slightest doubt. But if, as all who use the engine declare, the work obtained from it is greater, and the durability of parts more lasting, than that of any other engine, is it not cheaper to pay a good price for what will last than a low one for what needs frequent repairs? Surely "Observer," who is so far ahead of the recognised rules of evidence, cannot go in for the penny-wise and pound-foolish principle! Complication is also relative. The only question is, does it work better? "Observer" can hardly refute the testimony brought in its favour as to durability and working by those who build and use it? Mr. Douglas, Mr. Salt, and others have again and again declared that the engines do work with greater equability, durability, &c., and all your readers get from "Observer" is a reiteration of objections. In my opinion, then, "Observer" has to do his work again, and leaving him to his task, which I doubt not he will resume with as much ardour as ever, I will conclude by saying that if the supporters of the Corliss engine will favour him with exact data as to working, consumption of fuel, &c., he will get along triumphantly, or, who knows, find the ground cut from beneath his feet.

I am, Sir,

Your obedient Servant,
NEXUS.

TO THE EDITOR OF ENGINEERING.

SIR,—The main feature of the Corliss valve-gear, and the one to which all the others are subordinate, is the "rapid cut-off," which reduces the amount of wire-drawing; but as the valve still takes some time to close, it cannot actually annihilate that action, and it seems to me that, unless it can be distinctly proved that this rapidity of motion is absolutely necessary, all the advantage of this much-praised valve-gear is imaginary. The balanced and divided valve, in this case, divide and lessen the work on the spring; but they are not peculiar to "Corliss" alone, and the most earnest advocate will not assume the regulation of the "cut-off" by the governor as a distinctive point. In short, it is only the mode of getting a rapid motion of the expansion-valve that is the novelty. We are all (even you, Mr. Editor) too fond of our own opinion to change it for any other man's "ipse dixit," and we require facts to convince us.

In the fine collection of engines at the Paris Exhibition there are endless varieties of cut-off motion regulated by the governor—Spencer's, which seems the quickest, the American Corliss Allen, by Whitworth, and so on, to any degree required. Now, Sir, is it possible to get diagrams from some of these engines to show at what speed of cut-off the wire-drawing action practically disappears, and to prove that this is attained only by the complicated arrangement of Corliss? Some such information, collected and arranged as an article in your journal, would be more convincing than fifty pages of discussion, and would be more valuable than if spread over the letters of your correspondents.

It might also be shown with what speed and delicacy the different valve motions control the admission of steam to the variations of work on the engine.

Mr. Salt's experiments will be valuable, for he tells us the main conditions under which they will be made, first with his present engine (I suppose) with separate cam-worked valves, and afterwards with the same sized cylinder, same speed of piston, same initial pressure of steam in cylinder, but with the "Corliss" motion.

Should he get no important saving, he will perhaps be astonished, but not more so than some of us will be if any considerable gain is the result.

I am, Sir, your obedient Servant,

J. C. E.

London, August 19, 1867.

BRONZE AND STEEL ORDNANCE.—It is stated that experiments are being made by the French Government on a new mode of constructing ordnance. The interior of the cannon is made of steel, and the exterior of bronze, and it is supposed that this construction will combine the maximum of wear with the minimum of liability to explosion.

THE WATERWITCH, THE VIPER, AND THE VIXEN.

TO THE EDITOR OF ENGINEERING.

SIR,—In your last issue you have given a table, showing the results of a series of trials of these vessels just concluded at Stokes Bay. This table is, no doubt, obtained from authentic sources, and gives the facts as they are recorded. I observe one error—a printer's one I should think—whereby the figures for the co-efficients of displacement have been made to change places with the co-efficient figures for the midsection. This error, however, will not do any harm to either vessel; but I would ask leave to object to the accuracy of the statement which you make in the paragraph introducing the table, namely, that "the Waterwitch has done better than on her former trials; but is still beaten by the twin-screw ships." This statement is not quite correct. At the former trials at the Maplin, the result was, Vixen 9.0, Viper 9.1, and Waterwitch 9.9 knots. There, the hydraulic beat both vessels. At Stokes Bay again, although of greater displacement, the Waterwitch beat the Vixen by about one quarter of a knot. It is true that the present record shows that the Viper, on the other hand, beat the Waterwitch by about a quarter of a knot; but it has yet to be shown how the enormous discrepancy between the work done and the horse power stated to be used by the Viper at the Maplin, and the work done and horse power stated to be used by her at Stokes Bay—same engines, same vessel—amounting to nearly 200 horse power, is to be accounted for. Further information will be required before the present table of results can be received as correct. The errors may be in the first set of trials or in the last; but that error, and gross error too, exists in one or other is certain; if any reliance may be placed on the principle, *ex nihilo nihil fit*.

In the mean time I think you will admit that it is only fair towards the hydraulic to be allowed to say that, so far as the admitted and undoubted proofs go, the Waterwitch must still be held to have beaten both Vixen and Viper; and, further, that there is not the slightest reason for supposing, as you have chosen to do, that there "is any thing defective in the design of the pumping machinery." It is the same machinery which beat both Vixen and Viper on the Maplin; and it tells largely in favour of this, that there has not been any change, alteration, or addition made in the propelling machinery from the original drawings of the inventor. The Viper and Vixen have had the benefit of nearly thirty years' experience with the screw, yet with all that experience both of these vessels have already had their screws, more than once, changed.

I may also be permitted to doubt—as you state—"that it is certain that improvements may be made in the jet system, so as to take in the water from the bow instead of at the bottom, and to eject it right aft." Doubtless many improvements may be looked for on the present arrangements, though, when these have already surpassed the thirty years' success of the screw, there cannot be a very wide margin of improvement to be reasonably looked for. Such improvements, however, are hardly to be expected from the suggested change of taking in and altering the current of the water. The original patent of Mr. Ruthven, in 1839, shows the water taken in by the bow and ejected at the stern; but, after great labour and many experiments, that plan was abandoned for the present one, which has given such extraordinarily good results.

London, August 19, 1867.

W. B.

A NEW BREECH-LOADING CANNON.

TO THE EDITOR OF ENGINEERING.

SIR,—There has just been added to the Paris Exhibition a breech-loading cannon constructed on quite a new principle, combining novelty, simplicity, and great power, possessing also several very important advantages and features.

The inventor is Mr. William Hewitt, of Bristol, and the cannon will be found mounted on his improved naval gun-carriage, Class 66, catalogue 26.

One of the principal features this invention possesses is the part selected for loading, which is just abast the trunnions, consequently the gun is not weakened or mangled in that part where the powder exists its full force; this principle will, therefore, admit of heavy ordnance being constructed with the greatest possible security and safety, there being no breech-piece to bow out or screw-threads to be stripped, arising from backward pressure.

The part chosen for loading (as before observed) is just behind the trunnions, and the opening is sufficiently large to easily admit of the projectile. The piece which fits into this said opening is tapered on both sides (to allow of its being easily withdrawn, and at the same time securing a good fit), and works on a joint similar to a foot-rule joint. When the breech or trunnion-piece is down in its place, it is locked by one half turn of a screw coming in contact with its face. This screw-lock travels back and forward on the principle of a slide-rest, which is worked by a handle from the back of the gun; when the said screw-lock is drawn back, the breech or trunnion-piece is at liberty to be opened, and when closed the screw-lock is run forward over the said breech or trunnion-piece—one half turn of the screw locks it. The breech-piece is dovetailed at the joint on which it works, which, combined with the screw and V slide, imparts great solidity, so much so that it would be impossible for it to give way, for it will be seen that the part spotted for loading is simply a channel for the projectile.

The bag containing the powder is inserted in the gun (in the aforesaid opening), and pushed back to the extremest end of the breech; the projectile is then inserted and pushed back clear of the joint on which the breech-piece works, so that when the latter is in its place it cannot be seen.

The model has attracted considerable notice and attention, and those well versed in heavy ordnance entertain a very high opinion of the principle, especially the part chosen for loading.

BREECH-LOADER.

FAILURE OF A RAILWAY VIADUCT IN INDIA.—The largest viaduct over the Chane Ghaut incline, 160 ft. high, have given way through faulty construction, and two trains thereby narrowly escaped destruction.

SHAPING-MACHINE.

TO THE EDITOR OF ENGINEERING.

SIR,—I think you did well to insert the amusing parody of a "trigonometrical solution" of the shaping machine movement, signed "Margrave Dillon," since there is no reason why an editor should keep all the good things to himself. Lest some of your more innocent readers, "ill at that reckoning which befitted the spirit of a tapster," might endeavour to find some method in "M. D.'s" madness, it will, perhaps, be as well to observe that a "trigonometrical solution" would be comprised in fewer lines. A reference to the diagrams accompanying Mr. Williams's letter in the last number will show that the time occupied in the cutting and retiring strokes of the link will be proportional to the sum and difference respectively of 180° and the angle of vibration of the link. Thus, if that angle were 90° , the respective times would be as $180+90:180-90$; that is, as 8 to 1.

I am, Sir, yours obediently,

AN ENGLISH ENGINEER.

FLOATING DOCK.

TO THE EDITOR OF ENGINEERING.

SIR,—I see it stated that the new floating dock at St. Thomas has sunk, and is in danger of being a total loss. Did not the same thing happen with one in Java?

Even supposing these accidents were the result of culpable negligence, they seem to show that there are great risks to be encountered in putting down floating docks. I should be glad to hear more about this.

I am,

ENQUIRER.

August 20, 1867.

THE LANCASHIRE AND YORKSHIRE RAILWAY.

TO THE EDITOR OF ENGINEERING.

SIR,—The remarks in ENGINEERING, of the 16th inst., with regard to Lancashire and Yorkshire Railway station, holds good for all other stations on this company's lines. The accommodation and attendance is nearly equally bad everywhere, and at Bolton station it is even better than on most others. However, this might be put up with if the fares were not about double what they are on other lines, and the officials not half as civil. This company, no doubt, has found out the secret how to make railways pay. It is by charging as much as possible, and giving no more than they can possibly help.

A CONSTANT TRAVELLER ON THE
L. AND Y. LINES.

Manchester, Aug. 21, 1867.

FLEXIBLE SANDSTONE.

TO THE EDITOR OF ENGINEERING.

SIR,—The *Times*, I see, states that a great geological curiosity has been deposited in the Hartley Museum, in Southampton, consisting of a piece of flexible sandstone, which is placed in a glass case, with an apparatus for showing such flexibility. I brought specimens of the same stone from India twenty years ago; and in the neighbourhood of Mirzapore it is very common. The flexibility is produced by connecting plates of mica, entering into the composition of the stone. A large part of the old fortress of Rotasghur, on the banks of the Saone, near the point where the Grand Trunk road crosses it, is built of this stone; and in India it is quite common, and is not there accounted a curiosity at all.

I am, &c.,

JOHN BOURNE.

THE PORTSMOUTH FLOATING BRIDGE.

TO THE EDITOR OF ENGINEERING.

SIR,—Your current impression gives woodcuts showing the construction and arrangement of the machinery erected by Messrs. James Watt and Co. on board the floating bridge connecting Portsmouth and Gosport.

The name of that firm is not mentioned, and the whole credit is given to Messrs. Lewis and Stockwell, who constructed the hull from drawings supplied to them.

Perhaps the matter is not of much moment though worthy of correction, as it is really another version of the play of Hamlet that important personage being left out.

Yours very truly

TOMKINS.

18, London-street, City, E.C., August 19, 1867.

"PICKING AND STEALING."—The death of a railway guard, killed through being struck by a bridge while he was on the top of a carriage endeavouring to detect persons damaging carriages may surprise some who are not aware how much mischief is done by passengers. In the course of the evidence given last month before the House of Lords' Committee on the bill which proposed to compel railway companies to provide means of communication between passengers and guards, Mr. Scott, the manager of the South-Western Railway, said, "I should no more think of intrusting our suburban passengers with means of communication than I should think of flying. Scarcely a day passes that we have not several of our carriages damaged; they cut the linings and fittings, break the glasses, and destroy the lamps." Mr. Fenton, the manager of the Metropolitan line, said, "We have to carry so many mischievous people that we are; obliged to remove all the straps from the third-class carriages, we have carriages continually cut." Mr. Seymour Clarke general manager of the Great Northern line, said both of London and Yorkshire, "These local (short) passengers, to whom no responsibility attaches, are very mischievous; they have no luggage, and there is nothing by which they can be detected; you would be astonished if you knew the amount of repairs we have to do resulting from pure mischief." He says, "They are fond of a bit of fun;" but, whether it be done from love of fun, or mischief, or pilfering, these persons are the enemies of the whole travelling public, and a discredit to us all.

THE CLEVELAND IRON TRADE.—The number of furnaces in blast in the Cleveland district is eighty-nine, and there are forty-five out of blast. The make of pig iron appears to be pretty well absorbed by current consumption. The manufactured iron trade of the north of England is considered a little better.

THE ENGINE TRIALS AT BURY.

TO THE EDITOR OF ENGINEERING.

SIR,—I beg to send you the following calculations to determine the piston speed and amount of expansion which would give the best results under the conditions of the late engine trials at Bury. I merely send the results, not the tedious details by which they were obtained. It is not the exact results that should be noticed, but rather the effect of friction, back pressure, and other losses on the economical speed of piston and grade of expansion under the society's conditions of trial.

Formula for Mean Effective Pressure.

(See Fig. 1.)

Let A B=stroke.

A C=cut-off.

A D=length of cylinder equal to passage and clearance.

P=cylinder pressure on suppression.

M=mean effective pressure.

R=useless resistances, i.e.=friction of engine, of strap, and of brake spindle+loss by back pressure, premature release, compression, &c.

T=time of running in minutes.

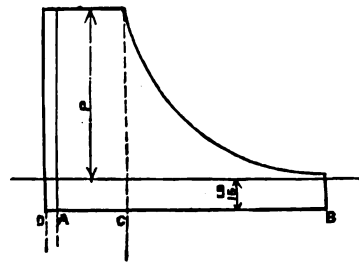
S=stroke of piston.

 $\frac{1}{100}$ =percentage amount of steam from A to C.

w=weight of a cubic foot of steam at (P+15) pressure.

n=circular inches per H.P.

FIG. 1.



$$M = \left(\frac{AC + CD \times \text{Hyp. log } \frac{BD}{CD}}{AB} \right) \times (P+15) - (R+15)$$

$$S = \frac{33000}{M \times n \times \pi/4}$$

$$\text{Steam per minute in lb.} = S \times \frac{n \times \pi/4}{144} \times \frac{1}{100} \times w.$$

When AD is very small, we may neglect the steam required to raise the pressure in it (when compressed) to the pressure in the steam-chest.

Let 14 lb. of coal make $14 \times 9 = 126$ lb. of steam.

$$T = \left(126 \times \frac{M \times n \times \pi/4}{33,000} \times \frac{14400}{n \times \pi/4 \times s \times w} \right) = \frac{126 \times 144 \times M}{s \times w \times 330}.$$

DOUBLE CYLINDERS AT 80 LB. PRESSURE.

With Single Valves.

AB.	A.C.	A.P.	P+15	R.	M.	T.	S.	S.
100	20	3	90	13.5	20.5	4	24	228
"	30	"	"	12	33.2	4	55	138
"	40	"	"	11.5	42.3	4	87	110
"	50	"	"	10.5	50.9	4	29	91
"	60	"	"	10	57	4	9	82

With Double Valves.

AB.	A.C.	A.P.	P+15	R.	M.	T.	S.	S.
100	15	3	90	6.5	20.2	5	53	231
"	20	"	"	6.5	27.5	6	1	170
"	30	"	"	6.5	39.2	5	44	119
"	40	"	"	7	47.8	5	13	100
"	50	"	"	7	54.5	4	46	85
"	60	"	"	7	60.8	4	24	77

SINGLE CYLINDERS AT 50 LB. PRESSURE.

With Single Valves.

AB.	A.C.	A.P.	P+15	R.	M.	T.	S.	S.
100	20	3	62	13.5	5.3	1	39	796
"	30	"	"	12.5	14.4	8	1	290
"	40	"	"	11.5	21.4	3	20	196
"	50	"	"	10.5	27.1	3	23	155
"	60	"	"	10	31.6	3	16	134

STEAM AT 50.

Double Valves.

AB.	A.C.	A.P.	P+15	R.	M.	T.	S.	S.
100	20	3	62	6.5	11.8	8	81	272
"	30	"	"	6.5	20.4	4	14	206
"	40	"	"	7.0	25.9	4	2	162
"	50	"	"	7.0	30.6	3	49	137
"	60	"	"	7.0	34.2	3	34	123

The friction, R, varies with the load and other circumstances. Let it be taken at 3 lb. extra to represent a mean engine.

STEAM AT 50.

AC.	Single Slide.	Light.	Heavy.	T.	AC.	Double Slide.	Light.	Heavy.	T.
80	369	553	2.22		80	241	861	3.88	
40	229	343	2.52		40	183	274	3.34	
50	174	261	3.1		50	152	228	3.27	
60	147	183	3.34		60	134	201	3.15	

BEST PISTON SPEEDS.

STEAM AT 80.	STEAM AT 50.
Single Slide.	Single Slide.
Heavy load. Light load.	Light load. Heavy load.
207 138	155 282
	196 294
Double Slides.	Double Slides.
255 170	206 309

The best rate of expansion will be observed to be when the final pressure equals the mean resistance, R, as before defined.

In indicator diagrams, if A B=R (as above defined), the engine will require more steam to do a given amount of work when the curve falls below B C, as at D, than when it is above as at E.

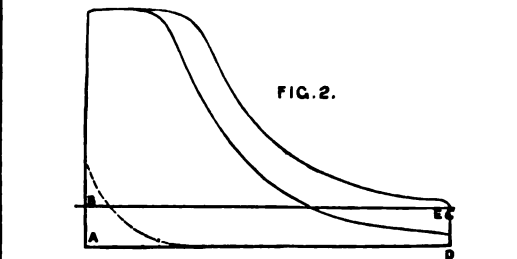


FIG. 2.

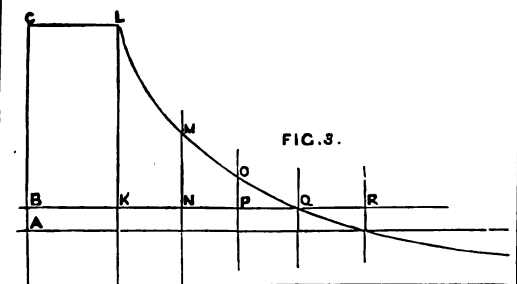


FIG. 3.

Referring to Fig. 8, let A C=steam pressure.

A B=R.

A D=stroke of engine per minute.

Conceive an engine using a given weight of steam per minute, and let steam be on the piston for whole stroke, the speed of piston being=A D. The spaces A L and A K will then represent the total work done by steam, and the work done in overcoming R; B C L K representing the useful work available to drive the brake.

If the speed be increased to A E, A C L M E will be the work done by steam, but B C L M N will be the available work. . . K L M N is available increase of work.

As the speed increases to F and G, N M O P and P O Q represent the increase of available work. But if the speed increase from G to H, then Q R S represents the loss of power.

Therefore steam cannot be usefully expanded below the line B R.

The line B R will not be quite straight, but nearly so.

B Q is the best piston speed for power.

But when we remember that since the wear and tear depends on the piston speed, and also that the point Q could generally only be reached by the aid of a larger cylinder than usual for the power required,

It is clear that there is a place where the increments of power O P Q, commercially cost more than they are worth.

A line might be drawn above B R, representing the commercial limit to expansion in an engine fairly loaded.

As to commercial engines, a separate adjustable expansive gear is of little value; it is generally set to meet the heaviest load, and then forgotten.

Cut-off, with a single eccentric when fixed, should depend on the boiler pressure: half stroke is too early with pressures under 50.

Lincoln, July 30, 1867.

Yours truly,

W. HARTNELL.

TRACTION ENGINES.

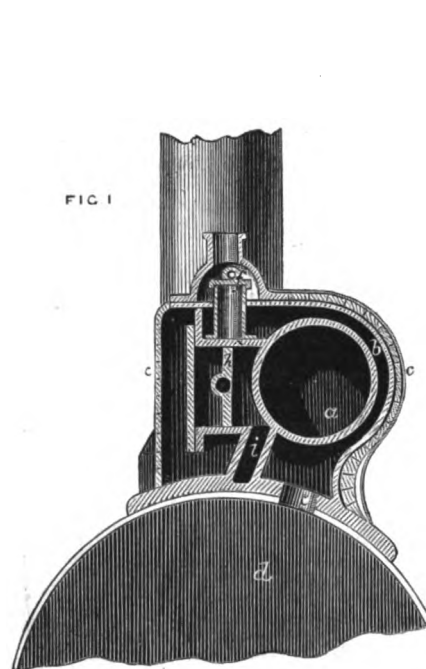


FIG. 1.

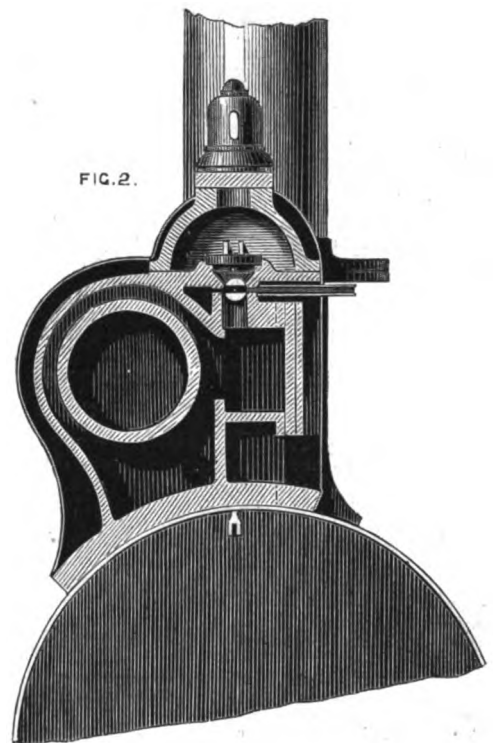


FIG. 2.

TO THE EDITOR OF ENGINEERING.

SIR,—Being naturally interested in everything relating to traction engines, we read with great attention the description given in your journal of the 2nd instant, of the locomotive exhibited by Messrs. Turner, of Ipswich, at the Bury St. Edmunds show of the Royal Agricultural Society. We had examined their engine, as well as we could, in the show-ground, and, believing the cylinder to be an infringement of Mr. Aveling's patent of the 21st May, 1861 (No. 1295), had asked Messrs. Turner for an explanation of its construction. Their reply was: "Our cylinder is not steam-jacketed; the exhaust, however, is carried into a casing which surrounds the cylinder."

Herewith we send you a tracing of the two cylinders—the one copied from your illustration, the other, Fig. 1., from the drawings accompanying the specification of Mr. Aveling's invention. If a comparison of the two drawings does not lead you to the same conclusion as ourselves, it will at least convince you that these gentlemen have shown great ingenuity in their effort to evade the consequences of too close imitation.

Perhaps we may venture, in addition to troubling you with the drawings, to ask your attention to the following quotations from our specification of 1861: "In order to prevent as far as may be the condensation of steam in the working cylinder, we place the cylinder in the steam dome, and bring the steam dome to the forward part of the engine. a a is the working cylinder, surrounded by a casing, b b, which forms the dome or chamber from which the steam is taken for supplying the cylinder. The steam-chamber is brought into direct communication with the boiler, d d, by means of steam-ways, e e; steam is therefore constantly circulating round the working cylinder. . . . The exhaust steam passes off by a port, f, to a pipe, k, opening to the funnel, l. This arrangement, it

"will be seen, not only prevents priming when the engine is ascending steep inclines, but also avoids the necessity for using a pipe for conveying the steam from the steam-chamber to the cylinder, or for the employment of a long pipe (as is now commonly used) for conveying the exhaust from the cylinder to the funnel."

The importance of this subject to ourselves must be our apology for the length of this letter. We fear it will scarcely have sufficient interest for you to compensate you for the loss of valuable time taken up by its perusal.

We are, dear Sir,

Your obedient Servants,

Rochester, Aug. 14, 1867.

A. VELING AND PORTER.

HEREFORDSHIRE WAGON AND TIMBER COMPANY (LIMITED).—We understand that these works and plant are so nearly completed as to enable the company to commence wagon building at once, and that some good contracts have already been made. Lying as Hereford does in the very heart of one of the finest timber-growing districts of the kingdom, and midway between the South Wales and Staffordshire iron districts, and adjacent to each, and being the centre of a vast railway system, besides having direct canal communication with the port of Gloucester, the company has every chance of success.

THE SUZ CANAL.—A transport service, organised from Port Said to Suez by the Suez Canal Company, has already acquired some importance. The business done during the last ten months has considerably increased, and the Peninsular and Oriental Steam Navigation Company is said to be contemplating the despatch of coal to its Suez station by this route.

THE "SIR HERBERT MADDOCK."

CONSTRUCTED FOR THE INDUS FLOTILLA COMPANY (SCINDE RAILWAY), BY MESSRS. WIGHAM RICHARDSON AND CO., NEWCASTLE-ON-TYNE.

(For Description, see next Page.)

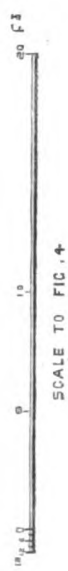
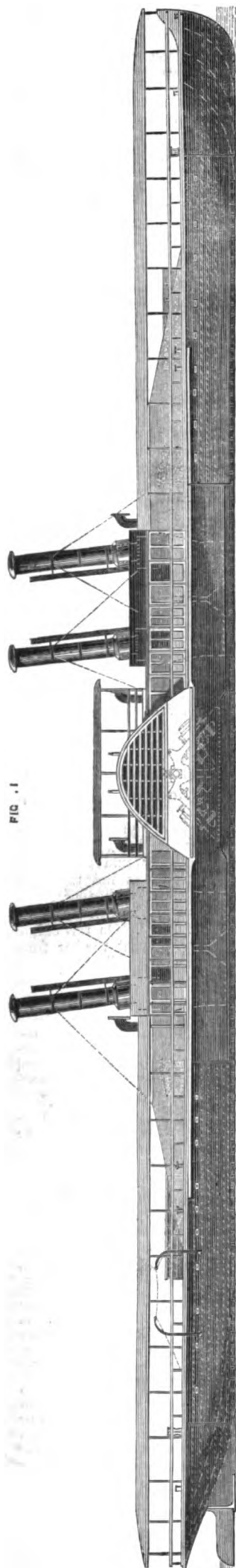


FIG. 4.



FIG. 2.

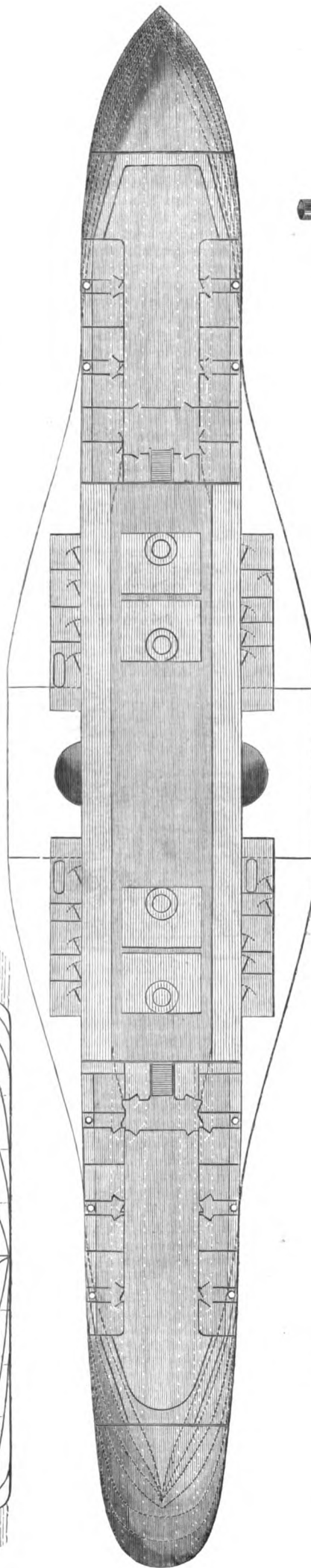


FIG. 5.

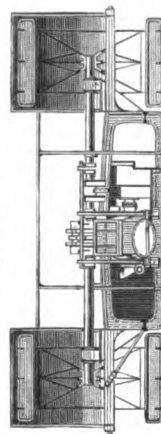


FIG. 6.

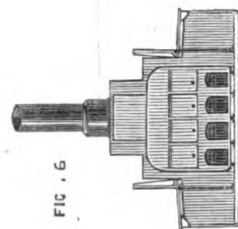
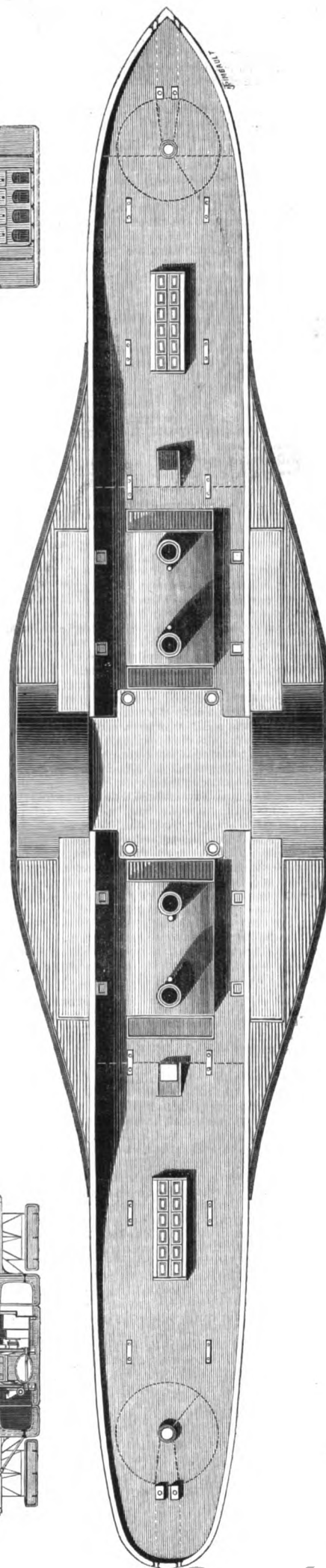


FIG. 3.



THE "SIR HERBERT MADDOCK."

We engrave, on the following page, a shear plan, deck plan, and sections of the Sir Herbert Maddock, the most powerful steamer at present on the Indus, our engravings having been prepared from drawings furnished by the builders, Messrs. J. Wigham Richardson and Company, of Newcastle-on-Tyne. The Sir Herbert Maddock was constructed for the Indus Flotilla Company (Scinde Railway), and was tested on the Tyne, and then taken to pieces and shipped to Kurrachee, where she was re-erected under the superintendence of Mr. Ward, Messrs. Richardson's foreman. The design of the vessel and machinery was got out under the superintendence of Mr. George Parker Bidder, and the trials were conducted by Mr. Kingsbury. We subjoin some of the leading dimensions of the vessel:

	ft.	in.
Length over all ...	275	0
" on water-line ...	265	0
Breadth of beam ...	28	6
Depth moulded ...	8	0
Extreme width over paddle-boxes ...	56	0
Draught of water in running trim ...	2	10

The vessel is simply constructed. The frames are spaced 2 ft. apart, and there are four transverse bulkheads, while the diagonal arrangement of the engines allows the coal-bunkers to be carried right fore and aft, so as to form stiffening girders, which, for greater strength, are carried above deck amidships. On board, also, the sides of the paddle-boxes and of the houses on the sponsons are formed by the side plating of the hull being carried up and suitably stiffened on the upper edge. This involves the necessity, which is not perhaps a disadvantage, of entering the houses on deck from the sponson side. A good deal of steel both in plates and angles was used in the upper works; it was all supplied by the Hoerder Works, in Rhenish Prussia. The awning of course is permanent, the stanchions being all hollow tubes. The rudder is of the usual construction, and is about 10 ft. long; it gives perfect command of the vessel, and no trouble whatever. It was contemplated to adopt the jointed rudder, but the idea was abandoned. There is a hurricane deck, as shown, over the machinery, and above this again is the awning. On the Tyne the vessel was launched end on without her machinery; but at Kurrachee she was sent into the water sideways with both her engines and boilers on board, a pretty good test of her stiffness.

The engines were made by the well-known firm of Robert Morrison and Co., of the Onseburn Engine Works. They consist of two inclined oscillating cylinders placed on the star-board side, as shown on the drawing, each being 65 in. in diameter with 4 ft. 6 in. stroke. The nominal power of the engine is 280 horse power collectively. The framing of the engines is formed by two immense triangular forgings, one on each side, the forging of these frames, which was a very heavy piece of work, being executed under Messrs. Morrison's large hammer. The air-pumps are two in number, and like the cylinders they are placed diagonally. They are worked from an intermediate crank on the port side. The smaller rods are hollow tubes, so made for the sake of lightness. The boilers are four in number, and are arranged in two groups, back to back. All the plates are of Lowmoor iron, and the boilers are calculated to stand a working pressure of 25 lb. per inch. The total weight of the engines and boilers with water is only 220 tons, which, allowing for the extra size of the boilers, and for the weight of water, gives a very low weight per horse power. The indicated horse power exerted by the engines of the Sir Herbert Maddock was 1040, with 20 lb. pressure in the boilers.

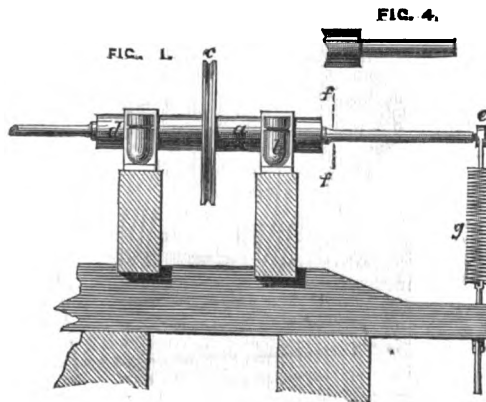
The trial trip in England took place in the month of February, and was carried out under very unfavourable circumstances, but the speed attained was $15\frac{1}{4}$ miles an hour. The vessel was also tried with two barges lashed alongside, each barge being 200 ft. long, 22 ft. beam, and drawing 2 ft. 2 in. of water. Under these conditions it was curious to observe that, after a certain speed was attained, the revolutions of the engines were increased from 29 to 39 without at all altering the speed through the water, showing the well-known fact that within practical limits of length of paddle it is impossible in these light-draft boats to obtain an adequate area of float, and that in shallow-water navigation, so long as the fulcrum is the fluid through which the steamer is moving, the loss of power, whether screw or paddle, will always be greater than in the case in deep water.

THE WATER SUPPLY OF MALTA.—The *Malta Times* states that several more discoveries of springs have been lately made in different parts of the islands, and adds, with reference to Mr. Bateman's proposal: "The excavation for water in the sandstone formation of the Massa Valley, as well as in other parts of the island, has been long practised with success by the natives. Mr. Bateman's suggestion of sinking a shaft through that rock has consequently no claims to originality. There are already several shafts of a like kind in the vicinity of the spot selected by that engineer, and, indeed, one, that of Mr. Scerri, lies within the distance of a few yards of it. It would, therefore, be highly improbable if water to some extent were not discovered in such a locality, not, however, for the reason stated in Mr. Bateman's proposal—the conversion of salt into fresh water by filtration through the rock, or from the sandstone itself being sufficiently porous to act as a sponge, but from the natural reservoirs in the sandstone, caused by the cracked and fissured nature of that rock draining the superficial rains from the neighbouring slopes. Up to the last accounts we have received, the excavation had proceeded to a little more than 85 ft.; and, although no great quantity of water had been met with, the character of the rock gave grounds for hoping that more would be found."

RAILWAY PROGRESS IN INDIA.—The length of railway in operation in British India, June 30, 1854, was 35 miles. The corresponding distance worked June 30, 1855, was 156 miles; June 30, 1856, 209 miles; June 30, 1857, 274 miles; June 30, 1858, 332 miles; June 30, 1859, 432 miles; June 30, 1860, 734 miles; June 30, 1861, 1028 miles; June 30, 1862, 1584 miles; June 30, 1863, 2234 miles; June 30, 1864, 2581 miles; and June 30, 1865, 2747 miles. These statistics are confined to Bengal and the North-West Provinces, Madras, Bombay, Scinde, and the Punjab.

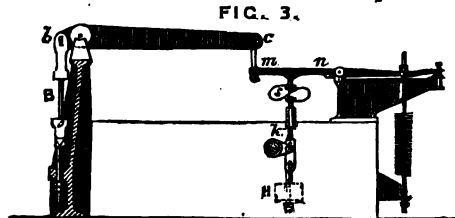
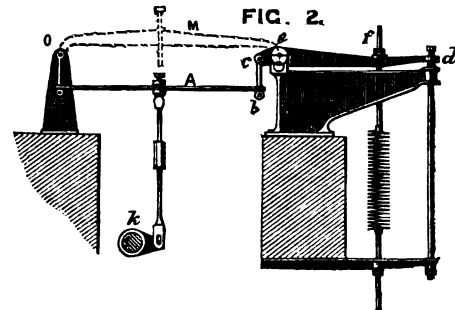
WÖHLER'S EXPERIMENTS ON THE STRENGTH OF METALS.

At the railway workshops belonging to the Niederschlesisch-Märkische Eisenbahn, in Prussia, M. Wöhler, the chief engineer, has for some years past been occupied in making a series of most interesting experiments on the strength of iron and steel when exposed to repeated strains within fixed limits and for a length of time. It is known, through the experiments of Mr. W. Fairbairn and of others, that the repeated application and removal of a load which is considerably below the breaking weight of any metallic bar will, after a number of such repeated applications, cause the fracture of the bar, and this apparent anomaly has been called the fatigue of metals. Exact laws for this so-called fatigue have, however, as yet never been obtained, and the few experiments made hitherto on this important subject have been utterly insufficient to derive any theoretical conclusions from them. Mr. Wöhler, having been charged with some comparative trials for ascertaining the relative value of steel and iron for railway axles, which are more than any other similar article exposed to repeated strains and to the effects of fatigue, decided upon commencing an independent series of experiments on a sufficiently large scale in order to arrive at some clear and instructive results. He constructed for this purpose a set of very ingenious machines which allowed him to expose his bars to vibrating actions and repeated strains within adjustable limits, and to observe carefully all the facts connected with each experiment. The results of M. Wöhler's numerous experiments and sketches of the special machines used by him are now exhibited at Paris by the directors of the Prussian State Railway, and we consider this exhibit one of the most interesting and important in the whole group of engineering objects collected there. The specimens, which are exhibited in a very small case in the Prussian machinery gallery, and are to be found only upon a careful search or inquiry, consist of a set of ten fractured bars of steel and of iron, and a small pamphlet affording the necessary explanations. From this pamphlet we have copied the sketches of the experimental machines used by M. Wöhler and the data of the strains borne by the different specimens. M. Wöhler commenced his experiments with a machine (see diagram, Fig. 1.)



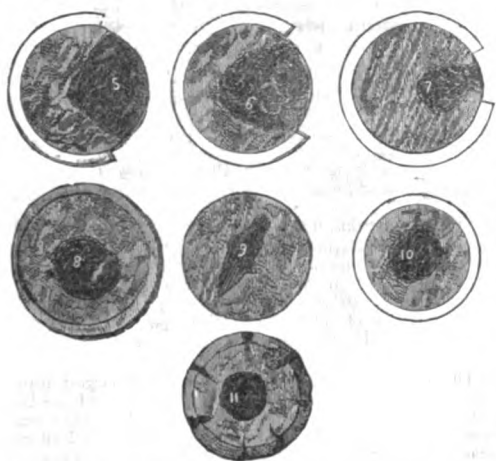
constructed for straining a cylindrical bar in a manner similar to that in which a railway axle is acted upon by the load it carries. The bar to be tested is fixed to the end of a rotating steel spindle (a), supported in a pair of bearings (b b), and provided with a pulley (c) for obtaining rotation by means of a strap. The projecting end of the spindle (d) has a central conical recess into which one end of the bar is pressed, the other end being turned down into a small trunnion which runs in the bearing (e), and upon which the adjustable action of the spring (g) exerts a constant downward pull. The bar is by this action bent down at the end to a fixed distance, and in its rotation the action of the spring makes this bend take place in all directions successively all round the circumference of the bar. Taking the section through any one diameter, we find that in each rotation the bar is bent and unbent in two opposite directions, so for each revolution there is a strain exerted upon it in tension and in compression alternately. The amount of this strain is adjustable by the tension of the spring (g), and measurable from the latter. The strain shown by the dynamometer being effected in tension and in compression, it follows that the effect upon each fibre of the bar is equal to the sum of the two actions, or double the effect of the simple strain indicated by the spring. The breaking strain for bars of best fibrous iron under these conditions has been found to be no higher than 8 to 9 tons

on the square inch, and the best soft cast steel had no more than 12 to 15 tons of tensile strength when strained in this manner, that is, strained between the limits of, say, 15 tons in tension and 15 tons compression alternately. There is, as an example of this kind, a broken bar of fibrous iron exhibited which had sustained nineteen millions of such alternate tensions and compressions with a strain of 9 tons on the square inch of section before fracture ensued. Now, if we take the total difference of change from a compression of 9 tons to a tension of the same amount, we find this to be 18 tons, or very nearly the tenacity of this material when strained in one direction only. In order to compare the effect of these strains with repeated strains which are of the same character, another machine represented by diagram Fig. 2 was designed by M. Wöhler. The bar under test (A) is in this case



held upon two supports or linear bearings formed as knife-edges (a b), and the strain is transmitted to it at the centre by the bar (m) moved by a crank (k). The spring (f), adjustable in the amount of its tension, is set so as to balance the bending power effected by the crank through the leverage of the arms (ce) and (ed). The bar is in this apparatus bent once for each turn of the crank, and the fibres are strained in each section in the same direction each time. The tension upon each fibre is therefore varying between the limits of zero and the strain indicated by the dynamometer. Under such circumstances fibrous iron has been found to break with a tensile strain of 15 to 18 tons, and soft steel broke with strains of between 22½ to 25 tons on the square inch. This having been ascertained, it was desirable to find the amount of strain which such bars would bear if the strain applied in one direction was not taken off entirely, but only partly removed each time. The apparatus was for this purpose provided with the bar shown in dotted lines on Fig. 2 (M). On this bar an adjustable pin was set, so as to prevent the bar from unbending itself altogether when the pull of the crank was removed, and the latter obtained sufficient play in the bearing of the connecting rod to allow for this. The bar was then strained within given limits, both of which could be calculated from the indications of the tension spring at f. With this arrangement the remarkable fact was shown by experiment that a steel bar may be strained to 40 tons on the square inch, and released, say, to a tension of 20 tons with the same degree of safety as a tension varying between 12½ tons and 35 tons would give. A steel bar may therefore be loaded and unloaded between 20 and 40 tons strain with safety, while it will break down if the load of 40 tons is altogether removed each time, and it will equally break down with a load of only 15 tons when the latter is applied in opposite directions alternately. M. Wöhler has also employed an apparatus for testing the bars upon tension direct. This is represented in diagram, Fig. 3. The bar (B) is inserted between two gripping pieces (a b), and the action of a crank (k) is transmitted to it by levers, the strain being counter-balanced by a spring, in the same manner as before. A second spring, of S form, is inserted for multiplying the length of movement between the test bar and the crank. The results obtained with this apparatus exactly coincide with those shown by the two other instruments, and the total result of their indications can be embodied in the following principle: viz., the fatigue of metals or their resistance to alternating and repeated strains does not correspond to the absolute amount of the strains repeatedly exerted upon them, but to the dif-

ference between the limits of variation of these strains, or to the dynamic effect of the changes which take place during the variation of the strain. The amount of total variation equal to the absolute breaking strength of fibrous iron has been found between 15 and 18 tons, and for the best soft cast steel it is between 22½ and 25 tons. Within the static limit of elasticity the same amount of variation is admissible with equal safety, no matter in what manner the total difference between the strains is arrived at. Alternating strains in opposite directions are acting in the same destructive sense, and must therefore be added to find the real difference or dynamic effect of the change. Besides these general laws, M. Wöhler has accidentally discovered several other facts of the greatest interest connected with these experiments. The bars occasionally inserted in his testing apparatus had a sudden change of section at one of their ends where they were inserted in the machine, a collar being turned on that spot, as shown by the sketch, Fig. 4. In all these cases the experiments proved that the strength of the bar at the spot where this sudden change of section takes place, is between one-fourth and one-third below the strength of the plain bar. The samples of fractured bars shown by M. Wöhler at the Paris Exhibition are some of the most characteristic specimens ever brought before the public. There is a set of such bars with their collars removed for a part of the circumference, and afterwards inserted into the testing-machine. The appearance of the fractures shows the effect of this in the most striking manner. We have, in Figs. 5, 6, 7, and 8, reproduced the appearance



of some of these fractures as nearly as this can be done, from a hasty sketch made on the spot, in the absence of any photographs or other good representations of these interesting specimens. Figs. 5, 6, and 7 show the fractures of bars with partly removed collars, and Fig. 8 shows a bar with a complete collar. The parts of the fracture shown dark have the appearance of fine soft steel of grey colour, while the rest shows a whitish very close-grained fracture and a wavy surface. It is perfectly obvious, from the appearance of these samples, that fracture took place gradually all round the collar at first, and the rest of the bar did not give way until the crevice or crack so formed had reached deep enough to the centre to reduce the section of the unbroken portion below the ultimate limit of strength.

Mr. Wöhler has also established the fact that a gradual change of section, such as produced by a round hollow of a sufficiently large diameter, does not cause such a weakening effect upon the steel bar as a right angle. The reason for this has been sought for in the mode of action of a cutting tool when working into a sharp corner, and it is plausible to think the cutting edge of the tool may have a similar cleaving action upon the solid steel as the corner of a diamond has upon a glass plate. According to this view, there would be a crevice or cleavage plane of infinite smallness produced in the corner between the collar and the rest of the bar, which weakens the section of the latter. It is, however, more probable that this effect is due to the break of regularity in the bending action exerted upon the fibres on the spot where two different sections meet abruptly. The appearance of the fractured surface next to the collar resembles very strikingly the fracture of those wedge-shaped pieces of steel which are forced out when a bar is broken crossways, and which represent the fractures through the compressed fibres. The darker portions in the centre of M. Wöhler's bars, on the contrary, resemble the fractures of bars ruptured by tension. It seems, therefore, that the sharp corner, by interfering with the flexibility of the bar, concentrates the action of

the bending force upon a more limited space, which is therefore less capable to resist the effects of repeated strains or vibrations. This seems to us a very important fact, when considering the nature of the strains to which iron and steel often are exposed in practice. It is possible that further inquiry into this subject may at some not very distant time prove that the method of superposing cylindrical rings in the construction of ordnance, which causes a series of such sudden changes of section, is a source of weakness and danger, since it interferes with the freedom of vibration in the whole mass of the gun, and caused places of weakness at each break of section. There are some more facts, which seem to point in the same direction, to be gathered from M. Wöhler's experiments. Fig. 9 shows a steel bar broken across its largest section in consequence of the weakening influence produced at that place by the pressure of the end of the spindle in the apparatus to which it was fastened. It has been found, particularly with regard to steel, that the strength of the bar is reduced by about one-third through the influence of a very moderate pressure exerted upon that bar by the conical hole in the centre of the mandril of the machine (Fig. 1), into which the end of the bar is jammed. This is an analogous case to the shrinking of rings upon each other by building up large pieces of ordnance; and considering the importance of all questions connected with this branch of engineering, we can only recommend the repetition of experiments similar to those of M. Wöhler, and the most earnest investigation of this as yet almost unknown subject, viz., the laws of the fatigue of metals. We have in Figs. 10 and 11 shown two sections of steel fractured by the apparatus (Fig. 1) of M. Wöhler under normal conditions. The radial shades in Fig. 11 are due to an unevenness of fracture at those spots, but they contain no cracks nor fissures, and are simply the result of the higher portions throwing shadows upon those which lie a short distance below. The fractures of fibrous iron which M. Wöhler has also exhibited at Paris show that this process of alternate bending has no tendency to change the nature of the metal and to induce crystallisation. There is one specimen which was bent more than nineteen millions of times before it broke, and yet the fracture is as fibrous as the original bar from which the specimen was made. M. Wöhler's modest exhibition may have been overlooked by ninety-nine out of every hundred professional visitors to the Exhibition, yet we believe ourselves justified in saying that his scientific and patient experiments will be referred to long after the majority of those things which have drawn a shower of medals and ribbons upon themselves at present will be dismissed and forgotten.

THE SHEFFIELD SAW-GRINDERS.—On Tuesday last a public meeting, called by the Rev. R. Stainton, was held in Paradise-square, Sheffield, the object being the delivery of an address on the recent "resolution" of the Sheffield saw-grinders. Mr. Stainton proposed the following resolution, which was carried unanimously, and delivered a long address in justification of his past and present conduct:—"That this meeting declares that the resolutions passed by the Saw-grinders' Union, on the 13th are inimical to their own interest as a union, contrary to the basis of social law, a violation of the laws of religion and morality, an outrage on humanity, and a disgrace to the town, and it claims the right, and feels it a duty, to call upon the union to expel the two members in question, and to offer an apology to the town for the evil and disgrace it has brought upon it."

THE NAVY.—It appears that at the commencement of the spring of this year the number of vessels of war employed on foreign and colonial service was as follows: Mediterranean station, 20, of the aggregate burden of 34,617 tons; North America and the West Indies, 29, of the aggregate burden of 34,827 tons; south-east coast of Africa, 9, of the aggregate burden of 7647 tons; the East Indies, 7, of the aggregate burden of 7590 tons; the Cape of Good Hope, 3, of the aggregate burden of 3078 tons; West Coast of Africa station, 13, of the aggregate burden of 15,179 tons; the Pacific station, 14, of the aggregate burden of 19,342 tons; China station, 40, of the aggregate burden of 30,246 tons; and Australian station, 6, of the aggregate burden of 6793 tons.

A LIFE RAFT.—Last week there was launched at Liverpool a lifeboat, constructed at the Hamilton Windsor Ironworks, on the principle of the raft which lately crossed the Atlantic. She is called the Rescue, and could carry, it is said, 80 persons, besides a crew of 14.

DEMAND FOR LABOUR IN CANADA.—Mr. Buchanan, the chief agent for immigration at Quebec, in his annual report, says: "Carpenters, masons, bricklayers, blacksmiths, shoemakers, tailors, boiler-makers, fitters, and all descriptions of workers in iron, are especially wanted in Upper Canada. Flax dressers, spinners, &c., and competent hands acquainted with woollen and linen manufacture will find employment in both sections of the province, where these branches of industry are making rapid progress. The average wages per month, with board and lodging, are, for farm-labourers, from \$8 to \$16; female servants, \$3 to \$6; boys over 13 years, \$3 to \$8; girls, \$1 to \$4; mechanics (per day), without board, \$1 to \$2 50c."

MR. BOURNE AND THE DUNDERBERG.

TO THE EDITOR OF ENGINEERING.

SIR,—Perhaps the following extracts from a discussion which has recently occurred in New York, in relation to the impregnability and general construction of the great French ram Dunderberg, will show that the opinion of the distinguished engineer, Mr. John Bourne, so flippantly alluded to by your correspondent, William Watt, C.E., is strictly correct.

A gentleman interested in the construction of the Dunderberg has stated: "I believe it is quite impossible for a gun on board a floating structure of any kind to get a shot into her hull—the only way to wreck her. The conformation of her hull is such that the 3½ in. of iron, backed by seven solid feet of timber, which compose it, cannot be struck except at such an angle as to render penetration, at the worst, much more than unlikely; and unless a shot were fired from a gun having its nose level with the water, it would not even be likely to penetrate." The opposition replied: "This random assertion is evidently made in ignorance of the great number of trials with heavy guns v. armour conducted at Shoeburyness and Washington. A glance through the records of these experiments proves it to be utterly fallacious. Take, for example, the 9 in. 12-ton Woolwich rifle, a gun now common in the English navy. Scores of experiments prove conclusively that this piece would, send one of its hard projectiles—shot or steel—clean through the Dunderberg. It may be true that the veneering of 3½ in. of iron on the hull is 'backed by seven solid feet of timber.' If this timber was of the species used for armour backing of the English and French ironclads and monitors, the statement quoted might be of some importance; but what will the Emperor Napoleon think when he is informed that this 'seven solid feet of timber' is almost wholly made up of *soft white pine*, which will offer as much resistance as pie-crust to a powerful projectile. . . . Is any one sure that dry rot has not commenced already in the pine backing? The conclusion of those beside myself, who are fully competent from their great experience to form an accurate judgment on such matters, is that this soft mass of timber adds greatly to the danger to which this vessel will be exposed from the enemy's projectiles; and this for the reason that the ridiculously inadequate 3½ in. of iron veneering is so easily penetrable by shells, that they will lodge well into the backing, if not projected with sufficient force to go clean through, and being confined in the backing, will explode with terrific violence in every direction toward the inside as well as the outside. A 9 in. elongated shell or an 11 in. spherical shell, with their heavy bursting charges, penetrating three or four feet in this nice soft backing and there exploding, would inevitably blow a great hole in the side of the vessel. It is scarcely possible to imagine a contrivance which could give more effect to the modern shell. If the backing was so thin that a shell could not be so strongly confined, or that the projectile could with more certainty pass into the vessel, the consequences would not be so disastrous; for in the one case the force of the explosion would be comparatively harmless, and in the other the hole might be plugged; but how is it possible to plug a chasm torn by a lodged and confined shell while the sea rushes in through the capacious opening?"

"As to the casemate, is it not absurd to expect that narrow 4½ in. brittle *hammered* plates, with '40 in.' of backing, composed to a very great extent of soft pine, will perform any other office than to add to the effect of penetration by modern shot, by supplying them with cords of splinters and chunks of broken iron? Remember the terrible havoc made on the gun-deck of the Galena by fragments of broken armour! The constructor of the Dunderberg thinks the 30° inclination of the side armour and casemate from the perpendicular to be a very important feature."

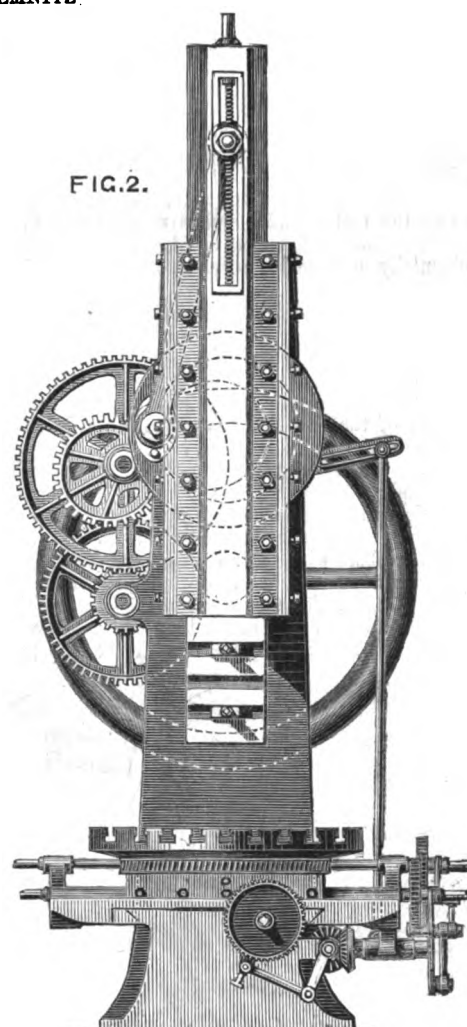
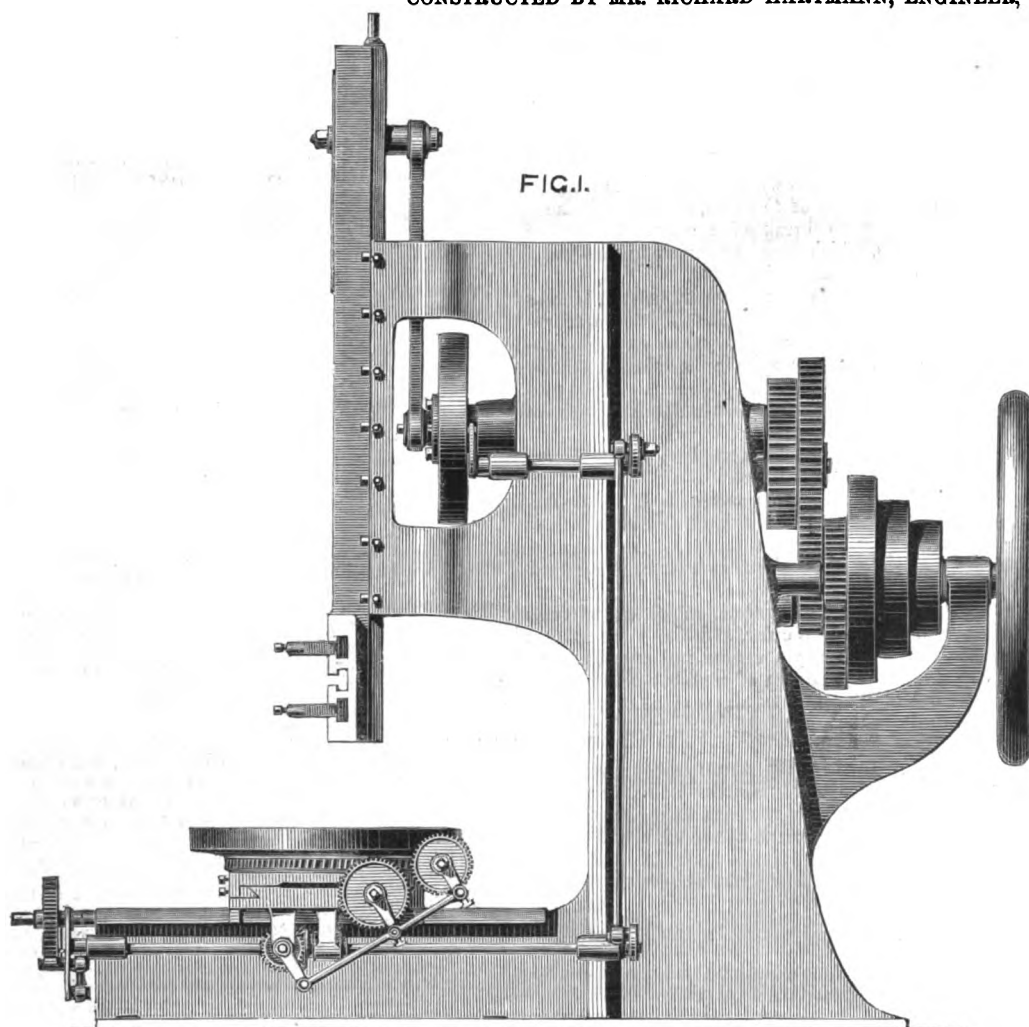
The projecting tail of the Dunderberg was alluded to as follows: "The tail, which projects some 30 ft. from the stern, over the propeller, rudder, and rudder-post, and which contains that useful apparatus, the steering gear, is even more inadequately protected than the side; hence the vessel is liable to be placed *hors de combat* by a projectile from a piece of moderate calibre. And what will become of this projecting tail if the vessel encounters a gale? Do the repairs put already upon it before it has been exposed to the strains of a higher sea than runs in the lower bay afford any indication as to what will happen to it when subjected to the pitching of a North Atlantic storm? The experience with the stem overhang of the monitors affords no criterion by which to judge of this matter; they are as strong as the Britannia-bridge, being built of iron in connexion with the hull, and, as the most critical examination has proved, were not injured in the slightest degree after having been exposed to the violence of the very heavy gales on our boisterous coast. On the other hand, the Dunderberg's tail is a flimsy structure of wood, which can never be so strongly fastened as to be able to resist the upward pressure of the sea during pitching. Neither can it be compared with the very strong short overhangs of the monitors Kalamazoo or Miantonomoh, built by Mr. Delane, which are constructed on sound mechanical principles."

The gentleman interested in the Dunderberg has stated, "We want something with healthy and comfortable quarters for the officers and crew;" very true indeed. But let us glance at the quarters for the officers of the Dunderberg, and see what sort of place that is for men to live in at sea, where she has not been as yet except in millpond weather. The ward-room is situated under the flat deck abaft the casemate, which, in ordinary ocean weather, will be washed by the sea, so hatches and air ports in this deck must be secured down water-tight, else the ward-room will be afloat, as it has been already more than once in the lower bay (so officers have told me). No means are provided for artificial ventilation, so how is any air to get into this den?"

"The following features in the Dunderberg's hull may be interesting to naval architects. The bottom of the Dunderberg is dead flat, and the bottom and side frames join at an angle like the roof of a barn; this novel method of construction saves the use of expensive curved futtocks, always used in building wooden ships; but then this cheapness is attained at the expense of the strength of the vessel. There is nothing to withstand the enormous upward hydrostatic pressure on this flat bottom, amounting to several thousand tons, except the weight of the

SLOTING-MACHINE, AT THE PARIS EXHIBITION.

CONSTRUCTED BY MR. RICHARD HARTMANN, ENGINEER, CHEMNITZ.



boilers and engines. Hence it is certain to be bulged upwards, and, among minor consequences, throwing the engine-shafting out of line. Hundreds of tons of pig iron were for a long time kept on the floor of the vessel to keep it down; and had the bottom been made with the usual round bilges, curved futtocks, and dead rise, it might have been rendered sufficiently strong. When this vessel rises and falls in a sea-way, the fluctuating pressures will cause the bottom to work like a pair of bellows.

"The daily papers of yesterday, alluding to the docking of the Dunderberg, state the vessel was raised 7 ft., the height required to attain the object sought. Yesterday men were at work repairing the wooden planks which project over the sternpost, the seams of which had become opened from the exposure of that portion of the vessel to the sun. It was Mr. Webb's explicit order that the Dunderberg should not be raised only a distance sufficient to admit of the repairs needed.

"The curious influence of the sun in opening the well-shaded planks under the overhang is quite interesting. As the vessel was raised only 7 ft., about one-third of her draught, it is clear that less than one-half her internal weight was allowed to bear on her pancake bottom. In this the superintendent of the docking operation showed a commendable prudence."

At 21 ft. draught every square foot of this bottom will be pressed upwards with a force of 1440 lb.. Assuming that there are 7000 square feet in this pancake bottom (and there is rather more than less), it will be seen that it must sustain an upward pressure of no less than 10,080,000 lb., or 5040 tons of 2000 lb. This is a most extraordinary construction of bottom for a sea-going vessel.

Allusion was made to the Dunderberg's gun-deck: "We have been charitable enough to assume heretofore that the Dunderberg can use the 15 in. twenty-ton guns with heavy charges. There is no fault with the gun-carriages; ample experience has proved them to be capable of handling the guns under any circumstances. But trials on the Dunderberg have shown that, with heavy charges, her gun-deck is so lamentably weak—being composed of pine 4½ in. planks laid on beams some 3 ft. apart—as to be sure to be destroyed by the use of the heavy gun with heavy charges." The allusion of Mr. Watt to the Dunderberg's 15 in. broadside carriage is all twaddle. Reference to the official report of the Bureau of Ordnance shows that a duplicate carriage was subjected to long and severe tests, through which it passed with the greatest success.

The following reference was made to the general character of the Dunderberg: "In order to show the want of practical knowledge of modern shipbuilding displayed in the planning of the Dunderberg, let us compare her with another ship, the British Bellerophon. Both ships are of nearly equal displacement, that is, they weigh nearly the same; they both displace about 7000 tons of water. The Bellerophon is plated all around to a height of 15 ft. above and 5 ft. below the waterline with 6 in. armour, backed by a backing of hard teak laid on an inner skin about ½ in. thick. The 6 in. armour also covers the casemate in the central part of the vessel. The gun-deck is laid with iron, and is strong enough to carry the carriage and 15 in. guns.

"The Dunderberg protects her sides with 8½ in. of iron, laid

on a timber backing composed of soft pine. Her battery is protected by but 4½ in. hammered plates, laid on a flimsy backing.

"The Bellerophon is fitted with a balanced rudder (copied from the monitors). On her trial her steering powers were as follows: Wheel to starboard, half-circle in 1 minute 58 seconds; full circle, 8 minutes 59 seconds. With helm to port, half-circle in 2 minutes 8 seconds. On trial, with helm hard over, the Dunderberg made the half-circle, that is from up to down the river, in 5 minutes 40 seconds, which makes the whole circle in 11 minutes 20 seconds.

"As to speed, the Bellerophon, at measured mile, averaged 14.8 knots, making from 76 to 77 turns, and it is said that on a subsequent trial she achieved 15 knots.

"The Dunderberg, at measured mile, averaged 13 knots, making from 51 to 53 turns.

"Finally, in comparing such ships as the Bellerophon and Dunderberg with a monitor like the Dictator, it should be borne in mind that while the former displaces 7000 tons, the latter displaces but 4500, which, as calculation shows, if it is increased to 7000, would enable the monitor to carry 15 in. of solid armour on her sides and a 20 in. turret, and engine power to give equal velocity. It is quite safe to say, that no gun likely to be made for many years could pierce such armour."

The following cable despatch in the *New York Times* of August 5th, announces the arrival of the Dunderberg at Cherbourg, August 3rd:

"Cherbourg, Saturday, August 3, 1867.

"To James W. Buchan and Co., Paris.

"The Dunderberg has arrived here in fourteen days and seven hours from New York. All on board are well. The vessel is in good condition. Although we had heavy weather and high seas, the ship behaved nobly, and proved herself a splendid sea boat.

(Signed) "WILLIAM H. WEBB."

The following passages made across the Atlantic simultaneously will enable British engineers to form an idea of the extent of the "heavy weather and high seas" she encountered:

"Scotia left New York, noon, July 24th; arrived at Queens-town, noon, August 2nd.

"City of Baltimore left Liverpool 4 P.M., July 24th; arrived at New York, August 4th. Stopped at Queens-town.

"St. Laurent left Brest, July 20th; arrived at New York July 31st, noon.

"China left Queens-town, July 20th; arrived at Boston, July 30th. Stopped at Halifax."

Respectfully,

A YANKEE ENGINEER.

THE NEW YORK PRESS AND THE DUNDERBERG.

TO THE EDITOR OF ENGINEERING.

SIR,—I copy the following from the *New York World*, of July 22, 1865. The occasion was the launch of the Dunderberg, and it was printed with elaborate woodcuts of this vessel, drawn to scale, and furnished to that paper by her constructor:

"The Dunderberg. Launch to-day of the largest mailed vessel in the world; the 'thundering mountain' of the U.S. Navy; an invulnerable marine Titan; a match for the wooden walls of 'all creation'; the Union-saving ram; an A 1 clipper, sea-going, wrought-iron fort; the heaviest armament ever put afloat—eighteen 15 in. and 11 in. guns; 5000 horse power; 7000 tons displacement; speed, 15 knots per hour; a ship that dwarfs the Warrior and La Gloire to cockle-shells; something for foreign digestion; a Yankee ship-builder's chef-d'œuvre.

"This vessel is, without question, the largest, staunchest, and most complete engine of naval warfare ever designed or constructed in this country, and, for time to come, will be the wonder and admiration of all who have any great conception of the power and magnitude of naval vessels of the present age."

"No European nation can boast a ship like this one of ours when she is fitted and manned for actual combat."

"The Dunderberg contract price was \$1,400,000, the same as the Dictator, which carries only two 15 in. guns. The Dunderberg has double the number of 15 in. guns, and twelve or fourteen (as the case may be) more 11 in. guns than the great ocean ram of the monitor style."

The following is from a letter of Donald McKay, shipbuilder, of Boston, to the *Commercial Bulletin*, copied in the *New York Herald*:

"I can allude with pride to that wonderful production of human genius, the Dunderberg, now in process of construction by Mr. W. H. Webb, of New York.

"I have personally inspected all the ironclads of England and France, but I have not seen one of them which, in originality of design, power, and completeness of detail, begins to compare with her. She combines the impregnability of the turret system with the advantages of the broadsides and ends. It is said she will cost over two millions of dollars; but this is not high when compared with the sums lavished upon the large ironclads of the Old World, which are far inferior to her as a vessel of war. I consider her a match for a fleet of such vessels as some of the best produced in France."

The above has been copied with the hope that, as the Dunderberg is now attracting considerable attention, it may be entertaining to the readers of *ENGINEERING*.

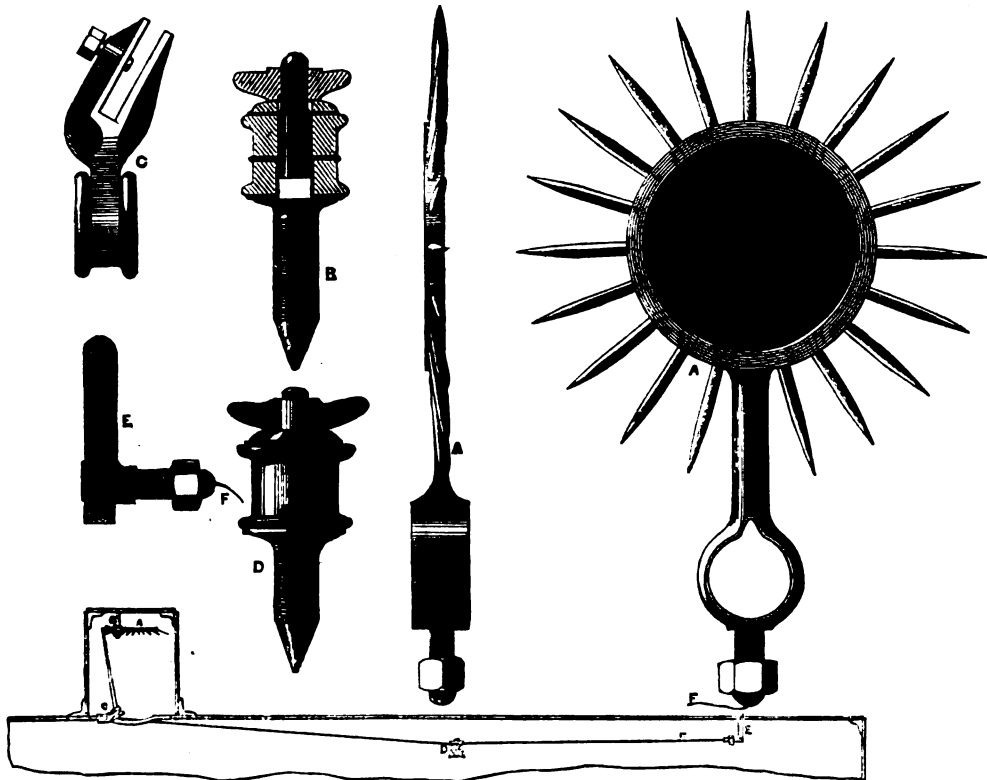
IRONCLAD.

HARTMANN'S SLOTTING-MACHINE.

THE above engraving, copied from a neatly executed scale drawing of M. Hartmann's slotting-machine, will serve as an illustration to our general remarks upon the engineers' tools exhibited at Paris by this well-known machine-maker. It has a stroke of 23 in., and a self-acting feed-motion for the table in two straight lines by means of a pair of slides, and for circular work by the superposed table worked by a worm and worm wheel. The quick return motion for the tool and slotting bar is obtained by means of a pair of elliptical wheels, and the slotting bar is guided in a continuous slide, which affords great steadiness of movement and accuracy of work.

BAKER'S ANTI-INCRUSTATOR.

CONSTRUCTED BY MESSRS. KITSON AND CO., ENGINEERS.



It is now more than eight months since we published in this journal a letter from Mr. Hoadley, of Lawrence, U.S., in which he gave an account of a "magnetic anti-incrustator" which was being used in America, with considerable success, for removing the scale from steam-boilers. The results mentioned in this letter attracted considerable attention, and they led Mr. George Livesey, of the South Metropolitan Gasworks, to have an instrument constructed from the description given by Mr. Hoadley, and to apply it to one of the boilers under his charge. Of the instrument constructed for Mr. Livesey we gave an illustration and description on page 24 of our third volume. The result of this publication was a letter from Mr. Baker, stating that he held the English patent for the anti-incrustator, and that the instrument had been for some months at work on boilers at Messrs. Maudslays, Sons, and Field's, the Monkbridge Ironworks, and some other places. More recently, the manufacture of the "anti-incrustators" has been taken up on an extensive scale by Messrs. Kitson and Co., of the Aire-dale Foundry, Leeds; and many improvements having been made in their construction, we propose giving a description of them in their present form.

In the annexed engravings, A represents the "battery," as is now called, which forms the main portion of the arrangement. It consists of a brass casting having inserted in it radially a number of steel magnets sharply pointed at the outer ends, as shown. The brass of which the casting is made contains a large proportion of copper, and the stem of the "battery" can thus be readily bent by hand, to suit it to various positions in a boiler. In the earlier instruments, the points of the magnets were protected by silvering them; but it was found that the water used in some boilers caused the rapid oxidation of this silver coating, and that the coating of oxide so formed, in a few instances, prevented the instruments from working properly. To avoid this, Messrs. Kitson now coat the magnets with copper, then silver them, and, finally, electro-gild them, this coating of gold effectually preventing any failure from the cause above mentioned.

The "battery" above described is so fixed in the boiler that it is fully exposed to the current of issuing steam on its way to the steam-chest. At first the instrument used to be fixed with the points of the magnets inclined downwards, but it was found that when so fixed there was a tendency for a deposit to be formed on the points of the magnets—any water carried up by the steam, and arrested by the anti-incrustator, draining down to these points and then dropping off—and the instruments are accordingly now fixed with the points sloping upwards.

The battery is supported by the insulating stud, B, this stud being formed as follows: The stud itself, which is screwed into the top of the steam dome, or any other convenient part of the boiler, is of brass, and it has a collar formed on it as shown in the engraving. Against this collar is placed a washer of india-rubber, and next this a pair of porcelain insulators with an india-rubber washer between them. Above the insulators is another india-rubber washer, and finally the brass washer and nut by which the insulators are secured. It will be seen from the engravings that the porcelain insulators are furnished with collars, between which the neck of the instrument is securely held, and they have also formed on them small projections, which fit into a groove on one side of the eye of the stem of the "battery," and thus prevent the latter from shifting round. The insulators are themselves prevented from turning on the supporting stud by that portion of the latter which passes through them being made square.

The "battery," being thus insulated from the parts of the boiler in its immediate neighbourhood, is connected with some

distant point by a stout copper wire, this wire leading from the end of the stem of the "battery" to a contact stud, E, screwed into the boiler at some convenient point, as shown in the sketch, representing the general arrangement of the apparatus. The wire is secured to the contact stud by inserting it into a hole formed in the end of the latter, this end being split and being provided with a tapered screw on the outside, so that by tightening up a nut placed on it the wire can be securely held. The same means are employed for connecting the wire to the stem of the battery. Where the wire is led round the corner formed by the junction of the dome and boiler, it is led through an insulator carried by a bracket, which clips the edge of the edge of the boiler-plate, a bracket of the kind being shown in the engravings at C. An insulating bracket, of the form shown at D, is also used in long boilers for supporting the wire where necessary. In the case of locomotive boilers a different form of contact stud to that above described has to be employed. In such the boiler's wire is soldered into the end of the contact stud, which is made straight, and is screwed in through the backplate of the firebox casing, the wire having been first inserted. The other end having been connected to the battery, the wire is drawn tight by screwing back the contact stud. In all cases the contact stud must be screwed into the plates dry, so that a perfect metallic contact may be secured between it and the boiler. It is also necessary that any boiler to which the anti-incrustator is applied should not be connected metallically—as by steam-pipes, &c.—with any other boilers, unless these are also provided with the apparatus. If this fact is neglected, the action of the instrument will be distributed over the whole of the boilers, and no really effective result produced on any of them.

Respecting the manner in which the anti-incrustator acts in removing the scale from a boiler we shall not say much here, and, in fact, no thoroughly satisfactory explanation of its action has yet been advanced. In fact, doubts have from time to time been expressed whether it produced any electric current at all; but recent experiments made by Messrs. Kitson at their works show decisively that an electric current does exist when the apparatus is in use. In the experiments referred to, the boiler to which the apparatus was applied was filled with water, so that the instrument was completely immersed, and the fire was then lit. The wire connecting the battery with the contact stud had been led, before being connected to the latter, through an insulated stuffing-box fixed on the front of the boiler; and a galvanometer having been placed in the circuit, any currents that passed through the wire could be observed. When water became thoroughly heated the galvanometer was deflected 4°; and when steam was got up and the water partly boiled off, so that the instrument was situated just above the water-line, this deflection rose to 11°. Finally, when the water level became still lower, and the battery became exposed to the full current of dry steam on its way to the boiler, a deflection of 14° was obtained.

Whatever doubts may be expressed as to the manner in which the anti-incrustator prevents the formation of scale and effects its removal, if already formed, there can be no doubt but that it does do these things. There are now some hundreds of the anti-incrustators at work both in this country and in America, and, except in those few cases already referred to, where, from defective construction, they failed from the formation of a non-conducting coating on the points of the "battery," they have given excellent results, scale already formed being caused to fall off in fragments, and the impurities of the water being deposited as a soft mud easily removable by the process of blowing off

Considering the trouble which is so frequently occasioned by the presence of scale in a boiler, and the expense and difficulty attending its removal by ordinary methods, it seems probable that an instrument which obviates these annoyances as completely as the anti-incrustator does will some day become as universal a boiler-fitting as a gauge-glass or blow-off cock.

WOOD-WORKING MACHINERY.

A new advertising dodge has sprung up in connexion with the Paris Exhibition, and to this a certain, although by no means the most reputable, portion of the press has lent itself. A second or third class firm, exhibiting, however, somewhat extensively, receives a bronze medal—a reward even greater perhaps than they deserved. They immediately write to the British commission a rignmarole of self-praise, professing to occupy the first position in the trade, refuse the copper distinction, and send their epistolary flourish to the newspapers. We consigned to our waste-paper basket a production of this kind only a few weeks ago, but were not at all surprised to see it in *The Engineer*. When, by an extraordinary omission, Colonel Anderson, of Woolwich, in reporting upon the wood-working machinery at the Paris Exhibition, omitted all mention of the leading exhibitors, who were the recipients also of the highest medal awarded in their class, we took occasion to point out that one or more of the firms to whom he had given such undeserved prominence, were new and comparatively unknown; and speaking only from their publicly exhibited machinery, it was evidently altogether second rate. We spoke the more plainly because of the enormous puff in which these gentlemen had indulged in the columns of our contemporary, a puff which no competent or discerning journalist would have inflicted upon his readers. In reply to this we were treated to a most impudent letter from this puffing firm, charging us with all sorts of hostility, and with the paltriest, nay the most contemptible motives, and demanding the insertion of the stuff in our own columns! Our readers were spared the infliction, but not so those of our astute contemporary, in whose columns the letter, considerably qualified however, and with a plentiful omission of names, appeared last week. So long, of course, as second-class newspapers are ready to print the bumptious effusions of second-class firms, disappointed at Paris and thirsty for notoriety in London, so long will the discerning public be highly amused, while taking care, however, to have as little as possible to do with both. We will not say that such contemptible trash is inserted for a consideration, but we can say that no money could have procured its insertion in *ENGINEERING*.

THE MONKBRIDGE IRONWORKS.

AMONGST the exhibits of iron and steel in the British department of the Paris Exhibition, the collection of articles sent by the Monkbridge Ironworks, Leeds, deserves a more special notice than that which we have given to it in our general reviews of iron and steel exhibits. The manufacture of railway materials, which is principally illustrated by this establishment, is of a high quality, although none of the new processes which have revolutionised the steel trade in recent years have been introduced at these works. The steel is made in crucibles, from Swedish charcoal iron mixed with the best marks to be obtained in Yorkshire, the product is very carefully tested and selected so as to insure uniformity of the material as regards hardness and strength, and by these means, as is well known to every steel master, a high quality of articles is produced, at a higher cost, of course, than steel is made by the more modern processes, but still of great reliability. The Monkbridge Works have illustrated their mode of making weldless tyres by punching a hole into the centre of a round ingot, and then winding out the ring so formed under the steam-hammer and upon the beak of an anvil. This mode of making weldless tyres, which has now become universal in England and in many Continental works, was, according to the statement of these exhibitors, first originated at the Monkbridge Works. There are some very fine weldless tyres exhibited, one made of iron, the other of cast steel. They are both intended for the Caledonian Railway. Another remarkable object in this Exhibition is the wood-disc railway wheels made at these works, and which are now being successfully introduced on some Continental railways.

INDIAN TELEGRAPHS.—The amount produced by the electric telegraph service of British India in 1861 was 53,639l.; in 1862, 73,452l.; in 1863, 75,525l.; in 1864, 91,762l.; and in 1865, 99,099l.

KURRACHEE HARBOUR.

THE interest which was evidently aroused by our former articles relative to the Kurrachee harbour works has induced us now to recur to the subject with a view of giving such further details and descriptions as were necessarily omitted in our former notices. Amongst others, we are now enabled to give in full Messrs. Stephenson's report to the Secretary of State for India, and which led to orders being issued for the total suspension of the works then in progress. The advisability of this step has repeatedly been called in question; but as, in consequence of the differences of opinion existing between Colonel Tremenhare, the chief engineer in Sind, and Mr. Parkes, the engineer under whose superintendence the works thus far have been executed, the whole question as to the probability of Mr. Walker's plans, if completed, effecting an improvement of the harbour commensurate with their cost, was referred to Messrs. Stephenson. The Government could hardly do otherwise than accept their decision and act upon it accordingly. And so the works have been summarily suspended, and, in the meanwhile, "Time"—a far more experienced engineer than those who had previously considered the subject—has been carefully preparing his report, which conflicts, in some respects, with the report of his contemporaries of Edinburgh. In order that the differences of opinion on this subject may be fully comprehended by our readers, it is necessary that we should give, first, Messrs. Stephenson's report *in extenso*, which was as follows:

"We have the honour to acknowledge receipt of the instructions from the Secretary of State for India, of date 13th December last, relative to Kurrachee harbour, which are to the following effect:

"The points to which it is desired that your attention should be particularly directed are—

"First, the validity or otherwise of Colonel Tremenhare's objections, and the consequent expediency or otherwise of stopping the works now in progress of execution according to Mr. Walker's designs; and, second, the amount of probability on general considerations that Mr. Walker's plans, if prosecuted to completion, will effect an improvement of the harbour commensurate with their cost."

"In accordance with the remit made to us, we have most carefully perused the various documents sent for our information, embracing in particular Mr. Walker's reports of 8th September, 1856, and 28th October, 1858; Mr. Parkes's reports of 5th June, 1858, 28th October, 1863, and 15th March, 1864; Colonel Tremenhare's reports of 19th May, 1864, 30th January, 1865, and 15th February, 1865; and Mr. Parkes's report of 29th September, 1865, upon Colonel Tremenhare's observations. We have examined the various charts of the locality that have been sent to us for our information, and, after fully considering the whole of the information thus afforded, we transmitted our opinions in draft to Mr. Parkes and Colonel Tremenhare for their observations, which having received and further considered, we now beg leave to submit the following report for the consideration of the Indian Government.

"Our first duty in this reference is to express our conviction of the importance of the subject submitted for our opinion. A design of works for the improvement of Kurrachee harbour was prepared by the late eminent James Walker in 1858. That design has, after due consideration, been adopted by Mr. Parkes, who has the advantage of personal knowledge of the locality, and has most clearly and ably expressed his views in his several reports. The work so designed and adopted has been, to some extent, executed; but it is admitted on both sides that, up to March, 1864, no permanently favourable results have followed. Colonel Tremenhare, who possesses a most intimate knowledge of the locality, and has carefully watched the works during their progress, has, in a very able statement, called in question, not only the correctness of Mr. Walker's information as to the physical state of the harbour, but also the soundness of his views as regards the works he proposes for its improvement. We have, therefore, in repeating our conviction of the importance of the subject, to express our feeling of responsibility in dealing with the able and lucid, but yet antagonistic, statements of Mr. Parkes and Colonel Tremenhare, and, above all, in laying the conclusion at which we have arrived before the Indian Government.

"The scheme of works, as proposed by Mr. Walker, included, 1st, the Keamari Groyne, on the east side of the harbour, extending from Keamari to near Manora Head, a distance of 7400 ft.; 2nd, the 'Manora Breakwater,' on the west side, extending for a distance

of 1500 ft. from Manora Head; 3rd, the closing of the Chinna Creek; and, 4th, the formation of extensive docks and basins in the upper part of the harbour.

"The two first named works were intended to effect the 'deepening the water over the bar,' which, Mr. Walker states, was the desideratum to which his 'attention was particularly directed' by the Government.

"On a careful perusal of Mr. Walker's first report, it appears to us that originally he had not held a decided opinion as to the origin of the 'bar,' as it has been called, which is situated at the mouth of the harbour, for he first says, 'the bar is, as has been stated in other reports, the result of the current from the harbour meeting the coast tide, its velocity being checked, and rendered insufficient to support and carry out into the tideway the matter which is brought in front of the harbour, apparently from the westward, by the heavy seas during the southerly gales;' and again, he says, 'it matters but little whether the sand which forms the bar is brought down by the land floods or is brought in by the waves and currents from the sea, or (which is the most probable case) brought round Manora Point from the westward, and lodged at the harbour's mouth. Its pointing eastward, or in the direction of the flowing coast tide and of the prevailing winds, appears to show that it is formed by heavy seas or by the tide when in that direction.'

"It appears from subsequent reports of Mr. Walker and Mr. Parkes, that ultimately Mr. Walker attributed the bar to what, beyond all doubt, is its *true and only* origin, namely, the action of the waves in throwing up the sand, and thus tending to form a continuous line of beach across the mouth of the harbour.

"But, whatever views may have been held as to this, the ultimate conclusion of the engineers was, that in order to deepen the entrance, the place termed 'the bar' must be protected from the action of the sea. In this view we entirely concur. As a general principle, we have, ever since 1842, when we had occasion to examine somewhat narrowly the characteristics of the Firth of Dornoch, in Sutherlandshire, insisted that such bars or shallows as that at Kurrachee could not be improved by any design that did not include works for *effectual* protection from the sea, and, acting on this principle, we have made our designs, and given our advice, with reference to many harbour improvements.

"As the advancement of the harbour of Kurrachee appears from the documents laid before us to be dependent on getting increased permanent depth of water at its entrance, it is obvious that all questions with reference to internal works may safely be considered as in abeyance until the improvement of the entrance is secured, and, therefore, we propose to confine our report to that all-important question.

"The chief work which has as yet been executed is the extension of the groyne from Kurrachee to opposite Deepwater Point, a distance of 2467 yards. From the evidence contained in the reports, it appears that the first effect of this work, as ascertained in 1863, was to increase the sectional area in the upper part of the channel, where it is confined by the groyne, and was so far beneficial; but that after the monsoon of 1863, with its winds and waves, had passed away, the sectional area was again reduced, and the channel was restored to pretty much its former condition in 1858, previous to the commencement of the works. During the same period it appears that the bar has also undergone certain changes, but it cannot be said that any permanent improvement, either of the inner channel or of the bar, has been effected.

"Mr. Parkes admits these adverse circumstances, but suspends his conclusion as to the cause, and concludes that the effect is merely 'incidental' and 'probably temporary,' and 'will disappear as the design is carried out.'

"Colonel Tremenhare, on the other hand, ascribes the decrease of sectional area of the inner channel to the increased current due to the formation of the groyne, carrying off the sand raised by the waves acting in the shoal water, and depositing it in the upper reaches, an action which he says will increase as the groyne is further extended, while he attributes the unimproved state of the bar to the inadequacy of the increased scour, opposed as it is by the monsoon waves, to produce any beneficial effect.

"We think it unnecessary to enter into details as to what has taken place in consequence of the works that have been executed. Mr. Parkes admits, as we have already said, certain adverse consequences, though he expresses himself as confident that, when the work is completed in terms of Mr. Walker's design, the evils complained of will be removed, and, therefore, it seems to us that the settlement of the question in dispute may now be safely determined by a care-

ful consideration of the following *conclusion and question*.

"The conclusion for consideration which has been arrived at by both Mr. Parkes and Colonel Tremenhare is, that the works cannot prove successful unless the shoal water at the entrance to the harbour is protected from the waves during the monsoon.

"The question for consideration is, Will the works, as designed by Mr. Walker, effect this object?

"With reference to the conclusion, we entirely agree with Mr. Parkes and Colonel Tremenhare that protection is absolutely required, and we hold this opinion, we suspect, even more strongly than these gentlemen, although Mr. Parkes, in his report of 15th March, 1864, urges very strongly the necessity of constructing the Manora breakwater, 'to the extent and in the line laid down by Mr. Walker.' So important, indeed, do we regard the question of protection, that we should have been disposed to consider the sea works for that purpose of *primary* importance, and to have postponed all internal works until the outer work had been executed, and its effect tested by actual trial.

"The question as to whether the works contemplated will effect the object in view we regret to be obliged to answer in the negative. We do not think that a breakwater, of 1500 ft. long, projected from Manora Head, more especially if it is laid out in the line proposed by Mr. Walker, will either shelter the bar or remove the evil.

"We are sorry to be obliged to come to this adverse conclusion, and in order to account for the difference between Mr. Walker's opinion and our own on this important question we feel bound to repeat that we do not Mr. Walker, in forming his original design, had sufficiently adverted to the following facts: first, that the sea is the true cause of the accumulation at the entrance to Kurrachee harbour; second, that the accumulation is of great amount, extending for a distance of three-quarters of a mile from Manora Head to the eastward in front of the harbour, while the bar in the navigable channel is not a sudden diminution of depth, but a very gradual shoaling; and, third, that the water in the bay itself is also very shoal, so that, in point of fact, in the present navigable channel there is no decided bar, properly so called. Had these facts been fully considered by Mr. Walker we think that he could hardly have arrived at the conclusion, that after the execution of the proposed works, 'at least 20 ft. at low water of spring tides, with an ample width of entrance sheltered from the worst winds, may be depended on.' It further appears to us, that when Mr. Walker proposed to remedy the evil by means of the proposed groyne and breakwater, he had relied on the increased scour due to the confined channel and the addition of the water gained by shutting up the Chinna channel to remedy the evil, and had not sufficiently adverted to the action of the sea, and this may account for the very inadequate protection from the waves which the Manora breakwater would afford. That work might check the movement of sand along the beach, if that were necessary, but could not shelter the extensive tract of sandbank which forms what has been termed the bar of the harbour. Unless this extensive sandbank is thrown completely under shelter, we confess that we cannot hold out the hope of any *permanent* improvement of the channel, and to effect this requisite amount of shelter, the sea works must necessarily be designed on a much more extensive scale than seems to have been contemplated by Mr. Walker. It is, perhaps, right to add that, even if constructed on such an enlarged design, the generally shallow water in the channel and bay leads us to regard it as doubtful whether the full depth of water expected by Mr. Walker could be permanently maintained.

"The remit made to us does not call for any expression of our views as to the present state of Kurrachee harbour or works for its improvement, and, therefore, we abstain from offering any opinion on that subject. According to our understanding of the advice sought from us, it is restricted simply to the question, whether the views of Mr. Walker and Mr. Parkes, or the antagonistic views of Colonel Tremenhare, are correct, and, without committing ourselves in every respects to the opinions of Colonel Tremenhare, we have no hesitation in reporting that, on the evidence laid before us, we have come to the conclusion that Colonel Tremenhare's fears as to the ultimate success of the design of Mr. Walker are well founded.

D. AND T. STEVENSON.

Edinburgh, February 26, 1866.

"P.S.—After the foregoing report was drafted, we received, for our further consideration, the letter from

* Mr. Walker's Report, 28th October 1858.

the Public Works Department of Bombay, of 21st December, 1865, communicating the memorandum and relative plans by Lieutenant-Colonel Fife, R.E., of the 21st November, 1865. Colonel Fife, in his memorandum, says, 'the present condition of the harbour is very unfortunate indeed for the shipping, the entrance over the bar being not only smaller than it used to be, but also excessively awkward.' This further evidence tends to confirm the conclusion which we drew from the information submitted to us, that no permanent improvement has as yet been effected by the works that have been executed. Colonel Fife suggests, 'in order to give the existing works a trial, to see whether they can maintain a channel opposite the harbour,' that harrowing or raking should be tried on the bar, and that a groyne should be projected from Deepwater Point, in order to give the current a set to the opposite side. The remit made to us having been restricted to the ultimate effect of the works now in progress, we have not entered on the consideration of the experimental measures suggested by Colonel Fife.

"The remarks from Captain Williams do not seem to call for any observations."

This report, as will be observed, was written in February, 1866, and immediately the works were stopped; nevertheless the state of the harbour has been constantly improving, and these improvements are due mainly, if not entirely, to the influence caused by the Keamari Groyne, and its extension, the east pier. The entrance of the harbour has so far improved between the years 1858 and 1867, that an addition of 52 acres, or 47.70 per cent., has been made to the area at and below 20 ft. in depth. The increase below 14 ft. is 3.15 per cent., and the channel on the east side of the harbour has greatly increased in size, while the bight on the west side is filling up. The area at low water has increased during the same period from 924½ to 1040½ acres, or 12.54 per cent. Over the bar, the east channel is now about double the width it was in 1858, but once and a half the length, and of course less direct. The west channel has disappeared, and instead of it a new channel has formed, further from the shelter of Manora, but three times the width and rather deeper, whilst the bar has diminished in width from 2440 ft. to 1870 ft., or by about one-fourth. All this has, as we have before remarked, been caused by only one part of the works, but to our mind these results should prove sufficiently conclusive evidence of the validity of Mr. Walker's plans, as to induce the Government immediately to order a resumption of work, and we fully expect soon to hear that they have decided upon reversing their previous decision on this subject.

THE AMERICAN TARIFF.

THE industry and trade of the United States are groaning under the nightmare of a tariff of duties on imports, almost high enough to be prohibitive. Steel rails, now so much wanted in the States, and so largely purchased in England and Wales, pay a duty of 2½ cents per pound, or more than 117. 10s. per ton, levied, not in currency, but in gold; this duty being as great as the original price of some of the steel rails made here. And yet this unconscionable amount of "protection," at the expense of the American railway companies and the American public, has done little to render that country independent of foreign steel works. The prices of labour and materials have become so frightfully inflated under this legislative bolstering, that it is doubtful if the steel-mills now getting to work in the States can ever pay a profit. An American ironmaster told us not many months ago that he had just paid 75 dols. a ton for cold-blast charcoal iron, 15 dols. a ton for Cumberland coal, and that his furnacemen and hammermen were paid 5 dols. a day.

Mr. David G. Wells, commissioner of revenue, framed a tariff bill, last winter, which would have lessened the duty on steel rails from 2½ to 2 cents per pound, or from, say, 117. 10s. to 94. 4s. per ton. Any one would have supposed that this proposed reduction would have been welcomed by the railway interests. Far from this being the case, however, the leading railway presidents at once petitioned Congress against the reduction, and this upon a string of extraordinary reasons of which we pointed out the unsoundness in our impression of February 1st (vol. iii., p. 116). We might have given an unexpected reason why some of these gentlemen were so anxious to have their railways taxed for the holy cause of protection. The first name on their list was not only that of a railway president, but also of the president of the Pennsylvania Steel Company, now putting down extensive Bessemer plant, and we have good reason to believe that some of the other railway presidents were shareholders in that

undertaking! Here were men privately and personally interested in the manufacture of Bessemer steel, and in keeping up the duties, yet seeking, in their official character as railway presidents, to manufacture a plausible case of the supposed advantages of a high protective tariff to the railway interest! Their pretence was that as high duties tended to increase home manufactures, this increase, by causing increased competition, would bring down prices, whereas the necessary effect of these duties has been just the contrary.

Mr. Commissioner Wells's proposal showed his disposition to lessen this excessive burden imposed in the name of "protection;" and when he called upon us recently, on his way through London, we were not unprepared for his decided expression of his opinion that too great protection was already granted for the true interests of American manufacturers, and that lower duties should prevail. The *Iron Age*, a New York journal devoted to the cause of protection, has taken up our simple statement of a fact as an "injurious calumny" against the commissioner, and calls upon him to contradict it. We feel sure that Mr. Wells does not hold two sets of opinions opposed to each other, one in New York and the other in London, and so far from contradicting what he has expressed to us, we feel sure that he would have no difficulty in demonstrating to any reasonable mind that the very "protection" now extended to American manufactures must ultimately lead to their embarrassment, if not utter ruin. The reason is easily perceived. There is a large party in the States whose interests are wholly opposed to protection. This party is occasionally in power, and will undoubtedly be in power again, and whenever this happens the high duties will be abolished. This was the case after 1846, when the high tariff of 1842 was repealed. Manufactures had been stimulated all over the country, and the manufacturers, just beginning to make money, suddenly found themselves assailed by an irresistible competition from abroad. In consequence of this works were closed, furnaces blown out, and there was wide-spread disaster and ruin. All this is certain to happen again under the present unhealthy conditions of American trade, for no nation will consent, for all time, to pay double what it need pay for manufactured articles, merely in order that home manufacturers may keep their heads above water while paying enormous prices for raw materials and labour.

THE UCHATIUS PROCESS.

MANY of our readers will still recollect an interesting invention made by M. Uchatius, an officer in the Austrian service, and which was first brought under public notice at the Paris Exhibition of 1855. It is a direct method of steel manufacture by mixing granulated cast iron and iron ore, in proper proportions, in a crucible, and by these means forming the exact combination required for any given quality of steel. In 1856, at the same time when Mr. Bessemer's invention had been pronounced to be a failure, this process was at the height of its renown, and experiments were made in France and in England on a more or less large scale, although not in anything like commercial practice, to test its value. A company was formed in France, and, we believe, under the auspices of the Government, for the working of M. Uchatius's patents, and everything then believed to be necessary for steel manufacture on a large scale was provided. The causes of failure in this instance are now perfectly intelligible, since the advancement of what may be called the science of steel manufacture has, since that date, enabled us to judge of the importance and value of certain details which were then unknown or overlooked, and the absence of which caused the practical failure of a process which in principle was perfectly correct, and would have in time become of considerable importance, had it not been superseded by the progress of a still more glorious and revolutionising invention, viz., the Bessemer process. The Uchatius process, however, has been commercially introduced at one place, and the steel works has continued its operations now for about ten years, and so far as can be judged from the excellent quality of its products, and from the continuance of this mode of manufacture with perfect success. The steel works referred to is at Wikmanshyttan, in Sweden. In 1862, this concern sent Uchatius steel to London, which was remarkable for its tenacity and uniformity of grain, and now in the Paris Exhibition we find the same works represented by another excellent collection of Uchatius steel. We understand that the Uchatius steel of Wikmanshyttan is used exclusively by the royal mint at Stockholm for dies of

coining presses, polished rolls, and other similar articles requiring steel of great strength and closeness and uniformity of grain. The reason why this process succeeded in Sweden and failed in France and in England is the same which made the Bessemer process first succeed in that country, viz., the purity of the Swedish ores. The ore employed for the Uchatius process at Wikmanshyttan is that of the Bisberg mines, which can be seen in its natural state at the Paris Exhibition, forming part of the large trophy of ironstone and iron erected in the Swedish machinery gallery. It ranks among the purest and richest magnetic ores to be found anywhere. From this ore and from granulated pig iron made of the same ore, probably mixed with iron containing manganese, if the original granulated iron does not contain a sufficient dose of this latter metal, the Uchatius steel is made. The production is not inconsiderable, and the article finds a market at Gefle, principally in the form of a bar steel of small dimensions, at a price of 30s. to 35s. per cwt. Uchatius's process would have become a practical success in England, had it not been swept away by Mr. Bessemer's invention before it had time to establish itself in practice. The steel manufacturers of this country and the public at large have all reason to be satisfied with the historical coincidence of the two inventions, since there would otherwise, and had Bessemer followed behind Uchatius, have been two revolutions to be passed through instead of the one which has taken place. We should have had to change from the old mode of steel conversion to the Uchatius process, and ultimately again from that to the Bessemer process.

LEAD FLOATING ON MOLTEN IRON.

SOME experiments have been made in Germany which seem to show that molten lead when dropped upon liquid iron remains floating on the surface of the latter. As the specific gravity of lead (11.5) is more than one-half greater than that of cast iron (7), there arose some discussion on this subject, which has been recently closed in a very satisfactory manner by the researches of Professor Karmarsch, of Hanover. An ironmaster in the vicinity of that town had sent to the professor some samples of such drops of lead lying imbedded in the surface of a cast-iron block, and which had been produced in the manner above described. Professor Karmarsch found, upon close examination, that these drops of lead, instead of being solid globules, as was supposed at first sight, were all hollow, forming bubbles composed of a metallic skin, and apparently empty in the centre, so far as his observation has been carried. He explains the whole by supposing that the molten lead, at the temperature to which it is raised by the contact with liquid iron, forms an incipient vapour of lead, which is prevented from escaping by the skin of solidifying metal which forms on the top. The lead vapour, according to this explanation keeps the lead resting upon the surface of the iron. It seems that in large quantities the result is different, since it is known that lead is occasionally tapped from the bottom of blast furnaces, which smelt certain classes of ores containing lead, and in these cases the lead is found below the liquid iron, according to its greater specific gravity.

TIN IN AMERICA.—A correspondent of the *Iron Age*, of New York, evidently one well informed as to the chemistry of tin, points out in much detail the fallacy of the reports as to the commercial value of the tin discovered in Missouri. In the course of his letter he says: "But I would chiefly draw attention to the 'result of a second analysis,' which is described with charming detail, and signed by the chemist (?) of the St. Louis Bureau of Mines. Leaving glittering generalities, the report now descend to figures (upon which chemistry is firmly based), and we are informed that 'three pounds five and a half ounces' (8400 grains) of 'selected tin stone' are taken and 'united with four ounces of two chemical substances necessary to facilitate disaggregation' (valuable information for any future assayer). This is 'composed in a sand pot at a white heat for two hours.' The result, which is said to be very satisfactory (?), is 11 grains of pure white tin, 17 grains of pure black tin. Now what this 'black tin' is is a mystery. Black tin is the usual name given in Cornwall to the oxide of tin, or tin stone; but after a properly conducted assay of two hours' duration, no black tin could remain in the pot. We have then 11 grains of white tin, or saleable metal, in 8400 grains, or a yield of one grain in 762, or less than one seventh of one per cent.—or less than three pounds of tin to the gross ton of ore, or less than one dollar's worth (best English tin is now worth 34c. per lb.) in a ton. All the saleable tin in the 'selected ore' would thus, according to the showing of the 'St. Louis Bureau of Mines,' not pay a Madison county man for mining alone. Now, let us add to this mining royalty hauling, breaking, stamping, washing, smelting, and transportation to market, and the enthusiastic capitalist would find himself patriotically producing tin from selected ore at a cost of at least \$13 per ton of ore, or \$10,000 per ton of metal, and when he worked up his 'selected ores' and began to mine 'average ores,' it is but reasonable to assume that he could then lay down tin at St. Louis at the moderate figure of \$20,000 per ton of metal."

THE SOCIÉTÉ NOUVELLE DES FORGES ET CHANTIERS DE LA MÉDITERRANÉE.

The great marine, engineering, and shipbuilding company which bears the above name is one of the most powerful and important concerns of its kind in Europe. At the Paris Exhibition the directors of this establishment show a large number of well-finished models, illustrating some of the most successful types of vessels of war and merchant steamers constructed at these works, and they have added to this a descriptive pamphlet, giving some interesting notes with regard to the dimensions and other details of their largest steamers, and their performances on their trial trips and on other occasions. From this pamphlet, also noticed on page 614 of our last volume, we gather that these works have supplied the French, Spanish, Italian, Turkish, Brazilian, and Prussian navy with men-of-war of heavy tonnage, and that their merchant steamers carry the flags of all nations, that of Great Britain and the United States of course excepted. Amongst the most celebrated ships built by the Société des Forges et Chantiers is the frigate *Numancia*, the well-known Spanish flag-ship at the engagement of Callao. This frigate is 315 ft. long, 56 ft. 10½ in. wide, and has a total depth of 36 ft. 9 in. She draws 27 ft. 4 in. when completely manned and loaded, and her displacement is 7420 tons. The hull is entirely of iron, the armour extending all over the entire length of the ship. The plates are 5 in. thick, and are backed by a thickness of 16 in. of teak placed in two superposed layers, one vertical and one horizontal, the former 12 in., the latter 4 in., in thickness. The armour extends 7 ft. 9 in. below the water-line. The plates are the make of Messrs. Petin, Gaudet, and Co., of Rive de Gier. There are two small armoured castles placed on the deck of this frigate, one for the commander, and the other for the steering apparatus and crew. The rigging and equipment is that of a second-class frigate, but the guns are very heavy. The time occupied by its construction complete was two years. It was launched in 1863. The engines are rated as of 1000 nominal horse power, and are a copy of M. Dupuy de Lôme's design. There are two cylinders of 84½ in. diameter and 4 ft. 3¾ in. stroke each, making 49½ revolutions per minute at normal speed. The screw has four wrought-iron blades, 20 ft. 10 in. extreme diameter. The price of this ship, not including its armament, was 7,895,000 francs, or about 316,000*l*. Another well-known war-ship is the iron-clad frigate *Maria Pia*, made for the Italian Government in 1864, and finished completely in eighteen months, at this company's shipbuilding yard. This frigate measures 256 ft. 6 in. in length, 50 ft. 8 in. in width, 31 ft. 1½ in. in depth. She draws 22 ft. 4½ in., and her displacement is 4362 tons. The hull is made of iron, and armoured all over its length, although not up to an equal height throughout. The central part, which contains the battery, is armoured to the full height of the sides, but at both ends the armour reaches up only to a height of 6 ft. 6 in. above the water-line. The armour-plates are 4½ in. thick, and were made by Messrs. Marrel Frères, of Rive de Gier. There are, in all, twenty-four guns on board, and the whole is rigged in the style of a corvette. The engines have two horizontal cylinders of 73½ in. diameter and 3 ft. 7½ in. stroke, making 54 revolutions per minute at normal speed. The screw is four-bladed, and made of cast iron. At the trial trips this ship made 13 knots. The *Maria Pia* took part in the battle of Lissa. Her armour has been indented at several places by solid shot, but it has not been pierced in any place. There is a sister ship, constructed by the same company, now in the possession of the Italian Government. The price of the *Maria Pia* complete, but without armament, was 4,300,000 francs, or 172,000*l*.

A third ship of this company's construction, that has been engaged in actual warfare, is the *Brazil*. This is a corvette, 200 ft. 9 in. long and 35 ft. 3 in. wide. Its displacement is 1518 tons. The engines have two horizontal cylinders of 250 nominal horse power. The hull is entirely of iron, and the armour is carried all round the ship to the full height of the sides above the water-line. The plates are 4½ in. thick, and were made by Messrs. Marrel Frères, and they are backed by 8½ in. of teak. The armament consists of four heavy Whitworth guns and four smooth bores. At the trial trips on the Rio Grande, this ship made 11.3 knots, with a considerable overcharge of coal on board. The *Brazil* was then sent to the Paraná, where it withstood the fire of the artillery of Chattas without its armour being pierced at any point.

Amongst the several other men-of-war of the Société des Forges et Chantiers de la Méditerranée, we may name the frigate *Friedrich Carl*, now in course of construction for the Prussian Government. This vessel is of 6000 tons, and has engines of 950 horses. Its contract price is 6,000,000 francs, or 240,000*l*.

The merchant steamers built by this company are in the service of the Messageries Impériales, the Russian Navigation Company, the Viceroy of Egypt, the Compagnie Générale de Transports Maritimes, &c. The Suez Canal Company has ordered five small steamers at these works, and these are now in course of construction. The engines of these small boats are high pressure, 8 in. in diameter of cylinder, and 6½ in. stroke, making 300 revolutions per minute. The whole engine is enclosed in a square casing, so as to protect it from dust and sand. The boiler pressure is 5½ to 6 atmospheres, or say 75 lb. The price of each of these vessels is but 740*l*. Messrs. Borel, Lavalley, and Co., the contractors for the Suez Canal, have also been furnished by this company with their principal vessels of transport. These are fifteen ships, each 127 ft. long, 23 ft. wide, and 10 ft. 7 in. deep, drawing 9 ft. of water. The displacement is 500 tons, and the engines 60 horse power. These vessels have attained 9 knots per hour, their contract speed being an average of 6 knots. The price of each of these vessels is 5800*l*.

THE RACHETTE FURNACE.

At the London Exhibition of 1862, a new kind of blast furnace was brought under public notice as an important improvement upon our present mode of smelting iron. It was exhibited in the Russian department by the inventor, General Rachette, in the Russian service. It was stated that a furnace of such construction had been successfully worked in Russia for some time, and several more furnaces of that kind were then about to be erected. The furnace is made of a long-rectangular form, with a row of several tuyeres at each side. The intention of this arrangement is to allow of a very large furnace being kept in blast by a great number of tuyeres, without incurring the danger of the blast being ineffective in the centre of the furnace. It is, in fact, the same idea as that embodied in the elliptical furnace, known as *Alger's* patent. The Rachette furnace exhibited in London, in the form of a small model, had six tuyeres at each side. The Russian Exhibition at Paris now contains another model of a Rachette furnace, exhibited by Prince Demidoff, and probably representing a furnace in blast at his works. There are twelve tuyeres at each side of this furnace, and the proportions of its height to the width, at what must be called the boshes, is much smaller than is usual in round furnaces. Another Rachette furnace is exhibited by a model in the Prussian department. It represents the furnace at work in Clausthal am Harz for smelting copper ores, and which is said to work in a very satisfactory manner. The only iron-smelting furnace, on General Rachette's plan, that has been set to work in Western Europe was erected at Mulheim am Rhein, in Prussia, some three or four years ago. This furnace has not worked for any length of time, as the company which had erected it failed. The causes of this failure are described by persons acquainted with this company to have been solely of a commercial character, and this failure gives, therefore, no sufficient evidence with regard to the merits or demerits of the Rachette furnace.

MACHINERY IN INDIA.—The value of the machinery imported into British India in 1849 was 18,064*l*.; in 1850, 8,079*l*.; in 1851, 20,666*l*.; in 1852, 14,337*l*.; in 1853, 26,457*l*.; in 1854, 52,788*l*.; in 1855, 126,303*l*.; in 1856, 435,512*l*.; in 1857, 244,433*l*.; in 1858, 465,453*l*.; in 1859, 587,566*l*.; in 1860, 871,531*l*.; in 1861, 870,251*l*.; in 1862, 553,883*l*.; in 1863, 506,518*l*.; in 1864, 585,516*l*.; and in 1865, 554,156*l*. These figures, it should be observed, do not include the value of the iron or the railway material and stores imported.

CHEERBOURG.—The Scientific Association of France commenced a congress yesterday week at Cherbourg, the meeting being continued on Friday and Saturday. The visitors inspected the lions of Cherbourg, including the digue, the arsenal, the armour-plated ships in the navy yard, the armour-plated frigate, *Rochambeau* (late *Dunderberg*), the workshops, the foundry, the forges, the great basins, &c. At the foundry a gigantic casting was shown; this was the spur or beak of the *Atlante*, weighing 18 tons.

THE SOCIETY OF ENGINEERS.—The Council have obtained permission for a visit of the Society to the works of Messrs. John Penn and Son, at Greenwich, on Friday, the 13th of September. Members and Associates who purpose joining the party are requested to communicate with the Secretary, on or before the 10th proximo. Members and Associates to meet at London Bridge Station at a quarter past 12 o'clock, on the 13th September, to proceed to Greenwich by train leaving at 12.31 p.m.

THE MONT CENIS RAILWAY.

ON Monday last, the 26th inst., the first engine and train passed over the Mont Cenis Railway from St. Michel to Susa, a distance of 48 miles. The summit crossed is at an elevation of 6700 ft. above the level of the sea, and attained by a series of steep inclines worked on the Fell centre rail system, the gradients on the French side varying from 1 in 30 to 1 in 12, and those on the Italian side from 1 in 16 to 1 in 11. The trip is described as having been most successful, and among those present were Captain Tyler, R.E., specially commissioned by the Board of Trade with a view to new postal arrangements; the Duke de Vallombrosa, Mr. Brogden, and Mr. Fell, directors; Mr. Brunlees, the engineer of the railway; Mr. Bell, resident engineer; Mr. Blake, who has carried out the works for the railway and the reparation of the road for Mr. Brassey; Mr. Alexander, who has superintended the construction of the engines; Mr. Barnes, locomotive superintendent; Captain Beaumont, R.E., and others. It is intended to open the railway for public traffic in October, and the railway communication between Calais and the south of Italy being thus complete, it is expected that the Eastern mails will be sent by this route, thereby saving forty hours.

NOTES AND MEMORANDA.*

SOLID pistons turned ½ in. larger than the cylinders, and forced into their places by hydraulic power, have been used with much success for high-speed engines. They are found to remain tight for a considerable time.

The term "twin-screws" originated in a nickname applied to *Romulus* and *Remus* on account of the meanness of their dispositions.

This fact has, from a confusion of ideas, led many to suppose that the Roman war galleys were fitted with the above mode of propulsion.

The adhesion of locomotive driving wheels may be increased by covering the tyres with emery paper. It can be best secured by gum.

The best wood for railway sleepers is birds-eye maple. In fact, no sleepers made of this wood have yet been worn out.

The lead of a slide valve is commonly made equal to twice the lap multiplied by one-tenth of the travel. This proportion works well if it effects a good distribution of the steam.

Paddle engines were first applied to the oracles of the ancient Britains. The slip of a strap on belt pulleys increases as the squares of the diameters of those pulleys. Hence, when two pulleys of different sizes are connected by a belt, the larger pulley makes the greater number of revolutions in a given time.

The durability of roofing-slates may be much increased by creosoting them.

All the machinery erected in the great pyramid, in the time of the Pharaohs, for stuffing mummies, was driven by water power.

Concrete is being gradually substituted for iron as a material for steam boilers. One of its great advantages is that no safety-valves are required, the concrete itself yielding when the pressure rises too high.

The first artesian well was sunk at Athens by Archimedes, to supply that city with water during a siege. The first Cornish pumping engine was also constructed by Archimedes.

On the Indian railways all the fast passenger trains are drawn by elephants. The latter are termed by the drivers "trunk engines."

When any of the Eastern princes are being conveyed over the above lines, a "tiger" commonly rides behind.

Corkscrews may be made of steel wire.

Link-motion was first applied to galley slaves by the ancient Greeks.

When James Watt invented his regulator for steam engines, he gave it the name "governor," out of respect to his aged parent.

RUNCORN.—A viaduct, which has been prosecuted for some time past by the London and North-Western Railway Company through Runcorn and on the Lancashire side of the Mersey is nearly completed; of three openings in the bridge over the river, two are finished, while the scaffolding for the third is being erected.

AMERICAN RAILWAY GAUGES.—One reason why the Erie Railway finds it difficult to pay dividends is the too great width of gauge (6 ft.), too large proportion of dead weight to the paying load. And this will apply to all roads with the extremely wide gauge, including the Atlantic and Great Western, the Ohio and Mississippi, and the Grand Trunk of Canada (5 ft. 6 in.). The English are reducing the width of their wide-gauge roads, and we predict that they will find this to be true economy. The prevailing gauge in the United States (4 ft. 8½ in.) is wide enough for all purposes of practical management, if we except the too confined space allowed for some details in the construction of locomotives. Had we adopted as the national gauge five feet, it would have been ample for locomotive details, and given width enough for comfort in passenger service, without greatly increasing the weight of rolling stock. Five feet would have been a wise compromise between the two systems, and the best friends of the railway system regret that there was no authority at the start to insist upon the adoption of that width for the entire country; and even now it would be a wise act of statesmanship to compel a uniformity of gauge. The exceptionally wide-gauge roads will never prove profitable, or rather they will never be economically operated in comparison with those of the 4 ft. 8½ in. system. The mechanical facts are all against the wide gauge.—*American Railway Times*.

* From a young friend lately married, and whose head appears to have been turned by his brief experience.

BLAKE'S STONE-BREAKING MACHINE.

CONSTRUCTED BY H. R. MARSDEN, ENGINEER, LEEDS.

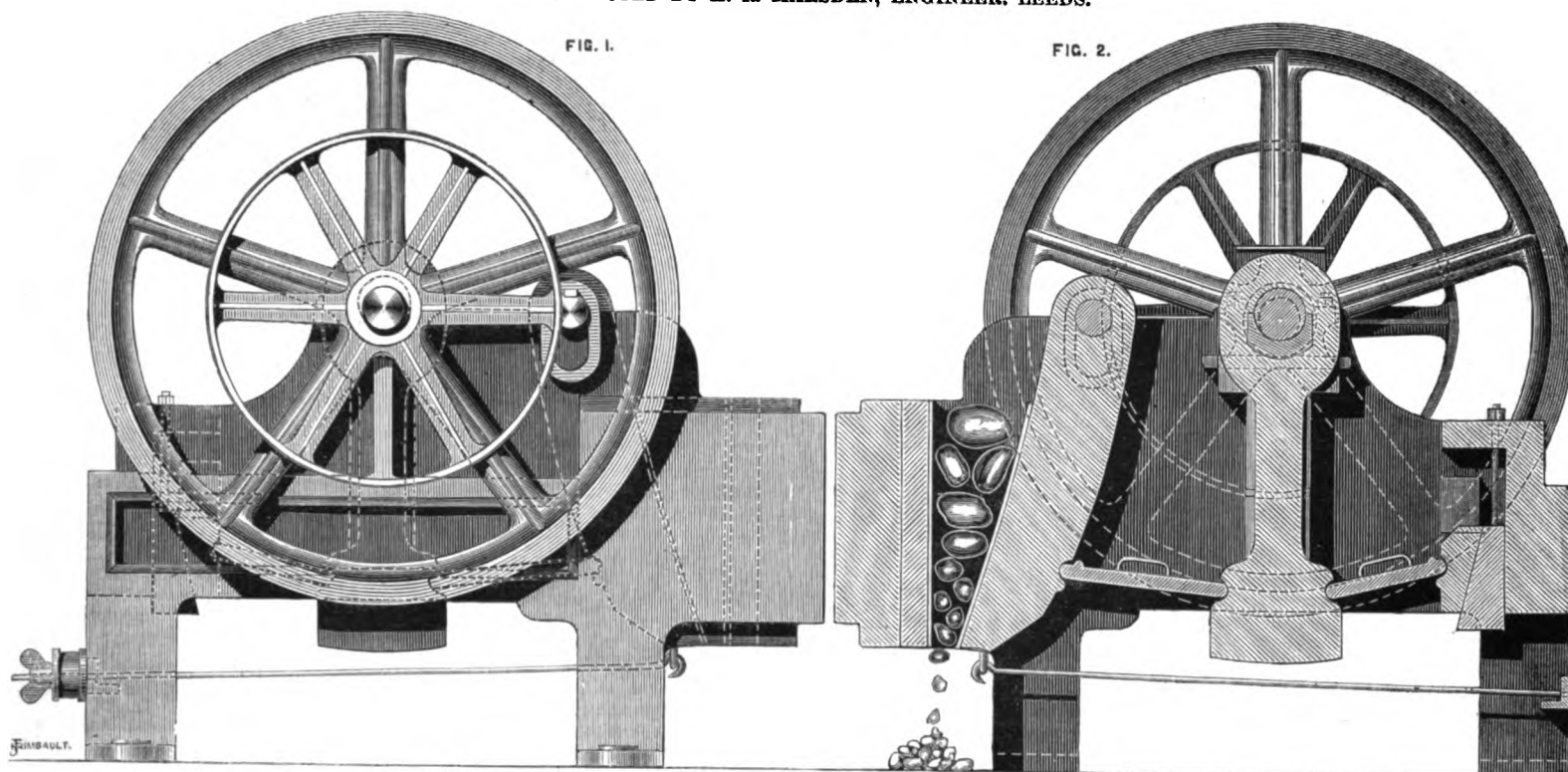
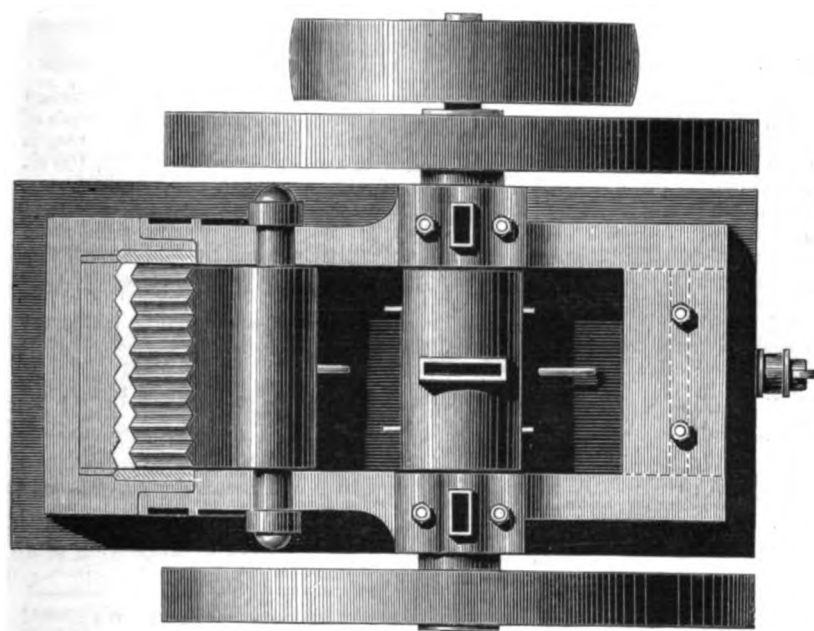


FIG. 3.



PERHAPS no labour-saving machine ever devised has superseded more wretched drudgery than Blake's stone-breaker. At the time when the Central Park, of New York, an American *Bois de Boulogne*, of even greater magnificence than its Parisian prototype, was being laid out with macadam roads, the want of a simple and effective machine for breaking road-metalting was especially felt. As with most mechanical wants in that inventive country, this was soon met by Blake's invention. Mr. H. R. Marsden, an English engineer, then residing in New York, had every opportunity of witnessing the success of this machine, and he resolved to make its merits known here on his return. This was five or six years ago, and already Mr. Marsden has made and introduced great numbers of these machines, which are now in high favour with road trusts, iron and copper miners, ironmasters, contractors, and all who have occasion to break considerable quantities of stone or refractory ores.

The machine is a beautifully simple combination of the simplest mechanical "powers," every part resisting strain in the direction in which its material and form are most effective. There is a solid vertical abutment at one end of the machine, formed by a ridged and furrowed cast-iron plate. A slightly movable plate, with its surface cut in the same way, is hung, in an inclined position, in front of this. The inclination of the movable plate is such that stones will be perfectly gripped between the two by their own weight, aided by the "crunching" surfaces of the plates themselves. The vertical section, which we give, of the machine shows this clearly. There are the stones, falling, by their own weight, into the narrow gorge between the fixed and the movable crushing plates or jaws of

the machine. The movable plate is freely hung from above, and its lower edge requires but very little motion, only this must be imparted with great force. In no way can this be more simply applied than through a toggle-joint worked by a stout crank, or rather eccentric, and connecting-rod, both of which are clearly seen. The connecting "rod," however, is a wide plate of cast iron, of abundant strength, working broad toggle-plates of the full width of the crushing jaws. The sections of all the bearing surfaces are shown too clearly to need any description, as is also the wedge for altering the closeness of the bite, this wedge regulating the position of the fixed abutment of the toggle plate at the back of the machine. The motion of the movable jaw, or crushing-plate, is so slight that the light rod shown beneath, drawn by, and drawing upon, the small india-rubber spring at the back, is sufficient to return the jaw at each stroke.

So long as a stone is not too large to enter at the top it will work its way down, cracking bit by bit until it drops at the bottom into pieces of which the maximum size corresponds to the opening to which the bottom of the movable jaw is made to work. There is no escape for the stone, and although the crunching, as judged by the sound, is tremendous work, it is really accomplished with but little engine power. The machine is run at, say, 250 revolutions or bites per minute, and 4 horse power suffices to break 40 tons of stone a day, or 8 cubic yards per hour. Here the crushing surface is but 10 in. wide, and the opening at the bottom, for hard granular stone, is $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in., that at the top being 7 in., to take in stones of that diameter.

These machines are in successful use by the Wigan Coal and Iron Company (Mr. Lancaster, of Kirkless Hall), by Belckow and Vaughan, and Hopkins, Gilkes and Co., of Middlesboro', the Monkbridge Iron Company, of Leeds, the Barrow Hematite Steel Company, the Derwent and Consett Iron Company, Naylor, Vickers and Co., of Sheffield, the Lillishall Company, Messrs. Harvey, of Hayle, Messrs. Dawes, of Barnsley, and other large ironmasters, and by great numbers of copper miners, chemical manufacturers, engineers of permanent way, contractors, road trustees, &c. We have desired to give special prominence to this machine, as despite its great simplicity and extraordinary success wherever it has been put to work, it is not even yet known to one-tenth the extent it deserves to be. For road trusts it is far cheaper than the cheapest paupers' labour, while for some purposes it will do what hand labour could hardly accomplish at all. We may add that Mr. Marsden's address is the Soho Foundry, Meadow Lane, Leeds.

THE DOWLAIS IRONWORKS.—No. II.

Of the seventeen blast-furnaces at Dowlais, thirteen are at the "old" works and four are at the Ivor works, nearly half a mile away. All are fed with raw coal, and are blown with a pillar of blast of from 3 lb. to $3\frac{1}{2}$ lb., heated to a temperature of about that of the melting-point of lead, or, say, 612° . The gas is taken from nearly all the furnaces, and is burnt under the boilers and blast-stoves, and a culvert, 750 yards long, conducts gas also from the old furnaces to the rail mills, nearly half a mile away. Sixteen of the furnaces are in blast, and the average weekly cast, for a long series of weeks, is nearly 180 tons each. The furnaces are tapped three times in twenty-four hours, or oftener. The masonry of the furnaces is square at the base, and takes the circular form about halfway up. Internally the furnaces are of different forms and dimensions. None are more than 18 ft. in diameter in the boshes, and few are as much as 50 ft. high, as the coal is not of sufficient strength to bear a high column of materials. The consumption of coal is about 30 cwt. per ton of pig-made. One of the Ivor furnaces once made 444 tons of pigs in one week, but the system of forcing has long been abandoned. No hoists are required, all the furnaces being built against the hill-side, the charging-stage being at the level of the ground behind.

The furnaces are blown by, in all, six engines, one of which, the Merthyr Guest engine (named after Sir John's second son), was, until the erection of the Darby engine at Ebbw Vale, the largest in the world. All are beam engines, and work singly. The Merthyr Guest engine has a 55 in. steam cylinder and 13 ft. stroke of steam piston, while the blowing cylinder is 12 ft. in diameter, and the blast piston has a stroke of 12 ft., the great beam being divided unequally. The flitches of the beam weigh each $16\frac{1}{2}$ tons, and the whole weight upon the beam gudgeons is 44 tons. Steam of 60 lb. pressure is worked without condensing, and is cut off at about one-third stroke. The working speed was intended to be twenty double strokes per minute, but it is actually about sixteen. The engine has a fly-wheel of about 35 tons weight, worked by a connecting-rod between the steam cylinder and the main centres. The blast is discharged into a main 5 ft. in diameter, and about 140 yards long, which thus acts as a regulator. The cylinders of this great engine were made and fitted at the Perran Foundry, Truro, all the other parts having been made, and the whole erected, at Dowlais by Mr. Samuel Truran, the company's engineer.

The blowing-engine at the Ivor works has a 144 in. blast cylinder also, but the stroke is only 8 ft. Besides the two already mentioned, are three with 190 in.

blast cylinders and 8 ft. stroke, and one engine with an 80 in. blast cylinder and 6 ft. stroke.

There are nine forges in all, six at the old works and three at the Ivor works, and these contain in all 160 puddling furnaces, working seven heats to the turn of twelve hours, or fourteen heats per day. This is with pig iron, but a small proportion being refined, although at one time all the iron made at Dowlais went through the refinery. Nearly all the puddling furnaces burn small coal, or screenings, and this upon the ordinary firebars. To obtain sufficient draught with this coal a fan blast is necessary; but this is not applied in a closed ash-pit, as is the case at the works of Schneider and Co., of Creusot. For the 160 puddling furnaces there are, in all, eighteen of Lloyd's fans, and these are generally driven in groups of two or four, and by independent engines. The blast is led in a pipe under the firebars of each puddling furnace, and discharged upwards along a line of openings or slots in the pipe, perhaps $\frac{3}{4}$ in. wide, and extending across the width of the ash-pit. The blast induces a current of air with it, and instead of beating back, as might be expected, drives its way in among the small coal, and really effects a good combustion.

The total quantity of coal (or, as is termed, the "yield" of coal) consumed in puddling per ton of puddled bars made is but 16 cwt., and, averaged over the whole works for a series of weeks, this is in the proportion of 13 cwt. of small coal to 3 cwt. of large. Beyond the fact that the coal is considerably richer in carbon than that used in Staffordshire and in the North, the greater quantity of coal used elsewhere, often 30 cwt. per ton of puddled bars, would appear difficult of explanation. As elsewhere, so at Dowlais, the puddling furnaces are fettered with calcined tap cinder, and with rich ore from Mostyn or Bilbao. The waste heat of the puddling furnaces is led off in flues to the boilers, these being well outside of the forge; so that were an explosion to happen, the danger would be greatly lessened.

The puddled balls are shingled in squeezers or under steam-hammers, and among the latter is the first one of 5 tons weight which Mr. Nasmyth made at Patricroft. The blooming is performed in three-high mills, the lift of the bloom from the bottom to the top pair of rolls being effected by gearing, while at some of the other works in the district it is effected by a steam-piston working in a cylinder. While's "continuous rolling-mill" for blooming was, we believe, first made at Dowlais, although it is not used there. While was roll-turner at the works. His mill has two pairs of horizontal rollers and one pair of intermediate vertical rollers, geared together so as to take the bloom through at one pass, the biting surfaces of all the rolls being practically in the same horizontal line. While's mill is employed at Ebbw Vale, and is much liked there. It saves the labour of three men, turns out a sounder and hotter bloom, and thus saves coal in reheating. It is a somewhat complicated machine, however, and to get at the lower bearings of the vertical rolls, in order to oil them, a tunnel has been made beneath it.

Mr. Menelaus has striven hard to introduce mechanical puddling, and he read an excellent paper upon this subject at the late meeting of the Institution of Mechanical Engineers, in Paris. The plan adopted is a development of that of Mr. Tooth, the iron being tapped direct from the blast furnace, or from a cupola, into the neck of a slowly revolving cylinder, or rather bottle-shaped vessel, lined with fire-resisting material. By sufficient barrel-churning the liquid pig "comes to nature," and forms a ball of malleable iron. But no kind of lining has been discovered which will withstand the mechanical action of the falling masses of iron, when this has begun to cohere, nor even while it is "coming to nature." The ganister lining of the Bessemer converters, the Dinas sand, tempered with fire-clay, and all other materials tried for lining, are so far knocked to pieces. If it be attempted to strengthen the linings by iron ribs, or holding-pieces, the iron undergoing puddling immediately attaches itself to these, and forms great warts and scabs difficult of removal. At present there appears to be little or no hope for this mode of mechanical puddling. Everything to abridge the labour required in making iron has been tried at Dowlais. Here Mr. Nasmyth's steam-jets, driven into the iron from a hollow rabble, were tried and abandoned, and so, too, some of the earlier trials of the Bessemer process were made here. The Dowlais Company now has one of the finest sets of Bessemer plant in the kingdom, having six 5-ton converters. Years ago, too, the so-called Richardson process was tried, compressed air being driven under the surface of the melted iron in the puddling furnace by means of a tubular rabble, connected to a flexible

air-pipe, and worked about by hand in the manner of an ordinary rabble.

We have said in our first article that every ounce of cinder from the puddling furnaces and all the mill scales go again into the blast furnaces, and although a certain proportion of silica is thus admitted to the charge, the quality of the argillaceous Welsh ironstone supplies an effectual corrective. The practice is the same at all the principal works in South Wales; and when it is considered that perhaps 28 cwt. of pig are employed in making a ton of rails, the recovery of the 8 cwt. of iron wasted in the puddling and mill furnaces is a matter of great importance. At the Ivor forges a tramway is laid between the puddling furnaces on either side, the tramway being 4 ft. or 5 ft. below the level of the floor, and the cinder is readily loaded into trucks, to be taken away to the blast furnaces.

We now come to the mills, of which there are seven, at the old works, including the famous "Goat mill," the finest ever erected, and six at the Ivor works. There are, at the old works, a 24 in. steel mill, a four-roll 21 in. girder mill, two 20 in. rail mills and three 18 in. bar mills; at the Ivor works are a 24 in. plate train, an 18 in. rail mill, two 12 in. trains and two 8 in. guide mills.

Of the great engines of the Goat mill we gave drawings and a description in our first volume, pages 325 and 326. They are a pair of non-condensing beam engines of 45 in. cylinders and 10 ft. stroke. In structure they possess no details requiring special remark; but no one standing between their great iron columns, sixteen in number, and supporting an entablature nearly 50 ft. square and 25 ft. high, can fail to be impressed by the immensity of the whole work. We have seen nearly all the largest engines ever constructed—the Haerlem pumping engines, the 112 in. and the 100 in. Cornish engines about London, the 127 in. cylinders 4 ft. 6 in. stroke of the Hercules, the 110 in. cylinder 12 ft. stroke of the New York and Bristol (not the English Bristol) line of steamers, the engines of the Great Eastern, and the Scotia, and the Adriatic, the fine large engines at Saltaire, and thousands of smaller examples; but the great blowing-engine at Dowlais and the twin giants of the Goat mill have impressed us with their wonderful size and quickness of action more than all others. There are many who would confess themselves repaid for a journey from London or the north, all the way to Dowlais, only to see these engines, and we can recount in our minds the names of some of the greatest men in our profession who have owned to a new sense of the sublime when standing before these Titans, the one doing the bidding of King Æolus, the other of the god Vulcan.

The steel train at Dowlais is a 24 in. mill, and this, perhaps the largest ever made, is found only large enough, and we understand that Mr. Menelaus has recommended other makers of steel rails to put down 26 in. trains. By the way, how generally is it known that there is at Dowlais one of the largest Bessemer steel works in the kingdom?—and that steel rails are made there from precisely the same materials as at Sheffield and at Barrow, and to stand exactly the same tests?

For hammering steel ingots there is a 10 ton duplex steam hammer, as designed by Mr. Ramsbottom for the Crewe works; but in the majority of cases it is preferred to "cog" or roll them. This is done at one end of the rail train. This train is reversed, at each pass, by a clutch, or "crab," worked by a steam piston. It was originally found that the horns of the clutch did not engage properly in both directions, the corners being knocked off by the frequent heavy concussions in reversing. So Mr. Menelaus has formed the face of one of the clutch-boxes with a cam-like rise and hollow, and, attached to the reversing lever there is a rolling disc on a vertical spindle, this disc following the line of the cam-face. It may not be quite easy to understand the arrangement without a drawing; but it is such that the clutch can only engage when the horns are at the right place, this place being represented by the hollow in the cam-face, into which the rolling disc enters when the horns come into gear. The rolls run at 40 revolutions per minute, and as the steel must be worked when partly cooled, hardly any amount of strength in the rolls is too great. It is thus that, although now having one of the largest trains ever made, Mr. Menelaus would, in a new mill, probably put down 26 in. rolls.

Hydraulic gear is now being fitted in the mills to haul the blooms, piles, and ingots out of the furnaces to save the labour of the men. Indeed, chain-gear has already been set to work at several of the furnaces, and the saving to the men, in hard work and exposure to heat, is already very great. It has been the con-

stant object to lessen the handling of iron, and indeed all weights, to a minimum.

It was at Dowlais, we believe, where the first rail-straightening machines were made, twenty-five years ago, and the cost of this work has diminished from 18d. to 7d. per ton. That this work was ever done by sledges seems now almost incredible. Mr. Menelaus, years ago, when with Mr. Fothergill, made, at his request, an colipile, the veritable steam-engine of Hero, and such a one as yet exists at Ingestre, for driving the saw for cutting the ends of rails. We believe that Mr. Ramsbottom, has a machine of this kind still in use for cutting rails at Crewe. It is wonderfully simple, and works at a high speed, but it is a great waster of steam.

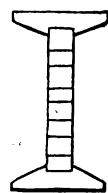
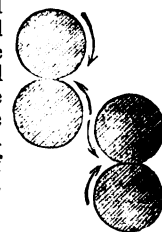
At Dowlais, the moment the ends of the rails are sawn off, they are passed, still hot, through a flattening-mill, and are thus brought to a form to be laid up in fresh piles. Such saws as are not required to be in constant use are worked by separate engines, as the constant running of a saw at high speed tells, of course, on the bearings.

At the Goat Mill, so named by Sir John, with his usual tact, in honour of the national emblem of the principality (for he was not a Welshman himself), there is a special mill for rolling wrought-iron girders, and it may be gratifying to some who have begun almost to believe in the alarming reports of foreign competition to learn that we saw 10 in. rolled girders passing through this mill, for delivery in *Holland*, and we may add that the price of the girders was but 9 $\frac{1}{2}$ per ton, free on board at Cardiff. The girder mill is called a diagonal mill, and has two sets of rolls arranged as in sketch. A little explanation will make it clear why a three-high mill would not do for girders. The bottom roll of the top pair would not answer for the top roll of the bottom pair, because of the difference necessary in the form and dimensions of the grooves, unless, of course, very long rolls were employed, so that the middle roll should have a separate groove for each pass of the girder in either direction, and this, with girders from 8 in. to 12 in. deep, would require a length of roll wholly inadmissible. A reversing train, too, is out of the question because of the high speed, 100 revolutions per minute, at which the rolls must be run to bring out such comparatively light sections in from 30 ft. to 50 ft. lengths. Those we saw rolled were sawn to 37 ft. 6 in., and weighed 112 lb. per yard. The four-roll diagonal mill meets the whole case, and the blooms go flying through at the rate of 600 lineal feet per minute, and with comparatively little lifting and lowering.

We should explain that the piles of these girders are laid up in the manner shown in the sketch, the top and bottom flanges being separately rolled, with a groove on the inner face of each, and puddled bars, cut to length, are piled between these. No fastening or binding of the pieces in this pile is required. It goes into the fire, and, when ready for the rolls, is so welded together as to readily bear handling. The welds, too, we are assured, are sound, although we will not undertake to personally answer for this. We should have supposed that the welding would not have been quite perfect. A somewhat similar mode of rolling beams has been practised since 1856 at the Phoenix Iron-works, at Phoenixville, U.S. The top and bottom flange pieces of the pile are first rolled separately, in the same manner and with the same form of groove, and plates are then set up vertically between them, and keyed into the grooves. The whole pile is then ready for the furnace.

For sawing the ends of such long beams a long carriage is required in front of the saw. If the beam be 50 ft. long, at least 30 ft. of its length must be supported, first at one side of the saw, and then at the other. The saw, not being constantly in use, is driven by an independent engine to save the wear of its bearings, and the carriage, about 60 ft. or 70 ft. long, and having one half its length on each side of the saw, runs up on its own wheels on guide rails. It is drawn up rather by a steam-piston, but although this is always pulling with full force, the carriage is only let up to the saw by means of a letting-off screw, regulated by the hand of the sawyer.

We have said but little of the Bessemer steel works, which occupy excellent buildings, and have six converters of five tons each, the only blowing engines at present being a pair of the well-known pattern of Hick, of Bolton, with 36 in. steam cylinders.



54 in. blowing cylinders, and 5 ft. stroke. A new pair of beam blowing engines is about to be added. We passed some time at the Bessemer works in company with Mr. George E. Gray, the engineer of the Central Pacific Railway of California, and with Mr. Walter Child, the chemist of the works, one of Dr. Peroy's boys, who has been six years at Dowlais. The same pig and spiegel are, of course, used at Dowlais as at Sheffield and in the north, and the quality of the steel is equally good. Mr. Child is using the Dinas sand, with a mixture of one-tenth of its bulk of fireclay in place of ganister, for lining his converters, and already the upper half of one had gone 265 rounds without relining. Indeed, the material is good for 300 charges or "blows." The blowing was fine, what the steel men call a "good warm blow," as distinguished from a "cold blow." We teemed a dozen ingots, the steel running with the gentle gurgling sound of milk, whereas when what is called a "cold blow" happens, the sound is as crackling and hard as that of peas in a pan, and the edges of the flame from the converter are as sharp and hard to the eye as if they were the edges of red-hot bars of iron. How the steel swells in the ingot moulds, then sinks again, and finally swells once more above the chalk-mark on the inner surface of the mould to which we had carefully poured it! Its first swelling is, doubtless, occasioned by the air taken down with the fiery stream, but considerable ingenious speculation might be devoted to the various alterations of volume which the ingot takes before setting. The Bessemer ladle and teeming valve is a beautiful invention, and is perfectly under control. Once in a great while, the iron valve-spindle, protected by fireclay, burns off in the melted steel in the ladle. Mr. Child was once thus caught with five tons of steel in his ladle, ready to set, if left there long enough. But, although the stopper was down, he got a piercer underneath and opened a passage through it, teemed all his ingots, and saved all his steel. The ingots are now to be made of the right weight for two railway bars instead of one, the ingot being cut in two at the hammer. This saves one crop end, and will secure, on the whole, still better work.

In all the works of Dowlais there are not far short of 100 steam engines, many of them of 40 in. cylinder and upwards. There are six blowing engines, eighteen mill engines at the "old" works and nine more at the Ivor works, four large pumping engines at the pits, more than thirty winding and underground hauling engines, besides many miscellaneous engines, and a considerable number of locomotives. All the works, pits, &c., employ 9000 workpeople, of which about 5500 are under ground and 3500 above. The company owns 400 horses, too, and hires 300 more. Of the workpeople, many are women and girls. The latter are powerful virgins, who make nothing of knocking down any young fellow of their own weight who attempts to take liberties with them. No gentleman, and certainly no lady, can see these sooty wenches at work without a feeling of pain mixed with shame; and yet the Welsh girls prefer to shovel coal out of wagons, to pile iron in the mills, to run the empty trams on to the cages at the pit's mouth, to break limestone—in short, to do any rough dirty work, especially if it requires stooping, than to go out to service. It is really difficult to obtain domestic servants in South Wales and in Monmouthshire. The girls prefer men's work, and to knock off at six o'clock, after which they are mistresses of their own time. And there is no doubt that the rough work thus chosen by them is more healthy than indoor employment, and we are assured on all sides that comparatively little immorality prevails in consequence of the promiscuous employment of men and women. As for the traditional Welsh custom of "bundling," we are told to believe that, where it prevails at all, it is only accepted lovers who enjoy the opportunity.

There are excellent schools at Dowlais, and probably three thousand children are under instruction. Under Sir Ivor Guest's orders, the late Sir Charles Barry built admirable school buildings, and there is besides, a really elegant "Athenæum," with a well-attended library and reading-room. Fourpence out of every pound of wages is stopped, one half for a sick fund, under the sole management of the men, the other for the medical and surgical service supplied by the company, and for maintaining the reading-rooms, &c.

We cannot prolong here our hasty and discursive notice of these vast works; but they are such as our country and our profession may well be proud of. That they may yet be surpassed in extent by other works of their kind is not improbable; but so long as metallurgical industry holds its accustomed footing in the affairs of the kingdom, so long will Dowlais be

famous as a monument of the individual energy and genius of Sir John Guest, and of the proudest age of British industrial and commercial power.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Scotch Railway Affairs.—The half-yearly meetings of several of the Scotch railways have just been held, or their directors have been indicating how they stand. First comes the Glasgow and South-Western, which assumed such a prominent position in the last session of Parliament on account of its attempt at amalgamation with the Midland. The directors yesterday resolved to recommend a dividend of 5½ per cent. per annum, carrying forward the sum of 5080l. to next half-year's account, and this, be it remembered, even after the enormous expense incurred in connexion with the (for the present) futile amalgamation project. The proportion of the legal expenses to be borne by the Glasgow and South-Western is to be based on the ratio which its capital bears to that of the Midland. Next session is not expected to bring forth any new projects on the part of the Midland, nor even a renewal of the project for amalgamation.

The Caledonian, one of the opposition to that scheme, is recommending a dividend of 5½ per cent., with a balance of 5500l. to carry forward. For the corresponding period of last year it was 7½ per cent.

The Busby Railway Company has just met. It is expected that the whole line will be opened for goods, mineral, and passenger traffic about the beginning of next year. A portion will even be open for mineral traffic before the end of the present month, or by the beginning of the ensuing week. The engineers, Messrs. Forman and McCall, are pushing forward the works with great energy. The same engineers also report to the directors of the Greenock and Ayrshire Company. The longest tunnel, that next the Greenock end of the line, is nearly completed, and the others are well advanced. They say the Cartburn and Bridge-of-Weir viaducts will be finished in a few weeks; that the piers of the large viaduct over Devil's Glen are nearly erected; that the bridges and culverts are finished, with few exceptions, that about 70 per cent. of the excavations on the Bridge-of-Weir contract have been made, and that there have been about 160,000 yards of rock and earth removed in all on the Greenock contract. The trade of Greenock is expected to progress still more rapidly than it has done when this new line is opened for traffic.

Mr. Geo. Robert Stephenson a Scottish Landlord.—The nephew of George Stephenson, and cousin of Robert, has lately become the owner of an estate in the Kyles of Bute, one of the most picturesque parts of the West Highlands. He has just settled down in it, and has lost no time in setting to work among the fishermen and other hardy Highlanders, among whom he is located, with the desire of stimulating them towards building good boats, encouraging clever seamanship, and developing every improvement likely to benefit the fishermen in their arduous calling. By means of a regatta held last week, and in which he ruled supreme, being commodore, vice-commodore, and all that, himself, he has had his name and kindness sung forth for many miles. At Cowes, he used to devote large sums of money to promote good seamanship, skilful boat-building, &c., as tested by regattas, and the west coast people are glad to receive him amongst them to do the like to them. At the Tighnabruich (there's a word for you!) regatta last week he gave 150l. in prizes, and there were no fewer than fifty-seven entries for them, including amacks, fishing-boats, &c. Mr. Stephenson's screw steam yacht, Northumbria, 420 tons, her tender, the George Crow, the St. Lawrence, 80 tons, the property of Mr. Stephenson's son, and a number of other boats of Mr. Stephenson's own fleet were present during the regatta. The kindness and generosity displayed in a variety of ways by Mr. Stephenson since his advent to the estate of Glen Caladh, and especially in the case of the regatta, have much endeared this son of a great family to the people about him.

Miners' Affairs.—Since I sent off my last week's "Notes," the miners of the Wishaw and adjacent districts have begun to settle down to systematic and quiet work. They are not wholly devoid of reason and common sense; and it seems that their employers can now lay claim to the possession of a share of both those very desirable commodities, for they have made offers that are accepted by the men without a grumble. The plan of remuneration, which I mentioned last week seems to have been superseded by the following one, which Mr. Russell and other coal-masters have proposed, and which has been accepted by a large majority of the men. The wages per day to be:

4s. 6d.	during the months of September, October, November.
5s.	" " " " December, January, February.
4s. 6d.	" " " " March, April, May.
4s.	" " " " June, July, August.

Mr. Alexander Macdonald, the miners' secretary, and president of the Miners' Association of Great Britain, boldly tells the men that it would be to their lasting dishonour to refuse to accept such terms if they were desirous of having an amicable arrangement. The terms apply to the miners of the other districts as well as to those in the "struck" and "locked-out" district. The mention of Mr. Macdonald reminds me that he is about to take a journey to America to make inquiries regarding the condition of the miner question out there, and that when he returns to this country he is not unlikely to show some ambition to become a member of Parliament. The "Lounge at the Clubs," writing in the *Illustrated Times* of last Saturday, regarding Mr. Macdonald, says: "For many years past there has been occasionally about the House a Mr. Macdonald, agent or representative of the working miners. I believe that he himself has been a miner; but however that may be, he is in some sort the agent of the miners, and, by his active and persevering advocacy, has done them good service in the way of shortening their time of labour, promoting education amongst them, and rescuing their young children, with or against their consent, from the dreadful slavery of the mines. I have often seen Mr. Macdonald, and have learned much about him from those who know more of him personally than I do; and I have long since come to look upon him as a clever, exceedingly shrewd, and clear-headed man, have thought that, if artisans should ever

have the power to send representatives to Parliament, he is the man whom the miners ought and would be very likely to send. Well, I learn that at the next general election he means to stand for some mining borough or district, and that it is very likely that he will be returned to Parliament. And I trust he will be. From what I know of Mr. Macdonald, I should say that he, if he should be returned, will prove no disgrace, but a credit to Parliament. Sheffield, though now so degraded, once had an Ebenezer Elliot working there; and who will say that he was not fit to represent his class?" If my testimony is of any value, I may say that the "Lounge" is not very wide of the truth in his characterisation of Mr. Macdonald. After leaving the pit, Mr. Macdonald became, what is called in Scotland, a *dominie*, the English of which is schoolmaster, and I know that many of the working miners hold him in the highest esteem for what he has done, both on behalf of themselves and of their children.

Rapid Ocean Steaming.—In my "Notes," the steamship *Cimbria* was mentioned some time ago as a Clyde-built vessel. She has just proved, by her voyage out to New York and back, that she is well worthy of the Clyde, as she has run the distance between that port and Cowes, en route to Hamburg in 9 days and 4 hours, a voyage that is hitherto unsurpassed. This is something like 7 days 22 hours between New York and Queenstown, and the performances of the fastest ships of the English line are thrown quite into the shade by it. The *Cimbria* was built at Greenock by Messrs. Caird and Company, who have built and engined all the Hamburg and American Packet Company's fleet, now numbering upwards of a dozen splendid vessels. Her sister ship, the *Hammonia*, cannot come up to the *Cimbria* in speed.

ROAD LOCOMOTIVE RACING.—On Monday morning, the 26th instant, in accordance with previous arrangement, two road steam-carriages, one made by Mr. Isaac W. Boulton, of Ashton-under-Lyne, having only one 4½ in. cylinder, 9 in. stroke, the other made by Messrs. Daniel Adamson and Co., of Newton Moor, having two cylinders 6 in. diameter, 10 in. stroke, started from Ashton-under-Lyne, at 4.30 A.M., for the show-ground at Old Trafford, a distance over eight miles. The larger engine, made by Messrs. Adamson and Co., is a very well constructed engine, and had a good quarter of a mile start of the smaller engine. The little one, with five passengers upon it, passed the other in the first mile, and kept a good lead of it all the way, arriving at Old Trafford under the hour (having to go steady through Manchester). The engine made by Mr. Boulton made the first four miles in sixteen minutes. The running of both engines is considered very good. On arrival at Old Trafford, they tested their turning qualities, and both engines turned complete circles of 27 ft. diameter both to right and left frequently.

THE FIRST STEAM WHISTLE.—So far as is known, the first steam whistle was made by a workman at Dowlais about 1832, and fitted to one of the boilers there as an alarm when the water fell short. Mr. Menclaus gives us the workman's name as Adrian Stephens. In 1833 a workman employed at Sharp, Roberts, and Co.'s, at Manchester, was sent down to Dowlais, to put up some shafting, and brought back with him a hand sketch and section of the whistle. This was shown to Mr. Fyfe then the locomotive superintendent of the Liverpool and Manchester Railway, who very shortly afterwards adopted it for his engines. The workman who brought the sketch from Dowlais was named Thomas Turner, and was a few years ago (and may be yet) employed at Messrs. Beyer, Peacock, and Co.'s locomotive works at Gorton, near Manchester. Mr. Beyer, some years ago, gave a tracing of the original sketch to Mr. Colburn who was visiting the works, and the last-named gentleman published it in *The Engineer*, December 20, 1861.

ICE MACHINES.—Texas papers assert that the various patent processes for preparing beef for northern markets, by canning, infiltration, &c., have practically failed. By manufacturing ice on the premises, the atmosphere of rooms in which the beef is packed for transportation may be kept so cool that the meat will not spoil during the operation. As the cattle are in the best condition for slaughtering during the warmest months of the year, the serious trouble heretofore has been that the beef spoiled before it took the salt, but the late introduction and use of ice machines has obviated this difficulty.

BELGIUM.—The administration of the State railways recently invited tenders for twenty locomotives. In consequence of the depressed state of Belgium mechanical industry, it was stipulated that the tenders should be confined to Belgian industrialists. The Seraing Company obtained twelve of these engines, and the Couillet Company eight; but the terms were very low. It is stated that in order to support, to some extent, the Belgian iron trade, orders will shortly be given out for a quantity of rails for the State lines.

AMERICAN CAST-IRON ORDNANCE.—The monitor's 15 in. gun used originally only 35 lb. of powder. Since the war, a charge of 100 lb. has been safely used; while at a trial of the 20 in. gun at Fort Hamilton, the charges were raised from 125 lb. of mammoth grain powder at the first shot, to 200 lb. at the fourth shot.—*Scientific American*.

AMERICAN "PROTECTION."—The mills are running at a loss in Lowell, Lawrence, and most of the other manufacturing towns in Massachusetts and throughout New England. The Manchester mills and print works have goods on hand unsold of the value of two millions of dollars. The same state of things exists with the Amoskeag Company.—*Scientific American*.

"WONDERFUL, IF TRUE."—The practicability of controlling the movements of balloons has long been the subject of anxious thought and numerous experiments, but, notwithstanding the many ingenious contrivances which have been attempted, the problem still remains unsolved. During recent wars we have seen balloons employed for reconnoitring purposes, and with great advantage, but as in all those cases free movement at the mercy of the winds would have been hazardous, the aerial machine retained a hold upon solid earth by means of rope and grapnel. It is, however, now stated that the object long sought in vain has at last been attained by a French mechanic, M. Daniel Dulau, of Bordeaux, who, after ten years of patient study, asserts that he has discovered a method of guiding a balloon by means of a very simple apparatus. As ballooning is now a part of military strategy as well as of popular amusement, it is to be hoped that some opportunity will be afforded of testing the merits of M. Dulau's discovery.—*Times*.