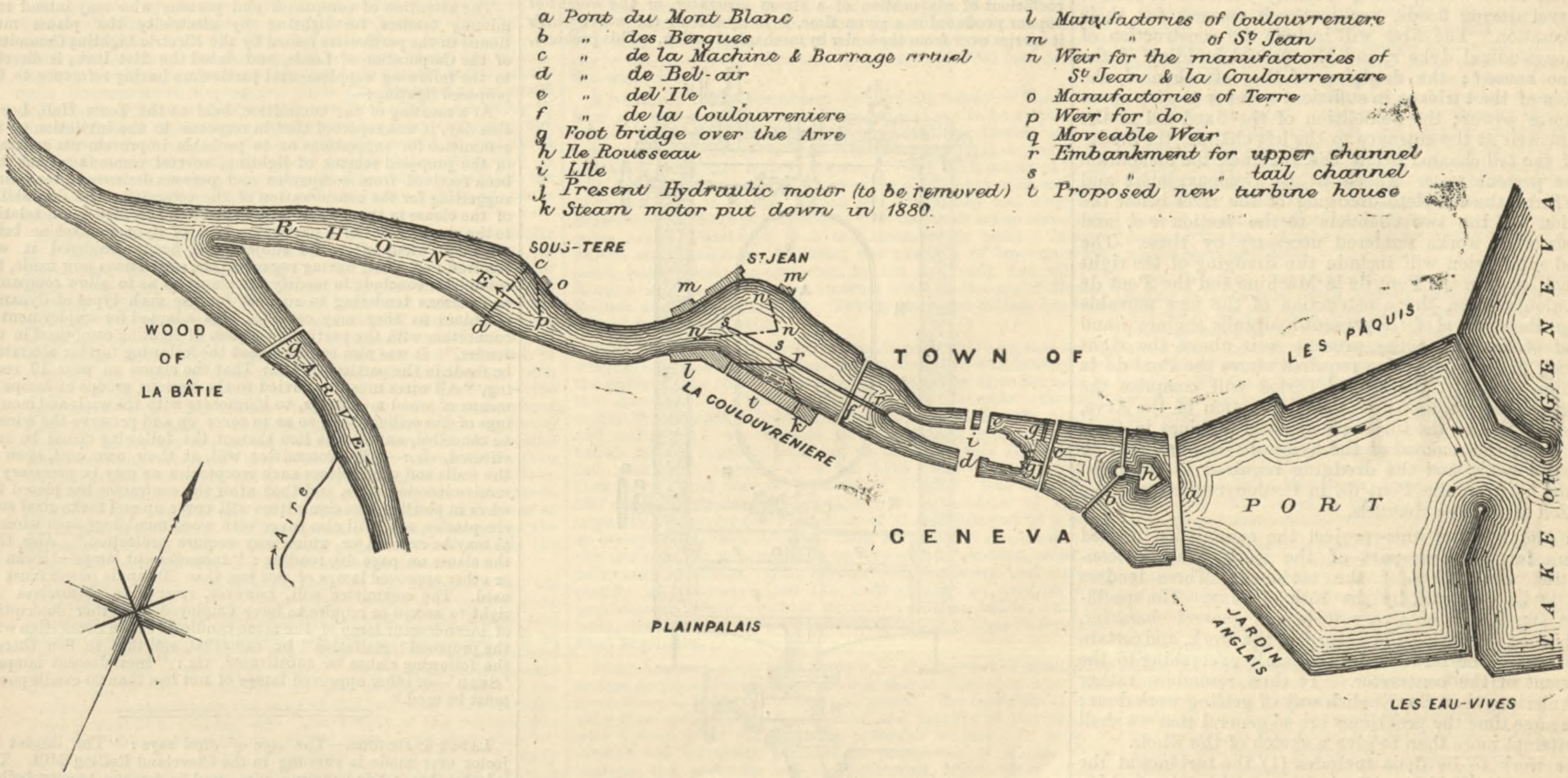
THE UTILISATION OF THE RHONE AT GENEVA.

IN our issue of 15th December, 1882, we sketched the history of the question of utilising the water power of the Rhone for the benefit of the town of Geneva. It will be remembered that the citizens, finding that on the one hand they were involved in a law-suit with the Canton Vaud for doing nothing, and on the other hand, that private speculators were proposing to do something without much consideration for their interests, insisted on their rulers taking the matter in their own hands; and that M. Legler, an eminent hydraulic engineer, was instructed to prepare a report to be referred to a commission appointed to deal with the whole question. This report, with a note upon it by M. Achard, one of the members of the commission, was published in September last, and our previous article contained some account of the measures recommended. Matters have now advanced much further. The commission have come to a definite conclusion as to the steps to be taken, have invited tenders for the construction of the works, and have published a second report, in which these works are specified. On this we propose to say a few words.

PROPOSED WORKS



M. Legler's first report proposed to divide the entire work to be done into three successive periods or stages. In the first period, A, the works would be commenced at the present weir—*c* on the annexed plan—which is situated at the Pont de la Machine, just above the well-known "Island" of Geneva. The first work would be to construct a movable weir—*g*—on the French system, cutting off the right hand of the two arms into which the Rhone is divided as it passes the Island. The sill of this weir would be at level *p n* — 4·50 m., or 4·50 m. below the Geneva datum, known as the Pierre à Niton. Both arms of the weir would then be regulated by dredging, so that their beds, starting from the above level at the site of the weir, would fall from thence with a regular slope of 0·13 per cent. From the lower end of the Isle a dyke *r* would be continued down the stream for some distance below the Pont de la Coulouvrenière, thus prolonging the actual separation between the two arms. Near the end of this dyke, but on the left or southern shore, a turbine-house would be constructed in part, together with a weir uniting it to the dyke, and some dredging would be done at the tail of this weir, to facilitate the getting away of the water. It was calculated that 50 cb.m. per second would be available in winter, 100 cb.m. in summer, and that a total power of 1300 to 1400-horse power would be realised.

In period B the tail channel below the turbines would be dredged to a depth of — 6·99 m., and the whole bed of the Rhone, from thence to the junction of the Arve, would be brought to a uniform slope of 0·108 per cent. This would lower the water level at the exhaust side of the turbines, and thus increase the available fall, whilst at the same time a larger quantity of water would be directed down the left-hand arm, and the turbines themselves would be increased in number. This, it was calculated, would give a gross power of 2600 to 2700-horse power.

In period C the tail channel would be still further deepened to the level – 9·70 m., and the river bed, thence to the junction of the Arve, dredged to a uniform fall of 0·0372 per cent. A further increase in the available fall would thus have been obtained. At the same time, the waters of the lake would have been kept back during the winter, when the supply is least, by stopping part at least of the turbines during each night, and thus enabling them to have a larger supply of water available during the day. By these two means the gross power available would have been 7000-horse power in winter and about the same in summer, when, although the fall is much less, the supply of water could have been raised to 350 cb.m. per second. This would, of course, entail a further enlargement of the turbine house and the supply of additional turbines. This proposed method of carrying out the works, while approved in general, was, however, criticised by M. Achard, the engineer member of the commission, as follows:—

(1) In period A there would be great liability to miscalculation as to the supply of water, especially in wet seasons, such as those of 1877 or 1879; and it would be necessary, therefore, to give a very small slope to the surface in the left-hand or commercial channel, and therefore to dredge the bed at the entrance of this channel below the proposed level of – 4·50 m.

(2) The right-hand or discharge channel has already a depth such that very little dredging would bring its bed lower than the level proposed above, thereby increasing its capacity.

(3) The inflow of the Arve necessarily banked up the water above so far as to render useless the great lowering of the bed between the confluence and the turbine house, proposed by M. Legler for period C.

M. Legler, while declining to recognise the first of these points as important, admitted the justice of the other two; and in a supplementary report he proposed the following modifications:—(*a*) The depth of the discharge channel to be increased by one metre—starting from – 5·50 instead of – 4·50 m.—but the sill of the new weir to be still at the – 4·50 m. level, so that it would have an abrupt fall of one metre below it. (*b*) To diminish by one metre the depth to which the tail channel would be dredged in period C, the slope remaining as before.

Being asked to report again on this amended scheme, M. Achard still insisted on the necessity of giving greater depth to the left or industrial channel, and of reducing the slope of its bed. He showed that 6000-horse power was all that it could be hoped regularly to utilise, and that this would necessitate a maximum supply for the left channel of 267 cm. per second, at the time when the available fall is least. He therefore proposed to fix the level of the bed at the entrance to the left channel, at – 4·90 m. instead of – 4·50 m., and the slope from them at 0·05 per cent. instead of 0·13 per cent., and showed that these data, combined with those laid down by M. Legler for the right arm, would give much improved results, both as to amount of discharge and uniformity in the power available. At the same time they would enable a change to be made in the method proposed by M. Legler for regulating the level of the lake; this could be kept at its maximum (– 1·20 m.) during the greater part of the time when the movable weir is not completely closed, and would escape altogether the condition most unfavourable for motive power, viz., where the level of the lake is near its minimum (– 1·80 m.), and yet the weir is not completely closed, allowing a part of the water to escape down the right, or unprofitable branch of the river.

After a conference with M. Legler, the commission decided on adopting M. Achard's views, giving the bed of the left branch a level of – 4·90 m. at the entrance, a slope of 0·10 per cent. along the Island, and 0·01 per cent. from the lower end of the Island to the turbines. At the same time the proper division of the work into periods was further discussed, and a new method sketched out which has since been elaborated. There will now be two periods only, of which the first is to be in two subdivisions. During the first subdivision would be executed the works which require no consent from the Canton de Vaud, or the owners of property upon the lake; while the second would comprise those which, being specially destined to control the level during floods, require such consent for their authorisation. The first will include the construction of the longitudinal dyke *r*, and the partial building of the turbine house *t*; the dredging of the left channel, the erection of the turbines in sufficient number to give about 800-horse power; the demolition of the fixed sill of the present weir at the entrance to the left channel, the dredging of the tail channel below the turbines, the demolition of the present water wheels at La Coulouvrenière and Sans-Terre, the complete dredging of the river below the junction of the two channels to the section *c d*, and various other works rendered necessary by these. The second subdivision will include the dredging of the right channel between the Pont de la Machine and the Pont de la Coulouvrenière, the construction of the new movable weir *g*, the removal of the present hydraulic engines *j* and *k*, and of the sill of the present weir above the right channel, and the dredging required above the Pont de la Machine. Finally, the second period will comprise the dredging from section *c d* to the junction of the Arve, the completion of the turbine house and turbines in their final form, the removal of the hydraulic engines, &c., on the right bank, and the dredging required in the right channel between the Pont de la Coulouvrenière and the junction of the two channels.

On the basis of this project the commission invited tenders for the first part of the work, viz., the construction and fixing of the turbines. These tenders were to be deposited by the 15th of May. The specification supplied is of a very wide and general character, and beyond indicating the nature of the work, and certain conditions to be fulfilled, leaves nearly everything to the judgment of the contractor. It thus resembles rather the American than the English way of getting work done; at the same time the provisions are so general that we shall not attempt more than to give a sketch of the whole.

The work to be done includes (1) the turbines at the Coulouvrenière Bridge; (2) shafting within the turbine houses and shafting or wire ropes outside to transmit the power from the turbines to the various manufactories; (3) sluices for discharge. The two latter may be made a separate contract if the Ministry wish. The left branch of the Rhone, which forms the channel of access to the turbines, will be prolonged from the Island downwards by an earthen or masonry embankment; in any case, the part between the end of La Halle and the Coulouvrenière Bridge is to be cut in stone.

The turbine house is to be built at the level of the Place des Volantines, and is either to be founded on land upon the Quai de la Poste, or, should the acquisition of the land prove too costly, then be built in the river. The contractor is to give a design for each of these. The turbines must be so arranged as ultimately to transmit power in the simplest manner to the existing manufactories on the right bank, to those on the left bank at Creux de St. Jean, to the works at Sans-Terre and to works which may be hereafter built at the junction of the Rhone and Arve. The turbines must be arranged with a view to future extension without stoppage of the existing works. There must be sluices for carrying off the excess of water during the first period when all the turbines are not in operation. M. Legler proposes to place these sluices in the longitudinal embankment, but the Ministry reserve the right of adopting another plan. The kind of turbine to be employed is left to the contractor; but he must give a full description of it, with advantages and disadvantages, and indicate the places where such are already at work. Each turbine must have a movable distributor, so as to regulate the supply of water according to the variations in level.

The following works for transmitting the power must be separately considered:—(1) Force pumps worked direct by cranks; (2) force pumps worked from a slow-running horizontal shaft; (3) electric machines worked by a quick-running horizontal shaft; (4) tele-dynamic or wire rope transmission to the various manufactories.

Several different projects may be presented both for turbines and transmissions, so as to utilise the available water power at its various levels, a table of which is given. The contract must include the supply and fixing of the turbines, transmitting apparatus, and sluices, with all necessary tools, appliances, &c., for their working. The bearings of the shafts must be fitted with lubricators such as do not require oil above once in twenty-four hours; and the couplings must be in halves, so that they may be uncoupled without disturbing the shaft. A commission nominated by the Ministry will examine the tenders, plans, specifications, and projects—and will award three prizes of £100, £60, and £40 respectively.

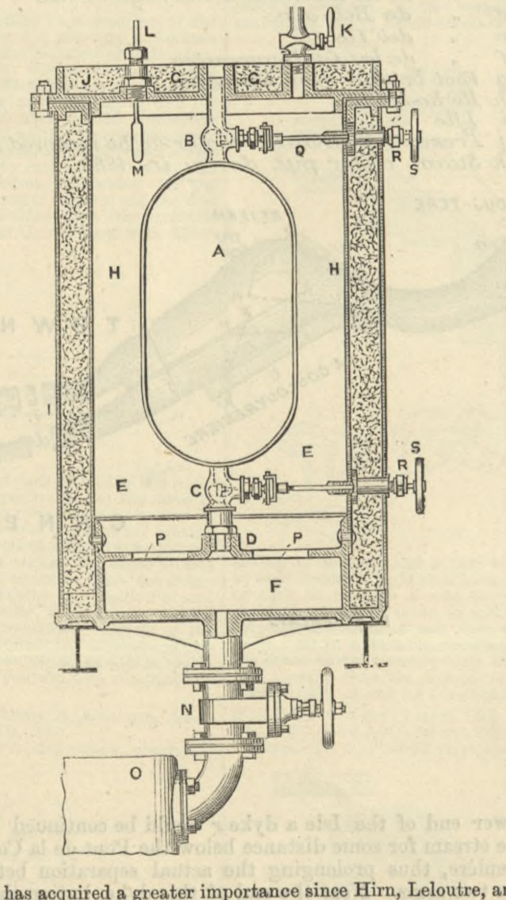
The sluices are to be ready four months after the acceptance of the tender, and when the buildings are ready for the contractor he must complete one-third of the turbines and transmitting apparatus within four months, two-thirds within seven months, and the whole within nine months, under penalties of £1 per day for the first fortnight, £2 for the second, and so on. All materials must be of the best materials and workmanship, and must not vary more than 5 per cent. from the weight estimated. When each third part of the work is completed it will be examined by a board of three experts, who will determine experiment (1) The power given off at the turbine shaft, as measured by the brake; (2) the volume of water expended, as measured by gauging the discharge with a Woltmann current meter; (3) the fall as measured by levelling above and below.

The contractor will be responsible for the working for two years after completion, and will have to replace any defective pieces. The turbines may be rejected entirely, if their efficiency falls below 62 per cent. The contractor is liable for all losses occasioned by accident, &c., during the progress of the works.

MEASUREMENT OF WATER MECHANICALLY SUSPENDED IN STEAM.*

By Palamede Guzzi, C.E.

The greatest difficulty which is encountered in determining the coefficient of evaporation of a steam generator, or the weight of vapour produced in a given time, is in measuring the water which it carries over from the boiler by mechanical action. This problem,



which has acquired a greater importance since Hirn, Leloutre, and Hallauer, by their overthrow of the old theories of the steam engine, have opened the way to the true theory, is not yet completely solved. The only solution of real importance among the many which have been hitherto attempted, is the one suggested by Hirn, and followed by the distinguished experimenters of the Industrial Society of Mulhouse, and others. Even this leaves some uncertainty, so that the Mechanical Committee of that society has recently renewed its offer of a reward for a better method. Hirn's plan consists in measuring the total heat of a given weight of steam, and comparing it with that which would be found in dry saturated steam, as given by Regnault's formula. His apparatus consists simply of a coiled tube, surrounded by water. But there is some indeterminate portion of the energy of the steam, which is so transformed as to be incapable of measurement. The vibrations generated by the flow of steam, in the coil, and in the surrounding water and air, as well as in the boiler itself, represent a transformation of heat into mechanical energy. A part is manifested in the form of sound, and is lost; only a small fraction of the remaining portion can reappear in a greater elevation of the temperature of the water. Moreover, during the flow of steam and its condensation in the coil, recent experiments have shown that there is a conversion of thermal into electric energy. It is true that Regnault's experiments were made under similar conditions; but for that very reason there is a greater need of other means of experimenting for purposes of comparison or confirmation. I have devised an apparatus, consisting mainly of a vessel which is filled with the steam of which it is desired to measure the humidity, and which is protected, as much as possible, against radiation and consequent internal condensation. Its capacity, and the weight of the vapour contained in it, being known, it is easy to ascertain the amount of dissolved or suspended water. This recipient, marked *a* in the accompanying diagram, is made of copper, in the form of a cylinder with hemispherical ends. It has an upper valve *b*, and a lower valve *c*, which is fastened by the screw *d* to the bottom of the chamber *e*. This chamber, which serves as the envelope of the recipient *a*, is formed of the double bottom *f* and the cover *g*, which are both of cast iron, and the cylindrical sheet iron wall *h*. The sides and top are protected by non-conducting materials enclosed in the external envelopes *i*, *j*, which are made of polished brass. The covering receives the pipe leading to the valve *b*, and contains the stop-cock *k*, as well as the stuffing-box *l*, through which passes the stem of the thermometer *m*. The double bottom *f* is put in communication, by means of the receiving valve *n*, with the steam-dome *o*; by means of the openings *p* with the chamber *e*; and, when desired, with the interior of the recipient *a*. The valves *b* and *c* are worked by means of the hand wheels *s* and the spindles *q*, which traverse the stuffing-boxes *r*. In order to diminish as much as possible the transmission of heat from *b* and *c* to *s*, the spindles are made hollow and pierced with holes, so as to increase the surface of contact with the steam of the envelope *e*, while the heat-conducting sections are diminished. In experimenting, the air is driven from *e* by opening *k* and *m*; *k* is then closed, and after some time *b* and *c* are opened. After the air is driven from *a*, *b* is closed. After some seconds, when the equilibrium of pressure is established, *c* and *n* are closed; the cover *g* is lifted, and the spindles *q* being withdrawn, the recipient *a* is removed to be weighed. The total weight, less the weight of the receptacle, gives the weight of the mixture of water and steam; deducting the weight of an equal volume of dry saturated steam at the same temperature, we obtain the quantity of water dissolved in the steam. Care is needed in determining the tare of the vessel *a*. To take account of the vapour which is condensed upon the inner walls of the vessel and adheres to them, it will be well to experiment with a generator from which no other vapour has been withdrawn, and which has not been heated for some time. Subtracting from the weight of *a*, thus filled with vapour, that of an equal volume of dry saturated vapour at the same temperature, we get the weight of the empty vessel, but internally bathed; this is the tare. The apparatus could also be applied to the determination of the density of dry saturated vapours, under high pressures, for comparison with the results of Fairbairn and Tait,†, and to find the values of *r*, in the formula of Clausius, $A\,P\,u = \dfrac{r\,P}{T\dfrac{d\,P}{d\,T}}$, for comparison with those obtained by Regnault.

* Abridged from a communication to the Milan College of Engineers and Architects, January 21st, 1877.

† *P. Mag.* (4), lxii., 230.

ELECTRIC LIGHTING IN LEEDS.

In our last impression we published the specification issued by the Corporation of Leeds for electric lighting. The following supplemental particulars relating to the proposed lighting by electricity of portions of the municipal buildings at Leeds for the Corporation have just been issued:—

The attention of companies and persons who may intend submitting tenders for lighting by electricity the places mentioned in the particulars issued by the Electric Lighting Committee of the Corporation of Leeds, and dated the 21st inst., is directed to the following supplemental particulars having reference to the proposed lighting:—

At a meeting of the committee, held at the Town Hall, Leeds, this day, it was reported that in response to the invitation of the committee for suggestions as to probable improvements generally in the proposed scheme of lighting, several communications had been received from companies and persons desirous of tendering, suggesting for the consideration of the committee the desirability of the clause in the particulars issued on the 21st inst., relating to the employment of a particular type of dynamo-machine being modified, when after the subject had been considered it was resolved:—"That, having regard to the suggestions now made, the committee conclude to modify the clause so as to allow companies and persons tendering to suggest for use such types of dynamo-machines as they may consider best adapted for employment in connection with the particular system of lighting comprised in the tender." It was also resolved that the following further alteration be made in the particulars viz.: That the clause on page 10 reading, "All wires must be carried to the various groups of lamps by means of wood mouldings, to harmonise with the walls and mouldings of the ceilings, &c., so as to cover up and preserve the wires," be cancelled, and that in lieu thereof the following clause be substituted, viz.:—"The committee will, at their own cost, open in the walls and other places such receptacles as may be necessary to receive interior wires, and that after the contractor has placed the wires in position, the committee will cover up and make good such receptacles, and will also cover with wood mouldings such wires as as may be exposed or which may require protection." Also, that the clause on page 10, reading: "Incandescent lamps—'Swan'—or other approved lamps of not less than 20-candle power must be used. The committee will, however, reserve to themselves the right to accept or require to have employed any other description of incandescent lamp of the same candle-power in connection with the proposed installation" be cancelled, and in lieu thereof the following clause be substituted, viz.: "Incandescent lamps—'Swan'—or other approved lamps of not less than 20-candle power must be used."

Large Injectors.—The *Age of Steel* says: "The largest injector ever made is running in the Cleveland Rolling Mill. The injector has a 5in. suction pipe, and is feeding twenty boilers located in various parts of the mill, one battery of boilers being 600ft. away from the injector. The steamboat Pilgrim has, says the *Mechanical Engineer*, four double-tube Korting injectors, each one capable of supplying 6000 gallons per hour, and they are believed to be the largest ever made for actual use. Each injector is 14in. long, and has 3in. pipe connections. The injectors in the Cleveland Rolling Mill have a 5in. suction to avoid friction in so long a pipe, but the direct connection to the injector itself is only 2in. We have this from a reliable party."

RAILWAY MATTERS.

THE National Exhibition of Railway Appliances was opened in Chicago on the 24th inst. The largest engine exhibited is one made in Patterson, New Jersey, for the South Pacific Railroad. It weighs 65 tons, and is 60ft. long, has eight driving wheels and two sets of cylinders, steam chests, &c.

IT is reported that the railway administrations taking part in the Dresden Conference—that is to say, the Belgian State, the Dutch State, the Berlin and Hamburg, and the Berlin, Hamburg, and Cologne—have agreed upon the points raised, and that the new tariffs will come into operation in a week or two.

WHEN, either from a depression of the track or from some other cause it is found that a foundation on the New York Elevated Railway has settled, a trestle work is immediately placed beside the column and the track lifted two inches by the aid of jacks. In this position it is allowed to remain for twenty-four hours, in order to test the strength of the false work. At the end of that time the foundation is uncovered, and a new one laid if necessary.

A FEW years ago a strong party favoured the purchase of the French railway system by the State; and a vast new system was laid out which it was intended that the Government should construct; the method of working the new lines was left to be decided in the future. The work on these new lines has been costly so far; a great deal has been begun and very little completed. It has been proposed that the new roads shall be parcelled out among the six great companies, by special contracts, and be constructed and worked by them.

THE Attock Railway Bridge was, a *Times* message from Calcutta says, formally opened on the Queen's birthday. A resolution published in the Government *Gazette* states that the Governor-General desires to record his satisfaction at the masterly and expeditious manner in which this important engineering work has been brought to completion. Thanks are given to Mr. Molesworth, the designer, and to all the officers employed on the works since the commencement of the surveys under Mr. Lee Smith, in 1865. The history of the Northern Punjab State Railway is reviewed at length; and the decision in favour of the broad gauge is described as having been amply vindicated by the late Afghan war.

THE Canadian Pacific Company has entered into arrangements with certain Canadian railroads by which it secures uninterrupted communication with Montreal. This, the *Colonies and India* says, will be a great boon to the maritime provinces, from which many thousands are flocking this spring to the North-West. A large subsidy will probably be granted to an American company to construct an "air line" connecting Montreal to Cape Breton Island. Thus in a few years the whole of this vast dominion will be a network of trunk railways; districts so wide apart as British Columbia, Hudson's Bay, and Newfoundland—now the remote outposts of civilisation—will be brought within easy distance of each other.

THE accidents which occurred in March on the United States railways, as recorded by the *Railroad Gazette*, are classed as to their nature and causes as follows:—Collisions: Rear collisions, 36; butting collisions, 8; crossing collisions, 3; total, 47. Derailments: Broken rails, 11; broken switch-rod, 1; broken bridge, 1; spreading of rails, 8; broken wheel, 7; broken axle, 4; broken truck, 3; land-slide, 1; snow, 1; accidental obstruction, 4; cattle on track, 1; misplaced switch, 10; unexplained, 32; total, 84. Boiler explosions, 2; broken connecting rods, 5; broken draw-bar not causing derailment, 1; broken wheel not causing derailment, 1; cars burned while running, 2. Total, 142. No less than nine collisions resulted from the breaking of freight trains in two.

THE Oxted and Groomsbridge Railway, which has been passed by the Examiners, is an extension from Croydon to Dulwich, by which the Chatham and Dover Railway will take its traffic to Holborn Viaduct, Ludgate-hill, Moorgate-street, King's-cross, and Victoria. The London, Chatham, and Dover Company has hitherto been excluded from the whole of the territory embraced by the counties of Surrey and Sussex, including Eastbourne, Hastings, Newhaven, Brighton, Shoreham, Worthing, and Bognor. The Company will by means of the new line obtain a position at Tunbridge Wells, the heart of that territory, and in addition secure access to Croydon, with its population of nearly 80,000, and the rapidly-growing suburban districts between Croydon and Dulwich. The new line forms a new route from Ludgate-hill and Holborn, Moorgate-street and King's-cross, where none now exists exclusively belonging to the Company.

THE foreign press has been devoting attention to the scheme of a city railway for Paris, the construction of which has doubtless been suggested by the success which has attended a like project at Berlin. Preliminary steps have been taken towards obtaining the necessary powers from the French Legislature. According to the plans now drawn up, the railway will be in two parts, one extending from the Lyons terminus to the Arc de Triomphe, and the other from Montmartre to Montrouge. It is also proposed to construct ten subsidiary lines, uniting at the new Post-office. According to the calculations of the commission which has been examining the project, the two main portions of the line would be completed within three years of the necessary powers being obtained. A low scale of fares is projected, and the scheme includes the utilisation of existing omnibus and tramway routes in correspondence with the new railway system.

IN a report to the Board of Trade on the explosion of the boiler of a tank locomotive at Summerlee Ironworks, Coatbridge, in March last, Mr. J. Ramsay says:—The locomotive was made for Messrs. the Summerlee Iron Company by Mr. Andrew Barclay, engineer, Kilmarnock, in October, 1869, and was, therefore, upwards of thirteen years old. The inside of the barrel plating is reduced by corrosion to about ¼in. thick, and over the whole of the surface of the plates that can be seen there is a great deal of pitting; but grooving along the inner edge of a longitudinal seam of the barrel—in the vicinity of the fore left-hand wheel of the locomotive—which has reduced the plate at that part to about 1/16in. mean thickness, is undoubtedly the cause of the explosion. Grooved plates are not by any means as strong as thin sound plates of equal thickness, and even if they were as strong they cannot sustain with safety the enormous working stress of 35,000lb. per square inch of cross-plate section, which was about the stress on the grooved part of the plate when the steam pressure was at 112lb. per square inch. It is, therefore, not surprising that the explosion occurred. Mr. T. W. Traill adds: It is evident that the boiler was worn out and the inspection inadequate.

THE constructive ironwork required in the extensions at the New-street railway station, Birmingham, which is to render it the largest in the world, is being steadily executed by the Bridge and Roofing Company, of Darlaston. In the new roof there will be ninety-two principals ranging from 67ft. down to 59ft. span, and curved to a rise of 20ft. in the centre. The nuts and bolts needed will weigh 700 tons. The firm are just now casting some of the enormous columns which will support this roof, and a few days ago I was present at a running out. The height of the column was 26ft., with a diameter of 1ft. 8in. of 1¼in. metal, with a base plate 3ft. square, the whole weighing, when finished, some 4 tons. Already the firm have made upwards of twenty such, and their manufacture may be considered quite an engineering feat, since they are cast in a pit—not horizontally. An unusual method, considering the size of the work, is also adopted in adding the ornamentation of the pillars; it consists in the moulding being struck up in the mould by a strickler. Such are the preparations necessary for the founding, that the casting boxes weigh with their charge of sand 30 tons, and the joints are planed. Some of the columns which the firm have yet to cast will be 29ft. 6in. high, 1ft. 10in. diameter, 1¼in. thickness of metal, and will weigh nearly 5 tons. When erected, they will be imbedded 4ft. in the concrete, and in addition to supporting the roof they will serve as down-spouts.

NOTES AND MEMORANDA.

ACCORDING to the last annual report of her Majesty's Inspectors of Explosives laid before Parliament there were in Great Britain at the end of the year 1881:—Factories, 86; magazines, 317; stores, 2045; registered premises, 15,669. Total, 18,117.

A MONTHLY report is now being published on the illuminating power of the Bolton gas. The illuminating power in standard sperm candles last month was 18·6; there were present 23·79 grains of sulphur in 100 cubic feet of gas, and 0·52 grain of ammonia in the same measurement. No sulphuretted hydrogen.

THE American Iron and Steel Association reports that the American manufacture of pig iron last year was 5,178,122 tons, being an increase of 11 per cent. over that of the previous year. The steel manufacture was 1,945,095 tons, also showing a small increase. The manufacture of rails was 1,688,794 tons, showing a small decrease.

THE number of miles of streets which contain mains constantly charged, and upon which hydrants for fire purposes could at once be fixed, in each district of the metropolis, is now as follows:—Kent, 85 miles; New River, 214; East London, 120; Southwark and Vauxhall, 119; West Middlesex, 88½; Grand Junction 48¾; Lambeth, 136¾; Chelsea, 68; making a total length of 880 miles.

AT a recent meeting of the Meteorological Society a note on "Atmospheric Pressure during the Fall of Rain," by A. Sowerby Wallis, F.M.S., was read. It related particularly to condition of atmospheric pressure while rain was falling during 1882. Out of a total of 136 rainy days—which were available for his purpose—on 54 per cent. the rain was accompanied by diminishing pressure; on 27 per cent. by increasing pressure; and on 19 per cent. by steady pressure.

THE sulphate of copper process of rendering wood uninflammable is open to the objection that if the wood splits the damp enters by the cracks and destroys it. A new process consists in injecting the timber with water in which soap is dissolved with the addition of a small proportion of sulphuric acid. The soapy water forms in the substance of the wood a fatty acid, which impregnates all the fibres and thus prevents, it is said, the damp from penetrating into the pores.

THE Port of London over sea trade for the week ending May 19th was:—Vessels entered in, 197; tonnage, 117,631; steamers entered in, 118; tonnage, 20,433; vessels entered out, 117; tonnage, 75,659; steamers entered out, 86; tonnage, 57,330; cargo vessels cleared out, 105; tonnage, 60,809; number of cargo steamers cleared out, 73; tonnage, 45,352; total, British vessels cleared out, 74; tonnage, 45,821; British steamers cleared out, 55; tonnage, 35,476; British sailers cleared out, 19; tonnage, 10,345.

HERR F. SCHELL, of Grund, has described some observations, recently made in the course of mining work in the Hartz Mountains, on the distance through which sounds are transmitted in rock. In a horizontal direction the firing of shots at the face of a cross-cut has been heard in a cross-cut driven toward it, the face of which was 447ft. distant from it. A level was driven on a vein at a depth of 538ft. below the surface, and happened to strike 187ft. distant in a horizontal direction below a stamp mill dropping stamps weighing 330lb. The dropping of the stamps on the surface could be distinctly heard in the heading below, which, in a direct line, the hypothenuse of a right-angled triangle, was separated by 571ft. of rock.

THE following method of making paper from wood and straw has been patented in the States by Mr. G. Archbold. Wood or straw, cut into small pieces, is macerated for twelve hours with dilute milk of lime, the mass is then placed in a digester and saturated therein with sulphurous acid under a pressure of four to five atmospheres. Within the space of one or two hours the structure of the straw or wood becomes so loosened that after the mass has been washed out it only requires further treatment with an aqueous solution containing 3 per cent. of calcium chloride and ½ per cent. of aluminium sulphate under pressure to bring it to the external appearance of cotton, and in this state, after washing out the salts, it may be at once worked up for the finest sorts of paper. The operation from beginning to end requires but 3 hours.

M. BOUSSINGAULT has recently presented to the French Academy a communication on the matter diffused or suspended in the air at great elevations. He has examined samples of the rain and snow which fell on the Alps from 1859 to 1865, and has found nitric acid varying from 0 to 0·66 mgs. per litre of water examined. The sample containing the largest amount of nitric acid also contained 0·3 mgs. of ammonia. He intends soon to compare the electrical condition of the northern and southern hemispheres, which condition probably affects the amount of nitrogen compounds present in the air and even in the soil. The writer also, says the *Journal of the Society of Chemical Industry*, notes the fact that hailstorms may occur in very elevated mountain regions, he having experienced one in the province of Riobamba at a height of 5900 metres above the sea level.

A DISPATCH from Greensburg, Pa., 3rd ult, says:—"The Lyons Run gas well recently developed has turned out to be a wonderful affair. The roar of the escaping gas is something terrific, and the amount of gas going to waste is enormous. It is estimated 6,000,000 cubic feet is daily wasted. The well is conceded by all who have seen it to exceed in power the old Murraysville well and the new wells of Messrs. Bolton and Doubleday and Pugh and Emerson's, all three put together. The new well is two and a-half miles nearer Pittsburgh than the Murraysville wells. Messrs. Bolton and Doubleday, imitating the example of boys on a fish pond, have bought an acre close by the new well, and will put down a well in the hope of securing some of the gas of Messrs. Brunot and Haymaker's well. Twenty thousand dollars has been offered for the new well."

THE behaviour of thirteen inorganic and twelve organic bodies when heated in a vacuum, their sublimations and distillations, and the nature of the residues, have been described by Herr Schueler in the *Annalen der Physik*. Many of the elements examined, especially selenium, tellurium, cadmium, zinc, magnesium, arsenic, and antimony, were capable of sublimation, while the very fusible metals, bismuth, lead, and tin distilled with difficulty, the last mentioned scarcely at a red heat. On the other hand, Demarcay found bismuth volatile at 292 deg., lead and tin at 360 deg., which Schueler explains by the presence of volatile impurities. During the whole time of the distillation of a metal an escape of gas was observed. But on repeated evaporation this phenomenon was imperceptible, or very slight. Sodium, selenium, tellurium, cadmium, zinc, arsenic, and antimony evaporate so readily in a vacuum that this method may be used for their purification. Many unstable mixtures, such as tallow, wax, and resin, distil so easily in a vacuum that they may thus be separated from impurities.

SOME kinds of white glass become, in the process of time, more or less deeply coloured under the influence of luminous rays. The most common tints are violet and green. The materials of ordinary glass are somewhat ferruginous and capable of tinging glass with a deep green shade by the protoxide of iron. In order to remove the colouring, peroxide of manganese is added, which changes the protoxide into a sesqui-oxide, which gives a feeble reddish-yellow tint. It is almost impossible to observe the proper proportions of manganese and iron. If there is too much oxide of manganese the glass has at first a violet shade; if there is too much protoxide of iron the glass will be greenish; if all the manganese is reduced to a state of protoxide the glass is colourless. The influence of light and air may gradually bring about a partial oxidation of the protoxide of manganese and a violet colouring which increases with time. The *Chronique Industrielle* says a shade which is due to an excess of manganese is observed in the Pinacothek, at Munich, where the upper windows of the picture gallery give a very marked violet light which produces a bad effect.

MISCELLANEA.

MESSRS. J. E. AND S. SPENCER, of Queen-street-place, Cannon-street, E.C., have been awarded a medal at the Gas and Electric Exhibition recently held at the Crystal Palace, for their exhibit consisting of all kinds of tubes and fittings, varying from ⅛in. to 15in. in diameter.

THE executive committee have decided, as soon as the necessary arrangements can be made, to open the fish market to the public from an entrance in the Exhibition-road, at a charge of 2d., between the hours of eight and eleven in the morning and from five to seven in the evening.

THE Press Association learns that the Commissioners of Irish Lighthouses have intimated to the Board of Trade their withdrawal from the committee on illuminants for lighthouses, on the ground that the proceedings of the committee have been unfair and prejudicial to the interests of the mariner. This committee is the same from which Professor Tyndall recently retired.

THE number of visitors to the Fisheries Exhibition on Saturday last was 19,114; last week the number was 132,949, while the total number of persons who have visited it since the opening is 219,984. Upwards of 21,000 catalogues have been already sold, and over 30,000 of the other official publications, which, as well as the catalogues, can only be obtained within the Exhibition buildings.

THE steamer Britannic, of the White Star Line, which left Queenstown on Friday for New York, put back on Monday evening. Her mails and some cabin passengers will be forwarded by the same company's steamer Republic, which leaves Queenstown on Tuesday. The Britannic reports that on Sunday, 600 miles west of Fastnet, a flaw was discovered in the crank shaft, and it was deemed advisable to return to Liverpool for repairs.

THE Liverpool Chamber of Commerce met on Monday, when a letter was read from the Postmaster-General, stating that the question of extending underground wires, which had already been considerably developed, had been the subject of serious consideration, and the Department was using its best endeavours to gradually increase the number. At the same time underground wires were as liable to disturbance from electrical causes as overground wires.

AN important question has arisen as to the sliding-scale in the Cannock Chase coalfield. The employers contend that the men should submit to a reduction of 1¼d. per stint, which would leave wages at 2s. 4½d. per stint; but the men argue that the net average selling price of coal not having fallen to 6s. 1d. per ton—for it is 6s. 2·92d.—they are still entitled to the 2s. 5¾d. which they have been receiving since September. The question has been submitted to arbitration, but the arbitrators have been unable to agree. Alderman T. Avery, of Birmingham, was asked to act as umpire, but has declined; and Mr. Alfred Young, barrister, will now be asked.

THE secret of the Keely motor is out at last. The *American Register* says that:—"In an outburst of confidence Mr. Keely has given the whole thing away in the following terse language: 'Molecular disintegration is the primary generator of vibratory phenomena. Propulsory forces emanating from analytical action upon compound fluid and vapour foundation evolve ethereal matter distinctive from oxydised, hydrogenated and nitrogenated compounds.' How supremely simple it is, now that we know it! Strange that somebody should not have made this discovery years and years ago."

A CORRESPONDENT from Christchurch, N.Z., writes:—"Colonial or native industries are springing up everywhere, such as flax and linseed, paper from native straw and flax, rope and string—for binding—barbed wire, frozen meat, cheese and butter, not to mention the excellent woollen factories, which turn out far superior material to the English-imported article. In less than twenty years' time we shall be quite self-supporting at the rate we are going at now. The meat-freezing industry is giving a fresh impetus to sheep feeding—for carcases as well as wool are marketable now—which in its turn will cause more demand for machinery."

ON Friday last, before the Select Committee of the House of Commons on the Manchester Ship Canal Bill, Mr. Daniel Adamson was recalled, and further cross-examined by Mr. Pope, Q.C., on behalf of all the petitioners. In answer to the questions addressed to him, the witness said he had based his calculations upon the supposition that the freight rates would be the same to Manchester as to Liverpool. Should events prove that to be a fallacy, the calculations would be in error to the amount of the inaccuracy in the assumption. This is an important point, for if the ships do not spend the extra day or two in getting to Manchester gratuitously, the profit derivable from the canal will be missing.

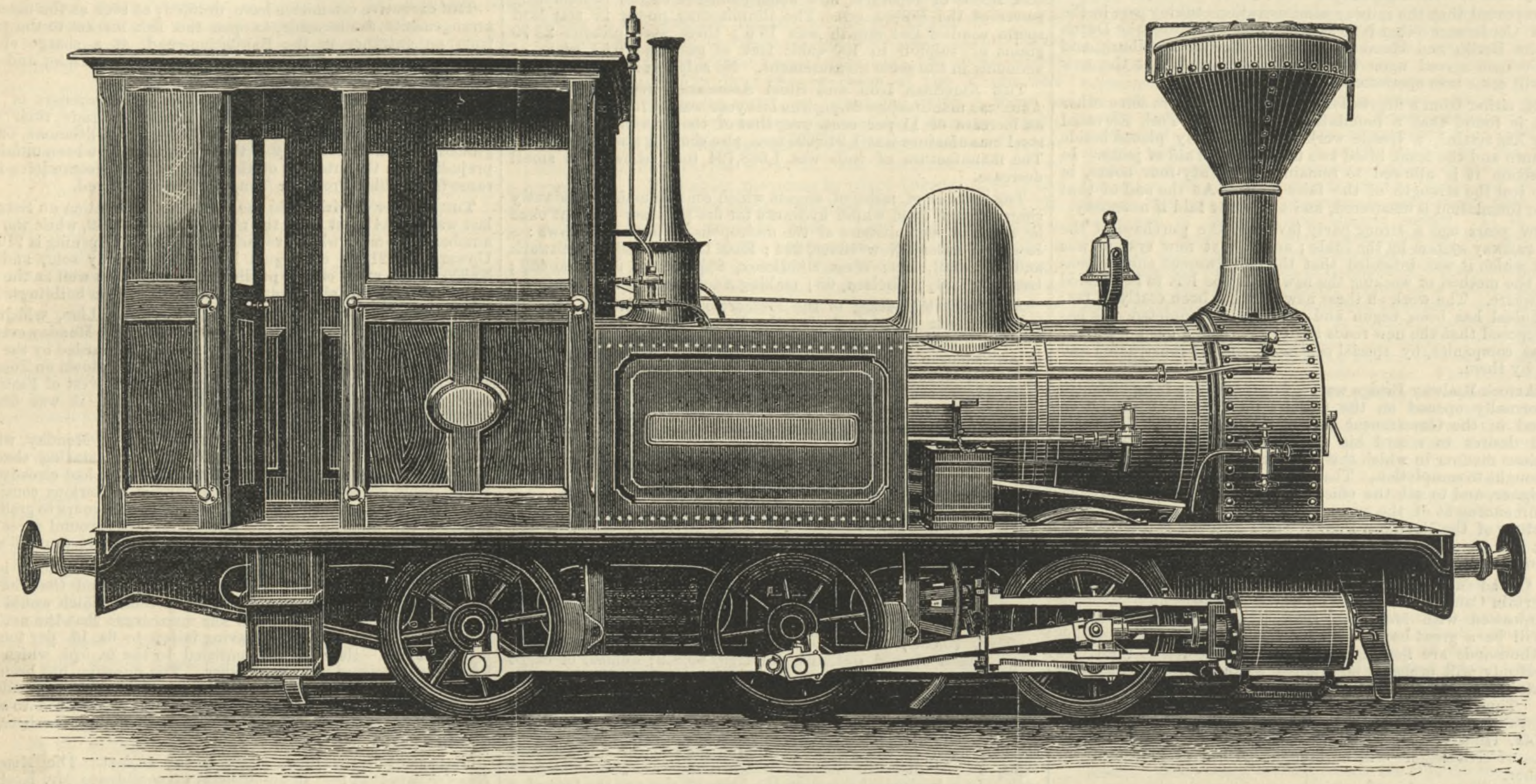
A SURVEY of the extensive landslip which recently occurred at Warden, in the Isle of Sheppey, shows that fully three acres of land have sunk from their natural level some 70ft. down. Had not Warden Church been pulled down three or four years ago, it would inevitably have formed part of the slip. As it is, the entire churchyard has been carried away, and is now located about half-way down the cliff. Although each decade shows a greatly diminished acreage in the Island of Sheppey, no attempt is made to construct works to resist the inroads of the sea; it is not worth it. Within living memory the lane now abruptly cut off once ran on for nearly half a mile, where now the tide covers the foreshore. Beyond the church was a coastguard station, and some 10 or 15 acres of land, all of which have fallen a prey to the encroachments of the sea. A landslip of such magnitude as the present has seldom been recorded.

ON Saturday, the 26th May, the Cuhona, a fine steam and sailing yacht, owned by Sir Andrew Barclay Walker, of Liverpool, was taken on her trial trip to Withernsea, where she attained a mean speed of eleven knots, the average of four runs on the measured mile, the engines indicating 450 indicated horse-power. The dimensions are as follows, viz.: Length, 157ft.; breadth, 26ft. 2in.; depth, 16ft. 6in.; tonnage, yacht measurement, 466. This fine craft was built and engined by the Earles Shipbuilding and Engineering Company, Limited, Hull, from the designs and under the superintendence of Mr. St. Clark Byrne, M.I.N.A., Liverpool. The cabins and state-rooms are fitted up most superbly, with carved oak and various other woods, to the designs of Messrs. Ernest George and Peto, architects, London, and are very elaborately decorated. The vessel is lighted throughout by Mr. Crompton, with Swan incandescent electric lamps.

AN American contemporary thus describes a piece of tunnel work which baffled the excavators from the same cause as that which gave so much trouble in the St. Gothard:—"The phenomena of a tunnel so filling itself up as to resist all efforts to open it is reported from Virginia, Nevada. In Castle District, at a point about five miles north of that city, is a tunnel that may be called an ex-tunnel. It was run about four years ago into the side of a steep hill, and was originally about 40ft. in length. When in about 15ft., the tunnel cut into a soft, swelling clay, very difficult to manage. After timbering and striving against the queer, spongy material until it had been penetrated some 25ft., the miners gave up the fight, as they found it a losing game. Being left to its own devices, the tunnel proceeded to repair damages. It very plainly showed that it resented the whole business, as its first move was to push out all the timbers and dump them down the hill. It did not stop at that, but projected from the mouth of the tunnel a pith or stopper of clay the full size of the excavation. This came out horizontally some 8ft., as though to look about and see what had become of the miners, when it broke off and rolled down the slope. In this way it has been going on until there are hundreds of tons of clay at the foot of the hill. At first it required only about a week for a plug to come out and break off, then a month, and so on, till now the masses are ejected but three or four times a year; yet the motion continues, and to-day the tunnel has the better of the fight by about 4ft."

TANK LOCOMOTIVE, NEWFOUNDLAND RAILWAY.

MESSRS. WILSON AND BROMLEY, WESTMINSTER, ENGINEERS.



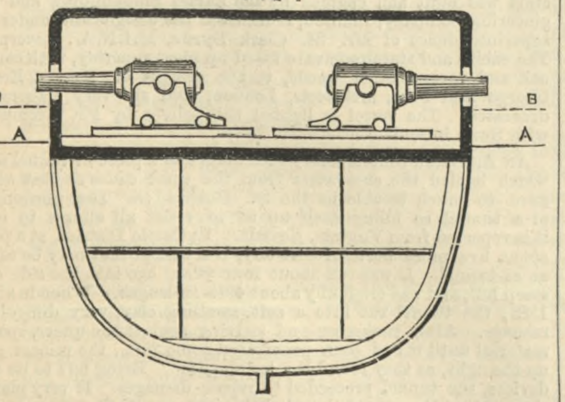
WE illustrate above a small engine supplied to the Newfoundland Railway by Messrs. Wilson and Bromley, Westminster-chambers. The engine is used for laying rails, inspecting the line, and drawing light trains. It has, we understand, given complete satisfaction. The following statement gives the principal particulars :—

Diameter of cylinders, 8in.
Stroke, 12in.
Diameter of wheels, six-coupled, first and third pair flanged, middle pair plain, 2ft 6in.
Weight in working order, about 10 tons.
Working pressure per square inch, 150 lb.
Two side tanks to contain each 100 gallons.
Steam dome on centre of boiler barrel.
Bell in front of steam dome.
Safety valves—a pair of Wilson-Klotz duplex, 2in. diameter, on top of fire-box, with funnel to top of cab.
Brake to each wheel, worked by a screw from the foot-plate, with all the brake blocks on the same sides of the wheels. Brackets for head lights.
Cab of teak, American style, with two sliding windows, one at each side, and two windows in front and two in back, with a seat across the engine.
Chimney, spark arresting, American style.
Buffers, two, side, at each end, of wrought iron.
Draw gear, American link coupling.
Two sand-boxes placed between first and second pair of wheels.
Boiler of mild steel, fire-box of ditto, tubes of iron.
Wheels of cast iron, open spoked.
Buffer beams of teak.
Axles of Bessemer steel, slide bars of ditto, with cast iron slide blocks.
Connecting and coupling rods of wrought iron, all fitted with brasses, and with keys to tighten up.
Piston and rings of cast iron.
Motion work of best wrought iron, thoroughly case-hardened.
One injector, one brass feed pump, ash-pan.
All boiler and other mountings complete as usual in the best locomotive engine work.
Regulator and steam pipes of cast iron.

SIR EDWARD REED'S IRONCLAD SHIPS.

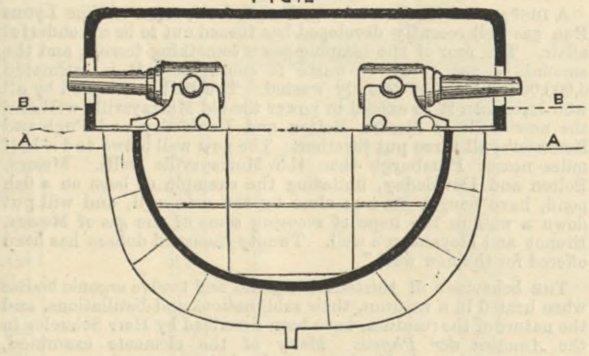
THE *Times* of Monday contains a long article descriptive of a new type of man-of-war, for which Sir Edward Reed has obtained provisional protection. We have commented elsewhere on this invention. No drawings have, of course, been made public as yet, but we have prepared the accompanying sketches to aid our readers in forming an idea of the nature of Sir E. J. Reed's proposals. It will be seen that they agree with the following description taken from our daily contemporary; A A may be taken to represent the normal water-line, B B the immersed load line. In no ship with an armour belt only has there

FIG 1



been protected depth sufficient to shelter effectually the engines and boilers, and, if there had been, the ordinary forms and proportions of ships would not have admitted of so great an elevation of weight as would have been involved in lifting up the whole propelling steam machinery to within its protection. The question of stability has had to be carefully studied, therefore, in combination with that of security, and those who are familiar with the course of ironclad construction, and even those who have acquainted themselves with it only through our columns, will know that Sir Edward Reed is a strenuous—we had almost said the only strenuous—advocate of such an amount and such an extent of natural stability as will continue to sustain a ship afloat and in an approximately upright position, even after she has sustained very serious injury in action, both above and below water. It is not surprising, therefore, that we find in his new type of ironclad a combination of protection both for the machinery and the ship such as is nowhere else to be found. It is easy enough, it is well known, to give abundant stability by mere increase of breadth; but increase of breadth, speaking generally, means increase of many undesirable qualities, and among them of resistance to propulsion, and consequently to loss of speed. This difficulty is overcome in the new type of ironclad by throwing the increase of breadth mainly above the water-line, where it affects the speed only after the ship has in action sustained injury below, and undergone increased immersion—when a mere loss of some speed is a very small loss indeed, compared with loss of ordinary speed at sea, and still smaller, of course, by comparison with loss of buoyancy and stability, or, in a word, loss of existence altogether in battle. From the extreme breadth of the ship, placed, as we have said, above water, or from a somewhat lower point at the side, an armoured deck or reversed dome sweeps down and across the ship below water, cutting off all the steam machinery and magazines from under-water attack. The screw propeller shafts in some cases are, and in some cases are not, also comprised within the armoured hull; where they are not, they are driven by vertical engines, working down through stuffing boxes in the armoured bottom, the connecting rods being protected where necessary by vertical trunks or cylinders of armour. Below the armoured hull, and extending forward of it and abaft it, is constructed a light iron or steel hull,

FIG.2



of sufficient capacity to supply whatever additional buoyancy the armoured hull needs, and of such form as to be favourable for the speed required, however great. This light hull, which rises to the usual height of a ship above water at the ends, is subdivided into a very large number of cells or small compartments. Over the machinery and magazines extends from side to side, and usually much above water, a stout armoured deck, which may be nearly a horizontal plane as usual, or may sweep dome-like across the ship, forming a curved upper surface from which turrets or barbette batteries may spring according to the armament the ship is to carry.

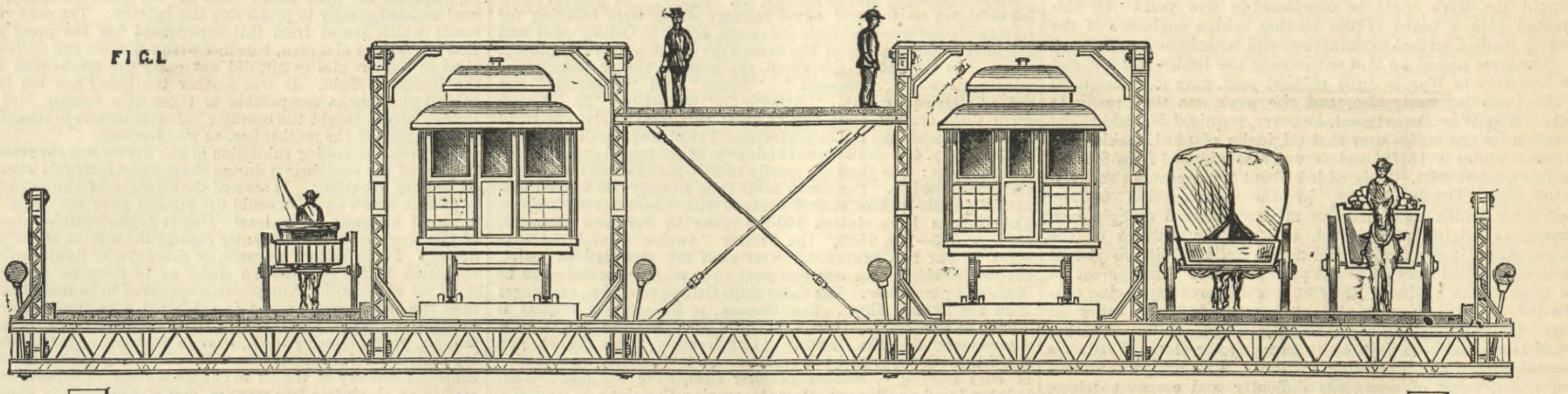
It will be seen from the above description that if we ignore all details—although some may be essentials of the new system—we may regard the new ironclad as a completely armoured hull, carrying all that is vital, surmounting an unarmoured cellular bottom, in which nothing delicate or explosive is carried, and which may undergo repeated torpedo attacks without any other loss than that of buoyancy, of which the upper armoured hull, from its form and proportions, has an ample reserve. Looking to the extreme violence of torpedo explosions at the point of contact, and to the rapidity of the dispersion of the explosive forces, Sir Edward Reed has provided in this new system against ever allowing the torpedo itself to come in contact with, or directly attack, the armoured bottom; the thin outer bottom acts, in fact, as an exterior and more or less distant defence for the true bottom of the ship, which is the armour-plated one. As regards the upper part of the ship, it will be seen that an old idea of Sir Edward's, as embodied in the Devastation and other of his "breastwork" ships, has been still more effectively realised in the new plan, because the whole width of the ship above water becomes an armoured breastwork, of greater breadth than the ship's water-line, instead of less, as in the breastwork type. As the light ends of the ship will ordinarily be carried up high above the water, and be formed as usual at the bow and stern, the new ironclad will not greatly differ in appearance from other armoured ships. We are glad to be able to add that while affording several increased elements of safety, some of them of the very first importance—viz., security against torpedoes and increased protected buoyancy and stability—the new plan tends to economy in ironclad construction and not to increased cost. It is true that it provides an armoured deck or dome under as well as above water, and this, of course, has to be paid for; but the deck armour is very much cheaper, weight for weight, than side armour—because of the great thickness and consequent expensiveness of the latter in manufacture—and the quantity of side armour requisite may, in many cases at least, be much reduced. In the designs which Sir Edward Reed has already in course of preparation—for foreign Governments, unhappily, as some will think—this reduction of side armour is a marked feature, and the protection against torpedoes will certainly be secured at no increase of cost as compared with other armoured vessels. There are minor features in the system tending to steadiness in a sea-way and to increase of speed, but these we must defer detailing until a future opportunity.

PROVISIONAL ORDERS FOR ELECTRIC LIGHTING.—We understand that Major Marindin, the officer appointed by the Board of Trade, has made his report on the inquiry, held at Westminster on the 10th May, and that as regards the St. Giles' district, a provisional order has been granted to the Pilsen-Joel and General Electric Light Company, Limited, by arrangement with the local authorities. The area to be lighted will be the south side of New Oxford-street and High Holborn from the centre line thereof, extending from Tottenham Court-road to Little Queen-street and the houses, premises, and buildings abutting thereon, and an area bounded on the north by the centre line of High Holborn from Little Queen-street to the boundary of the parish of St. Giles'-in-the-Fields, on the east by the said parish boundary line, and on the south by the houses on the north side of Lincoln's-inn-fields and the houses on the south side of Twyford's-buildings, and on the west by the houses on the west side of Little Queen-street. The Pilsen-Joel Company has already established a lighting station in that area, and has been for some time past successfully lighting large business establishments from that station. A special meeting of the Westminster Board of Works, who have opposed the introduction of electric lighting into their district, was held on Wednesday afternoon to consider their further course of action. Writing with reference to the opposition of the District Board and their refusal to appear at an inquiry officially instituted to consider the applications by companies for provisional orders applying to the Westminster district, the Board of Trade stated that they were extremely anxious to meet the views of the District Board, but the resolution of that Board placed them in great difficulty. The letter continued :—"That resolution appears directed not so much against the orders of the companies as against the policy adopted by Parliament in the Electric Lighting Act of last Session. The Board of Trade are perfectly ready to hear any objections of the District Board on the ground either that there are no consumers in the district who would wish to have the electric light if provided, or on the ground that the company are unable or unwilling to provide a proper supply or to submit to proper conditions. If, however, the District Board of Works should absolutely refuse to give the Board of Trade assistance, the Board will not feel justified under the Act of last Session in declining to proceed with the orders simply because the District Board without further reason refuse their assent to them; and it will be their duty in that case to obtain such imformation as may be in their power, and, if a *prima facie* case is proved, to settle an order or orders in the best manner they can and to lay them before Parliament." The Westminster District Board, after a warm debate on Wednesday, adopted the following resolution :—"That the Board of Trade be informed that this Board, on further consideration, do not see that the present requirements of the district justify them in negotiating with the promoters of provisional orders for supplying electricity in certain portions of the district, and that they think no orders are necessary at the present time, and that the Parliamentary Committee be, therefore, instructed to oppose the obtaining of any provisional orders referred to in Major Marindin's report, and further that the opinion of the parishioners upon the subject be tested by a public meeting to be convened upon the subject, when the question of availability of supplying electricity generally is more thoroughly tested."

THE BROOKLYN SUSPENSION BRIDGE.

MESSRS. JOHN A. ROEBLING AND WASHINGTON A. ROEBLING, ENGINEERS.

FIG.1.



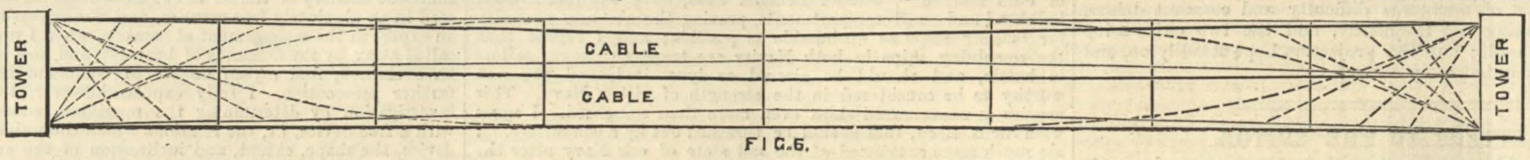


FIG.6.

THE Great East River Bridge, uniting New York and Brooklyn, was opened on Thursday, the 24th of May. One hundred thousand people, it is said, passed over it during the first twelve hours, which is not surprising. The people of New York and Brooklyn bear much the same relation to each other that those of Middlesex do to those of Surrey as far as London is concerned. If all communication had had to be carried on by ferry until the 24th of May, it may be imagined that considerable interest would be taken in the opening of a bridge across the Thames.

We give this week some views of the bridge modified from engravings which have appeared in the *Scientific American* and *Harper's Monthly Magazine.* We need hardly say that the bridge is on the suspension principle, and it towers up over the river, so as not to interfere with navigation. It is a double bridge, in the sense that it can be used for both road and railway traffic, as shown by the cross section Fig. 1. The cars will be drawn across by an endless rope from the J. A. Roebling Company's Wire Works, Trenton, N.J. It is 1½in. in diameter, 11,700ft. long, and weighs 19 tons. It is accompanied by a duplicate rope of the same weight and strength, which is to be held in reserve for use when the first rope wears out. The bridge has been thirteen years in building, and has cost about £3,000,000. The two towers are each 274ft. high and 1595½ft. apart. The length of the bridge between the anchorages of the cables is 3500ft., and between the termini 5989ft. There are four cables, shown in section in Fig. 2, each having a solid section of nearly 145 square inches, and containing 1,732,086 lb. of wire, with an estimated strength of 75 tons to the square inch, so that the four cables represent 6,928,346 lb. of wire and 43,500 tons of strength. It is 88ft. wide and 135ft. clear above the water in the centre of the span. The principal particulars are as follows:

Construction commenced January 2nd, 1870.
Size of New York caisson, 172ft. by 102ft.
Size of Brooklyn caisson, 168ft. by 102ft.
Timber and iron in caisson, 5253 cubic yards.
Concrete in well holes, chambers, &c., 5669 cubic feet.
Weight of New York caisson, about 7000 tons.
Weight of concrete filling, 8000 tons.
New York tower contains 46,945 cubic yards masonry.
Brooklyn tower contains 38,214 cubic yards masonry.
Length of river span, 1595ft. 6in.
Length of each land span, 930ft., total 1860ft.
Length of Brooklyn approach, 971ft.
Length of New York approach, 1562ft. 6in.
Total length of bridge, 5989ft.
Width of bridge, 85ft.
Number of cables, 4.
Diameter of each cable, 15¾in.
First wire was run out May 29th, 1877.
Cable making really commenced, June 11th, 1877.
Length of each single wire in cables, 3578ft. 6in.
Ultimate strength of each cable, 12,200 tons.
Weight of wire, 12ft. per lb.
Each cable contains 5282 parallel—not twisted—galvanised steel, oil-coated wires, closely wrapped to a solid cylinder 15¾in. in diameter.
Depth of tower foundation below high water, Brooklyn, 45ft.
Depth of tower foundation below high water, New York, 78ft.
Size of towers at high water line, 140ft. by 59ft.
Size of towers at roof course, 136ft. by 53ft.
Total height of towers above high water, 278ft.
Clear height of bridge in centre of river span above high water, at 90 deg. Fah., 135ft.
Height of floor at towers above high water, 119ft. 3in.
Grade of roadway, 3¼ft. in 100ft.
Height of towers above roadway, 159ft.
Size of anchorages at base, 129ft. by 119ft.
Size of anchorages at top, 117ft. by 104ft.
Height of anchorages, 89ft. front, 85ft. rear.
Weight of each anchor plate, 23 tons.

The stations at the ends of the bridge are to be elaborate structures of glass and iron. The one on the New York side is to be 260ft. long and 59ft. wide, with a platform on the bridge end 70ft. long. The cars will pass through the station, and are shifted from one track to the other on switches between the station and end of the approach.

The foundations of the bridge had to be put in in caissons, fitted with air locks, the New York tower being built up from the bed rock 80ft. below the surface of the water, and the Brooklyn Tower from the clay 45½ft. below the surface. The Brooklyn caisson was got ready in May, 1870, and the work completed in March, 1871, a fire which necessitated flooding the caisson delaying operations for two months. The New York caisson was towed into place in October, 1871, and sunk in position in May, 1872. Engineer Roebling was the first victim of his great work, having crushed his foot and died of lockjaw in 1869. His son, Washington A. Roebling, has continued the work, although his personal presence has not been possible since he got caisson disease, from which he has not recovered. The "caisson disease" is the result of living under atmospheric pressure greatly above that to which the human system is normally adapted. The blood is driven in from the exterior and soft parts of the body to the central organs, especially the brain and spinal cord. On emerging into the open air, violent neuralgic pains and sometimes paralysis follow. Advanced consumption is, on the other hand, stayed, and sometimes remedied, by compressed air. Dr. Andrew H. Smith, surgeon to the Bridge Company reported 110 cases of the "caisson disease," of which three were presently, and probably more finally, fatal. At 118ft. above high-water mark each tower is divided into three sub-towers by two avenues each 31½ft. wide. These rise 120½ft. further, above which the full towers are elevated 30ft., with the saddle, Fig. 3, that supports the bridge cables resting upon them. In May, 1875, the Brooklyn tower was finished, and in July, 1876, the New York tower. The bridge floor is 118ft. above high-water mark at the towers and 135ft. in the centre of span. It is shown as it appeared in course of construction by Fig. 4 and Fig. 5. Fig. 8 shows the expansion joint, as we may term it. The framework consists essentially of two systems of girders at right angles to each other. The principal cross-beams or girders supporting the floor proper are light trusses 33in. deep, placed 7ft. 6in. apart, and to these are attached the four steel rope suspenders from the cables. Half-way between these principal floor beams are lighter ones, to give additional support to the planking. To unite these cross-beams together, and to give the proper amount of stiffness and strength to the floor, there are six parallel trusses extending along the entire length of the bridge. The floor beams are further united together by small longitudinal trusses extending from one to the other, which, together with a complete system of diagonal braces or stays, form a longitudinal truss of 86ft. in breadth. It will be seen, thus, that this combination has immense strength, weight, and stiffness, laterally, vertically, and in every direction. To relieve the cables in some measure of this enormous burden, and at the same time effectually prevent any vertical oscillations in the bridge floor, there is a multitude of suspensory stays of steel wire ropes diverging from the tops of the towers to points about 15ft. apart along the bottom of four of the vertical trusses. These stays extend out for a distance of 400ft. from the towers, and are of themselves capable of sustaining unaided that portion of the roadway and its load in position. At the towers the girder-work is firmly anchored down, and again confined against the lifting or pushing force of the wind by a system of under-stays lying in the plane of the floor, so that no conceivable cause can ever disturb its rigid fixity of position and form. At and near the centre of the span, however, where these stays do not act so efficiently against any tendency to distortion, and to still further unite and stiffen the whole system, the two outside cables are drawn inward toward each other at the bottom of their curves. By this means each of them presents its weight in the form of an arch against an oblique pressure from below and the opposite side, and resists more or less in the same way any force from the like directions. The two inner cables at the same time are drawn apart at the bottom of their curves, thus approaching each its outside neighbour, and pairing with it, so as to combine their opposing arches against lateral forces from either direction. The weight of the whole suspended structure—central span, cables and all, is 6740 tons, and the maximum weight with which the bridge can be crowded by freely moving passengers, vehicles, and cars is estimated at 1380 tons, making a total weight borne by the cables and stays of 8120 tons, in the proportion of 6920 tons by the cables and 1190 tons by the stays. The stress—or length-wise pull—in the cables due to the load becomes about 11,700 tons, and their ultimate strength is probably 49,200 tons. Fig. 6 is a plan of the cable system.

FIG 7

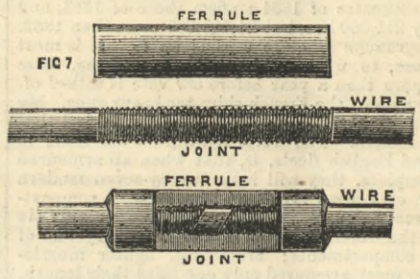


FIG.2a

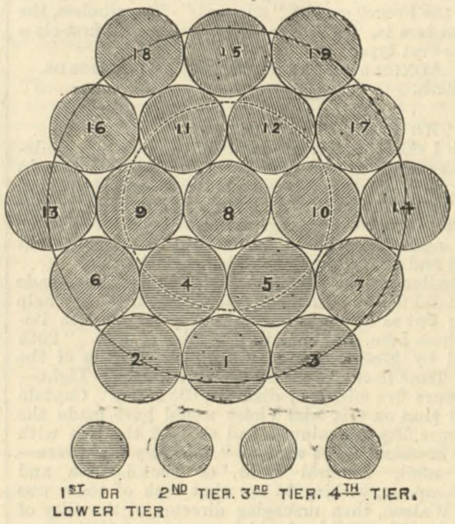
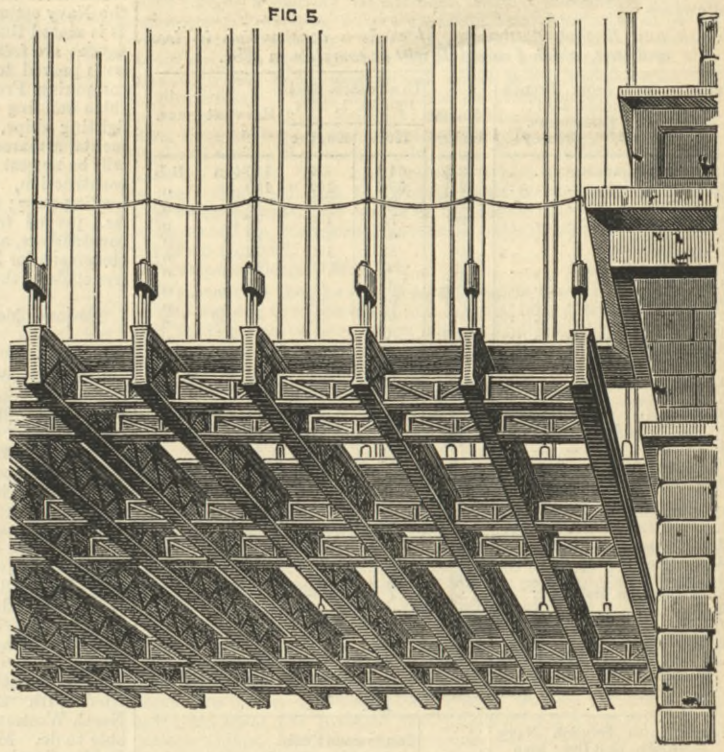


FIG 5



The anchorages of the cables are 930ft. from the towers on each side of the river—huge constructions of masonry weighing 60,000 tons each and covering a surface 119ft. by 132ft. The cables are composed of 5282 wires each, as stated above. They are arranged in ropes, each containing 278 single wires, and nineteen of these ropes in each cable, so that when bunched together the cable is nearly 16in. in diameter. These wires were carried back and forward between the anchorages and over the tower, each continuous wire having a length of almost exactly 1,000,000ft., or nearly 200 miles, in length, passing from anchorage to anchorage, back and forth, 278 times. The turns of the wire at each extremity of the skein pass around a solid block of iron shaped externally like a horseshoe, with a groove in its periphery, in which the bend or bight of the skein lies as a skein of yarn is held on one's thumbs for winding. Each shoe or eye-piece was fixed—after the strand was finished—between the ends of two anchor bars, a 7in. iron bolt passing through the three, and so connecting the strand with the great anchor chain at either end. After a skein was fully laid in position—passing, of course, over the tops of the towers—it was compressed to a cylindrical form at every point by large clamp tongs, and tightly bound with wire at intervals of about 15in. throughout its length. The lengths of wire are united by the steel coupling, Fig. 7. The work of stringing the wires began in June, 1877, and was completed in October, 1878. Once a bundle broke from the anchorage, darted across the tower, and fell into the river. The bridge is divided into five parallel avenues, the outer two, each 19ft. wide, being for vehicles, and the central one, an elevated road 15½ft. wide, for pedestrians. The other two avenues are for cars for passengers, There have been twenty persons killed on the works and over 100 cases of caisson disease occurred. The approaches on the New York side begin at Chatham-square, and on the Brooklyn side end at Sands and Washington-streets. It is the intention to permit foot passengers to cross free, to charge tolls to vehicles, and to hold the passenger car franchise for the benefit of the bridge at a charge of five cents apiece.

The New York correspondent of the *Times* states that Mr. William C. Kingsley and Mr. Henry C. Murphy, of Brooklyn, were the original projectors of this bridge. Mr. Kingsley conceived the project as early as 1865, selected the site, and hired an engineer to make a plan and estimates. Mr. Murphy was the president of the bridge trustees until last year, when he died, and Mr. Kingsley succeeded him. In 1867 the Bridge Company was chartered with 5,000,000 dols. nominal capital, 500,000 dols. being subscribed by prominent people, who organised the company and governed it until 1875, when the bridge was made a public work, and given in charge to the Board of Trustees. John A. Roebling was the engineer, and in 1867 made his plan and estimates, wherein the cost of the bridge proper was given at 7,000,000 dols. and the approaches 3,800,000 dols. He then thought the work could be completed in five years. Of this reported plan a board of the leading bridge engineers of the country made a critical examination, and unanimously approved it. Congress passed an Act authorising the bridge in 1869, and the Secretary of War, in June of that year, gave it his approval as not impeding navigation, and the work was then ready to begin. The War Department, however, required 5ft. additional elevation for the bridge over that originally planned, making the clearance under it 135ft., and it was also widened from 80ft. in the first plan to 85ft. This added about 8 per cent. to the estimated cost. Other changes, in the construction of the approaches, which are of massive masonry instead of light iron trusses, as originally projected, and the foundations of the towers, which it was found could not be built on piles, as at first intended, swelled the cost to the present figure. The approaches are magnificent viaducts, their supporting archways being constructed for utilisation as storehouses, 400,000 dols. being set apart for putting fronts and floors in them. Another 500,000 dols. has been devoted to carrying the elevated railways over the bridge and providing stations. The bridge construction was a work of enormous difficulty and constant delays, dissensions breaking out frequently, and the two cities being often at loggerheads; but the projectors kept steadily on, and ultimately surmounted every obstacle.

LETTERS TO THE EDITOR.

[*We do not hold ourselves responsible for the opinions of our correspondents.*]

ENGLISH AND FRENCH NAVIES.

SIR,—I shall be very much obliged if you will publish what follows:—

French and English Battleships, of modern construction in iron and steel, which I calculate will be complete in 1885.

Names, &c., from French Navy estimates, 1884; also other particulars. "Armament," Brassey.	Armour inches	To advance 100th by Jan. 1, 1884. Hull.	Engine.	Heaviest guns.	
1. Admiral Baudin	21½	64 2	70	100-ton	B.L.
2. Formidable	21½	58·5	100	100 ,,	,,
3. Caiman	20	80	100	72 ,,	,,
4. Indomptable	20	75	100	72 ,,	,,
5. Requin	20	·C	100	72 ,,	,,
6. Terrible	20	83	100	72 ,,	,,
7. Admiral Duperré	22	C	C	48 ,,	,,
8. Devastation	16·5	C	C	48 ,,	,,
9. Foudroyant	16·5	95	98	48 ,,	,,
10. Marçeau	18	55	50	48 ?59	,,
11. Vengeur	14	C	C	48 ,,	,,
12. Tonnant	18	C	C	48 ,,	,,
13. Fulminant	14	C	C	34 ,,	,,
14. Furieux	19	88	100	34 ,,	,,
15. Tonnère	14	C	C	34 ,,	,,
16. Tempête	13	C	C	34 ,,	,,
17. Redoubtable	14	C	C	20 ,,	,,
18. Vauban	10	100	100	14 ,,	,,
19. Duguesclin	10	84	100	14 ,,	,,
20. Friedland	9	C	C	20 ,,	,,
Building. Completion uncertain					
21. N Brênnus	18	7·70	—	?100 ,,	,,
22. Neptune	18	23	30	?100 ,,	,,
23. Magenta	18	15	20	48 ?59	,,
24. Hoche	18	31·7	50	48 ?59	,,
25. N Charles Martel	18	7·70	—	48 ?59	,,
26. N	18	—	—	48 ,,	,,
27. N	—	19	—	48 ,,	,,
8. Canonnières Cuirassés					

Seventeen other vessels are named in the French estimates, making a grand total of forty-four.

Names from English Navy estimates and list; also other particulars. "Armament," Brassey.	Armour inches.	To advance 100th by 31st Mar. 1884 Hull.	Heaviest guns.	
1. Inflexible	24	C	80-ton	M.L.
2. Collingwood	18	75	43 ,,	B.L.
3. Edinburgh	18	82	43 ,,	,,
4. Colossus	18	99	43 ,,	,,
5. Conqueror	12	To complete	43 ,,	,,
6. Agamemnon	18	C	38 ,,	M.L.
7. Ajax	18	C	38 ,,	,,
8. Thunderer*	14	C	38 ,,	,,
9. Dreadnought	14	C	38 ,,	,,
10. Neptune*	13	C	38 ,,	,,
11. Devastation*	14	C	35 ,,	,,
12. Monarch*	10	C	25 ,,	,,
13. Alexandra	12	C	25 ,,	,,
14. Temeraire	11	C	25 ,,	,,
15. Belleisle*	12	C	25 ,,	,,
16. Orion*	12	C	25 ,,	,,
17. Sultan*	9	C	18 ,,	,,
18. Superb*	12	C	18 ,,	,,
19. Hercules*	9	C	18 ,,	,,
Building. Completion uncertain				
20. Rodney	18	47	63 ,,	B L.
21. Anson	?	8	63 ,,	,,
22. Howe	18	27	63 ,,	,,
23. Camperdown	?	16	63 ,,	,,
24. Benbow, to advance to about tons	?	2147	100 ,,	,,
Cruisers.				
25. Imperieuse	10	80	18 ,,	,,
26. Warspite	10	66	18 ,,	,,

Nineteen other seaworthy vessels may be added, making a grand total of forty-five. By giving the progress in 100ths, facts are arrived at, and no room left for controversy. The French up to January 1st, 1884. The English March 31st, 1884. Engines not given in 100ths. Those marked * have large ship-sinking compartments, I fear, French, 0; English, 9. C stands for complete at present.

My view is that the French have twenty-seven and the English twenty-four fighting ships and two cruisers, as above, built and building. The others should never go into action. The compartments are so large that the sending them into battle is wilfully to endanger men's lives, and the armour is so thin as only to cause slaughter when struck by modern projectiles. The guns are all small—ours muzzle-loaders—unequal to meet the battle ships above; and the vessels themselves hardly safe as peace ships, remembering the Grösser Kurfürst, Vanguard, &c. Sir T. Brassey published the names, &c., of sixty-two armoured English ships and sixty-four French in his "British Navy," vol. i., pp. 550-4, 572-6. Ministers are reported to have stated—Navy debate, May 8th, 1883—"It was admitted that of late the French had made great efforts to strengthen their Navy, but their expenditure had remained almost stationary in the last three years." The increase has been—see French Navy Estimates, p. 1332—"Differences au Budget de 1883, en plus, francs 53,276,159"= £2,131,046 more than 1882. They are building three ironclads to our one by contract, and employ 23,000 dockyardmen to our 18,000. They also vote 2,977,610 francs to complete new ships in three years instead of six. Our Navy is so starved that we have no frigate squadron to exercise young officers and men, which they are also reported to advocate, and which is a great necessity. Again: "We are especially strong in first-class ironclads of the newest type." I can only find one such—Collingwood—and five building, the plan of Inflexible and Co. having been abandoned, with citadel, armoured turrets, guns mounted low, muzzle-loaders, &c., &c., to imitate the French, and "adopt" barbette, breech-loaders, &c. Again: "In general fighting efficiency no ships of equal tonnage which were building for foreign Navies were, in their judgment, equal to Collingwood and the later improvements of the same type which are now building, whether in respect of the speed, the armour, the protection, the buoyancy, or the armament." "Speed" and "buoyancy" are proved after equipment. "Armour"—"protection:" The French carry thick armour from end to end; ours, alas! only one-third the length, and thus fail in protection. The plan of the Collingwood in Brassey, p. 471, shows lower ends even of the funnel exposed. As to armament: Our guns are mostly muzzle-loaders; all the French are breech-loaders. See above table from Brassey; 38-ton, 35-ton, 25-ton muzzle-loaders cannot contend with 48-ton breech-loaders. The Italians have sixteen 100-ton guns to our two proposed, and—p. 316—"in 1885," the French "twelve"—total, twenty-eight to our two proposed. Our guns are mounted in pairs, the French single; so our two guns—out of four carried—can be disabled by one blow. The sister ships Collingwood, &c., are longer than the French ships. See Brassey, p. 316. Their longest is 328ft. to our 330ft., though in 1876 our scientific length was, Agamemnon and Co., 280ft. "Construction:" The French and English battle-ships and two cruisers—see table above—except nine of ours marked *, besides Leander class, have the fore-and-aft bulkhead and small compartments, proving the absolute necessity for making ships as unsinkable as possible; and I repeat that the remaining ships in both Navies are traps to drown sailors in battle, and should be altered or dynamited, and are not worthy to be considered in the strength of either Navy. This applies to unarmoured ships even more than armoured. I agree with Sir E. Reed, this should be thrashed out by a committee. I am much more convinced of the sad state of our Navy after the debate than I was before. Our last gaiter button is supposed to be ready. The French estimates of 1884 confirm those of 1883, and the whole vote is only £15,000 less, but £1,115,000 more than 1882. The shipbuilding programme is quite worked up to. It is most remarkable that France, to whom the Navy is as nothing, votes the Navy estimates more than a year before our vote is talked of. It is stated that I have given the French ships too heavy guns. My figures are from Brassey, vol. i. I shall be delighted to find that he is proved to be mistaken. The worst feature on our side, in comparing French and English fleets, is, that when all armoured ships building are complete, they will have twenty-seven modern fighting ships, really of newest type as to build, small compartments, armament, armour, &c., while of our twenty-four only six will be newest type—the others built on an abandoned system of construction, large compartments; armament, lighter muzzle-loading guns; armour, most armoured only one-third their length, &c.; proved to be obsolete by being abandoned by their own constructors, and the French system "adopted." Nevertheless, the statement for Ministers is, "We are especially strong in first-class ironclads of the newest type."

ADMIRAL OF THE FLEET, THOMAS SYMONDS.

Torquay, May 28th.

THE IRISH MAIL CONTRACT.

SIR,—Although I should prefer not to break through the regulation which you have made at the end of "Fair Play's" letter in your last number, that there shall be no more letters on this vexed subject, yet I am sure the usual justice of your paper will permit me a short space to defend myself against what I consider a gross attack, not only against myself—I do not care about that—but against the Violet and the company to which she belongs.

"Fair Play" challenges the dates, &c., on which Violet made quick passages. I did not give them, as I do not see that they help the matter at all; but as he seems to thinks they are of such importance, I give them here, and hope they will be of use. "20th July, 1880. Trial by Messrs. Laird and Captain Moodie of the Board of Trade. Time from Admiralty pier to Poolbeg Light—adverse tide—3 hours five minutes; distance, 65½ miles." Captain Moodie calculated that on this trial Violet would have made the passage in two hours fifty-five minutes had she had the tide with her. On another occasion Violet was—as "Fair Play" is aware—tried with the mail, Admiral Dent, of the London and North-Western Company, wishing to see what each of them was able to do. Mr. Watson, then managing director of the City of Dublin Company, had the mail boat which was to run that afternoon changed on purpose to have the quickest boat, Ulster, for the race, and did everything to ensure success as far as the mail was concerned. The two vessels started side by side at the breakwater light and ran for one hour, at the expiration of which Violet pulled up three miles ahead of the Ulster, and it took the latter ten minutes real hard driving to catch her up again. The Violet only had her ordinary crew and firemen; the Ulster had eight extra firemen, and we may therefore suppose she was run at her best, although beaten so ignominiously. This was in 1880, and about the same time the Lily and Violet were run full speed every trip to see what sort of passages they would make. Night after night they were in before the mail, until at length Mr. Watson sent a complaint to the railway company that the mail boats were hustled in the bay by Lily and Violet. To satisfy the City of Dublin Company, the express boats were ordered to keep their regular time, and not to be in before it; and to ensure this being done, Lily and Violet's furnaces were bricked up and their pressure considerably reduced. Under these conditions they have been running ever since until they were put on the recent trials, when they were restored to their regular trim; and they soon asserted their speed again after that was done. On the night of the 26th March last, after the bricks had been taken out, the Violet left the North Wall twenty minutes after the mail left Kingstown, and although handicapped by four miles, passed the mail in the bay, and came in first. This evidently is the beating "Fair Play" alludes to, as it occurred on the Monday which he speaks of. Only last Tuesday week the Violet on her ordinary morning passage from North Wall, without the least extra pressure more than she usually works with, made the passage in three hours twenty-eight minutes, and returning to Dublin at 2.15 next morning, made the Baily Light in three hours eight minutes from the breakwater, but met with a dense fog in Dublin Bay which obliged her to run dead slow to the river.

Surely these facts speak for themselves. I could go on for hours writing down her fast passages day after day. I shall not again trouble your columns on this subject, as I fail to find any who take interest in it, except to run down the Lily and Violet, which will always have the utmost support of J. G. B.

Dublin, May 26th.

THE PROBLEM OF FLIGHT.

SIR,—After abandoning the use of captive devices as not suited to determine the conditions of flight, I at once set about continuing the investigation by using a mechanism which should be free. In addition to the unsuitableness of captive devices, the further reason that experiments with a free apparatus would teach lessons valuable to the operator in artificial flight seemed conclusive, and after the use of a rudely-constructed effigy, I proposed to go on to one made with more care by skilled workmen, using the best procurable materials for the purpose.

The first experiment lasted about four months, during which time the device was made over repeatedly, the whole aim merging into an effort to preserve equilibrium. The device was fastened to the tops of trees and high posts, so as to have a free movement of 30ft. or 40ft. to the extent of the tether. As finally made, it consisted of a spread of wings of 39ft. by 6ft. in width, and weighed, with the operator, about 350 lb. It required more patience and endurance than I ever expect to bestow upon the matter again, to obtain any mastery over the mechanism in a brisk breeze, but I repeatedly stood against the breeze at the extremity of the tether as long as five minutes at a time, and at all points within the boundaries of its action for a few seconds or minutes, as the wind would blow steadily, or as I could succeed in keeping the device properly balanced. It would stand at the extremity of the rope against the wind better than in any other situation, as the cord assisted greatly in preserving the balance. The only valuable result which issued from this experiment was the proof it gave that the weight of a man, together with a nucleus and surface sufficient to support him in air, did not carry the mechanism beyond the limits of flight. It was neither too heavy nor too large to exhibit phenomena comparable to those of a soaring bird, while incidentally it taught the operator valuable lessons in regard to the management of the mechanism, as was foreseen.

The most interesting exhibition of the device was the astonishing delicacy of the equilibrium during those short intervals when it was on its good behaviour. It seemed that a state of things had come to pass in which a person could lift himself over the fence by the straps of his boots. The least—almost imperceptible—movement of the operator, would instantly change the motion of the floating device. It would dart upwards, or sideways, or downwards, upon a motion of the operator so slight as to seem no more than a mere act of the will. Any position appeared to be more favourable than the one it was in, and it exhibited a restless proclivity to change its place. I gathered a fund of experience from these tedious, yet interesting trials, enough to warrant me in constructing a more careful contrivance with which I expected to obtain a sufficient mastery of the air to cut loose from all support and proceed in an absolutely free manner, and was engaged in discovering an expert in the management of bamboo, when I was unexpectedly called away by the demands of business, and now after two years have elapsed, find myself unable to command the time for its further prosecution. I fully expect, however, to complete the investigation by determining the maximum conditions of flight with a free device, *i.e*, the relations which the weight of the whole device, the shape, extent, and inclination of the surface and the rate of motion should bear to each other, so as to be translated through still air with the greatest possible velocity. Such a device would, as I understand it, be a maximum device, one which would in action give the best results.

With such knowledge I expect man to construct a mechanism which will translate him through the air with a perfection which will reduce to insignificance the feats of the most perfect bird which ever existed. I do not expect man to excel a humming bird in weaving himself in and out of a gooseberry bush, nor a swallow in going up and down a house chimney on wings, but for all the purposes of air navigation which are valuable to a man, I expect him to obtain complete mastery. I expect him to outdo the birds as much as a steamship outdoes a whale.

The reason for that opinion I here give. The structure of birds has not been produced by the requirements of flight alone. Their surfaces are adapted to the conditions of their existence admirably, but other elements of necessity have determined the quality of their mechanism than the one of translation through air. To establish a perfect mechanism of flight the front line of the advancing surface should be a sharp edge, and no obstructing portion should be presented anywhere upon the under surface which could deflect the air from a free course to the rear edge. No bird is thus made. The front edges of their wings are blunt in every instance observed. The beak, head, and feet, all offer resistance, *i.e.*, they deflect the air from the course which produces flight, and hence cause retardation or friction, a loss of power which is not returned by the expanding air at the rear edge of the surface. For the purposes of artificial flight all this will be avoided. The wing surface will be made for air navigation, and for that alone. A man need not use his wings to steal a fish from a fish-hawk in mid air, nor go through those astonishing feats of lofty tumbling displayed by a man-of-war bird for amusement. He will obtain his subsistence as he does now, walking erect on the earth, and will use his wing surfaces when he wishes to travel the air, just as he now uses a boat when he wants to travel the water.

I do not look upon the various devices employed by myself in this investigation as having resulted in any definite lesson of value excepting the last—in some measure—mainly incidental. The sailing birds exhibited all the phenomena in a far more perfect manner than any artificially produced contrivance; and after the discovery of a theory which accounted for all the movements of those birds upon known mechanical methods I considered those movements explained; and, further, that artificial flight was entirely feasible. That the scientific world should be in such total ignorance of the performances of soaring birds seems to me little short of disgraceful, and the frenzied attempts to get into the air after the manner of a humming bird, while the whole family of the soaring kind exhibiting methods which might be imitated with ease, have received no attention, positively seems to lack the ordinary promptings of common sense. I. LANCASTER.

Chicago, Illinois, May 15th.

SIR,—Mr. Lancaster's letter, in your impression of May 18th, although interesting as showing the patience and perseverance he has brought to bear in his endeavour to account for the fact of certain birds sailing directly against the wind without any motion of their wings, nevertheless does not impress me as being a satisfactory explanation of the phenomenon. It may be I have misunderstood his latest experiment, the description of his apparatus being somewhat difficult to comprehend in the absence of diagrams; but I have an idea he may have mistaken the vibration of the iron rod, to which his plank was fixed, for direct horizontal force, since he does not appear to have had any instrument to measure the opposite thrust. I can more readily believe in the partial success of his effigies, sailing in free air, because to whatever unknown, perhaps accidental, circumstances may be attributed their movements in opposition to the current of air, he is able at least to speak of the actual fact without liability to error. The results of trials of moving air on flat surfaces at Penn's Works, to which he alludes, are very much what might have been expected. By the way, is not the direct action at 15 per cent. = 0·53 an error? Should it not be 0·33? When, however, he assumes, further on, that the vertical force may be something, while the horizontal force may be nothing, I am not able to follow him. It appears to me that when the horizontal force of the current becomes 0, the vertical force will also cease to exist.

I have the most implicit faith in Mr. Lancaster's description of the habits of those birds he has so long and carefully observed. That they can and do sail in opposition to an air current, without using muscular energy, is not open to doubt; and all other movements, including the circular and constantly rising one, are easily to be conceived upon the same hypothesis. To account for this singular anomaly is a much more difficult matter, and however cleverly manipulated may have been Mr. Lancaster's experiments, and however insufficiently I may have understood his descriptions, he will pardon my saying I think he has barely more than touched the fringe of the subject. I for one shall be glad to learn he is continuing his experiments, and still more to know he meets with a success he has so well merited. Will Mr. Lancaster permit me to suggest an experiment? Let us assume the direction of wind to be W. Now let us erect two poles in a line N and S, each about 50ft. high. Let a line pass from the top of one to the other, and from that line let there be suspended by a cord 25ft. long the effigy of the bird to be experimented upon. The bird will be 25ft. from the ground, and the poles will be too far off to cause any deflection of the wind. Then from the tail of the bird a fine silken cord could be carried far to the rear, and, passing over a pulley on a pole 25ft. high, could be fixed to any apparatus for measuring the forward thrust. A similar cord might be carried to a very thin pole far in advance of the bird, and so serve equally to indicate the tendency of the effigy to move to the rear. Now, as to the most important feature of the effigy. It should be of the exact size, shape, and weight of the bird it represents; indeed, the skin of the bird itself, stuffed to its living weight, would be the best of all models; but failing that, I do not think it would be difficult to have one constructed of artificial materials. By two or three steel wires passed through the body of the bird and across the wings these latter could be adjusted to various positions until they fulfilled the conditions required. The tail should be similarly treated for varying the position. By such an apparatus I believe it would be quite possible for the first part of the inquiry to be successfully pursued, and the discovery made as to what divergence of the currents of air by the wings has the effect of urging the body of the bird forward.

It suggests itself to me that the wings of the bird may very likely divert the air from its normal course until it represents the two sides of an angle, of which the apex is the hind part of the body of the bird. If that be the case, there would be two currents of air coming into collision at the apex, the result of which would be a considerable pressure upon the body of the bird at this point urging it forward with a force hardly expected.

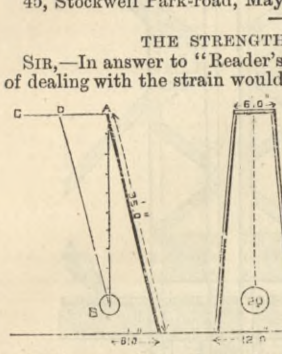
A very important circumstance not to be lost sight of is the smoothness of feathers in one direction only. Passing the finger along a feather from the root to the tip, it will be easily understood how little resistance a current of air will meet from friction in that direction; but pass the finger from tip to root, and it will be found there is every impediment to a current of air through frictional resistance. Depend upon it, nature has not supplied this feature without some perfect purpose. Its application to the above theory is self-evident.

W. DAVEY BENNETT.

45, Stockwell Park-road, May 26th.

THE STRENGTH OF SHEAR LEGS.

SIR,—In answer to "Reader's" query, I think the simplest mode of dealing with the strain would be graphically. Firstly:—



The weight, 20 tons, would be 10 tons on each leg. Let A B represent by any convenient scale 10 tons. Draw A C parallel to guy rope or holdfast, if there is one; if not, at right angles to A B. Then draw B D parallel to the shear legs, cutting A C in D. By scaling B D, you will get the compressive strain, 10½ tons, while D A will give the tensile strain on the guy or holdfast, 2½ tons.

With regard to the safe load on cross-piece, the breaking weight of beam will be 20 tons × 10 factor of safety = 200. Then

$$\frac{\text{length in feet} \times \text{breaking weight in pounds}}{\text{breadth in inches} \times \text{constant}} = \text{depth in inches}$$

squared.

Taking 200 tons as breaking weight, the constant for pitch pine at 544—P. Barlow—length, 6ft., and assuming the breadth at 14in. $= \sqrt[2]{352{\cdot}94}$, or 18·8in. deep. In practice it would be better to have two beams 15in. deep × 9in. wide, giving the same area.

Sectional area of legs.—There is no completely reliable information as to the resistance of long columns. The following is Gordon's formula, modified by Trautwine to suit timber:—

$$\left.\begin{array}{c}\text{Breaking weight in lbs.}\\ \text{per sq. in. in area}\end{array}\right\} = \frac{5000}{1 + \left(\frac{\text{sq. of length in inches}}{\text{sq. of breadth in inches}} \times {\cdot}004\right)}.$$

Taking the compressive strain of the leg at 10½ tons, and assuming for convenience the breadth at 14in., we get

$$B\,W = \frac{5000}{1 + \left(\frac{420^2}{196} \times {\cdot}004\right)}$$

$$B\,W = \frac{5000}{4{\cdot}6} = 1086{\cdot}9 \text{ per sq. inch in area.}$$

The weight to be carried is 10½ tons × 10 factor of safety for wood = 105 tons × 2240 = 235,200. Then $\frac{235{,}200}{1086{\cdot}9}$ will give number of square inches necessary to take the weight = 216·39 square inches; and $\sqrt[2]{216{\cdot}39} = 14{\cdot}7$ ∴ for a square section the dimensions would be 14¾in. × 14¾in., and for a rectangular one 15½in. × 14in.

E. M. R.

SIR,—In reply to your correspondent "Reader," the factor of safety for timber shear legs should not be less than 10—see "Stoney on Strains," p. 495—and, assuming that the resultant pressure on the legs from the suspended weight and the pull of the down-haul equals 30 tons, the breaking load of one leg should not be less than 150 tons. If the leg be square fir or pine timber, this requires it to be from 15in. to 16in. square—*idem*, p. 282—or, allowing for the transverse stress due to its own inclination, say 18in. to 20in. square.

N. D. Y.

Dublin, May 30th.

ELECTRIC LIGHTING.

SIR,—In your leader on the above subject in last week's issue, you were good enough to refer to my letter about the Varley flexible carbon, which, you feared, contained news too good to be true. The object of this letter is to show that the representations therein made were well within the mark. First, however, let me refer to your objections, which I take to be (1) the enormous rate at which this carbon is consumed from the fact that it consists of a number of small filaments which offer a large surface to oxidation; and (2) that no lamp has yet been devised to burn this carbon, nor can one be constructed without great difficulty on account of the feed being rapid, continuous, and variable. I am free to admit that in the earlier experiments, before the smallness of the current required was known, the consumption was somewhat rapid, but now so far is it otherwise that the flexible carbon under like conditions has something like four times the durability of the Carré carbons. I should think, too, that the increase of luminosity, instead of being due to oxidation of the filaments as suggested, is due solely to electric conduction through radiant matter, and I am confirmed in this opinion by the fact that when burned in carbonic acid gas—a non-supporter of combustion—the same increase is manifested as when burned under ordinary conditions. It is well known that a bale of cotton wool, though a loosely compacted mass of a highly inflammable material, will be but singed or charred in a fire sufficiently fierce to destroy furniture and like hard substances, which is due to the fact that air cannot penetrate the interior of the mass with sufficient rapidity to maintain combustion. The same is true with regard to books, and I am inclined to the belief that the same cause accounts for the slowness of combustion in the flexible carbon. Up till the present these experiments have been conducted mainly with a view to obtain subdivision of the arc, so as to extend the use of electric lighting in its cheapest form; flexibility of the carbon, that candles of any length might be used; elasticity of arc to increase the focal area and to obviate the necessity for delicacy of adjustment in the lamp required, and an arc system capable of being economically used side by side with incandescence. Now that these carbons can be made in coils of any length, each coil being of uniform diameter and of uniform resistance throughout, and requiring to maintain it at the best burning point a certain amount of current which is easily ascertained, the construction of a lamp, I think, will present no difficulty. Many methods naturally suggest themselves. A simple method would be to arrange the carbons side by side in Jablochkoff fashion, having them insulated by an elastic material and wound round a drum, to be paid out together by clockwork regulated according to the carbon and current.

Now as to the question of cost. The total consumption of one of these carbons burned as a negative pole against a Carré carbon positive during four hours was under half an inch. Assuming that when used as a positive the consumption would be two and a-half times as great, and assuming the subdivisions to be 50 instead of 87, as actually obtained, then $\frac{\frac{1}{2} + 1\frac{1}{4}}{4} = \frac{1}{2}$in. per hour nearly × 50 = 25in. at ¼d. per foot = per hour ½d. Add to this the cost of gas for 1-horse power gas engine at per hour 1d., making the total cost of 50 lamps of 100-candle power each 1½d. To this must be added interest on plant and expenses, which on account of the smallness of the current required would be small in proportion.

The same amount of illumination by gas would require at least 2500 cubic feet of gas, which at 3s. 2d. per 1000, the price charged by the Gaslight and Coke Company, would cost 7s. 11d.

As I said in my last, I shall be happy to have these experiments repeated for the satisfaction of any expert who may so desire.

JOHN RONALD SHEARER, A.C.A.,
One of the Varley Patents Proprietary.

10, Basinghall-street, London, E.C.

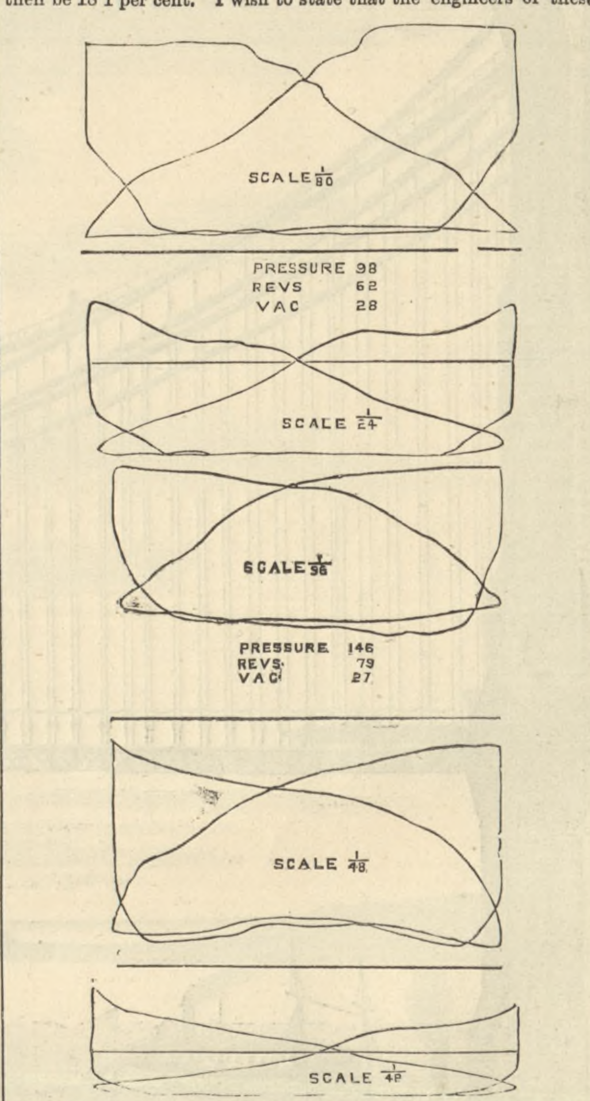
[Mr. Shearer does not state at what rate the Carré carbon burned, and in the absence of this statement the experiment named conveys no information of any value.—ED. E.]

DOUBLE v. TRIPLE EXPANSION ENGINES.

SIR,—There were two steamers built by Messrs. T. and W. Smith from one model, and in all respects identical except the propelling machinery. The first was finished in October, 1881, and the second in March, 1882. The first ship has two cylinders, 23in. and 46in. diameter, with 33in. stroke, and a boiler 12ft. 9in. diameter and 10ft. 6in. long, having 1649 square feet of heating surface, and a working pressure of 100 lb. The second ship has my three-cylinder engine, the cylinders being 14½in., 20½in., and 40in. diameter, with 33in. stroke, and a boiler 11ft. 8in. diameter and 10ft. long, having 1292 square feet of heating surface, and a working pressure of 150 lb. Both these vessels being now above twelve month old, I have taken an extract from the log-books of each, showing the number of hours under steam, the distances run measured on the charts, and, when practicable, checked by the tables of distances. An account of bunker coal has also been taken from the owner's books; the result being as follows:—

	Two-cylinder engine.		Three-cylinder engine.
	From Oct. 18, 1881, to Dec. 17, 1882.	From Mar. 18 1882, to Dec. 17, 1882.	From Mar. 11, 1882, to Dec. 31, 1882.
Hours steamed	4,237	3,061	3,365
Knots steamed	32,964	23,754	26,545
Bunker coal supplied for all purposes, tons	1537·25	1121·25	1014·75
Mean speed, knots per hour	7·77	7·76	7·89
Mean consumption, tons per day	8·66	8·78	7·23
Percentage of time steamed	41	46	47

The second column for the two-cylinder engine is given in order to show the comparison with the three-cylinder engine during the same period of the year. Allowing the speeds to be equal, the saving in coal is 17·6 per cent. for the same time of year, and as in each case the coal consumed by the donkey boiler in mooring the vessels and discharging cargoes, &c., is included. If, therefore, say 0 25 tons per day for this is taken of each, the saving would then be 18·1 per cent. I wish to state that the engineers of these



vessels were not aware that the log-books were to be examined for any such purpose as that named above, and the coals supplied to each steamer were of the quality usually supplied. In fact, I wish it to be clearly understood that the vessels were not run for any competitive trial, but in the usual way of business, and practically in the same trades. The indicator cards are given reduced one-half for each engine.

The above result fully confirms a sound practical comparative test which happened in the following manner:—The two steamers were loaded and bunkered from the same colliery, and sailed from the Tyne the same tide, each bound for Oporto. The three-cylinder ship was one hour the soonest to Dover, and four and a-half hours the soonest to Oporto bar, showing that the three-cylinder ship is not the slower of the two. From Oporto the latter vessel went to Pomaran and loaded home; the other went to Bilbao and loaded home—the respective distances are about as 3030 to 2596, and the coal consumed was as 100 to 105, showing a saving of coal of 18⅔ per cent., irrespective of extra speed.

I have the permission of the owners of the yacht Isa, and the steamers Claremont, Albertina, and Milicent, to state that these vessels are giving uniformly satisfactory results.

A. TAYLOR.

25, Queen-street, Newcastle, May 26th.

LIARDET'S SPRING AND DOUBLE ACTING WINDLASS.

SIR,—Referring to Mr. R. Lindsay's letter in your issue of the 18th instant, it may be well to know I have no pawls to click on my windlass; the only noise is that of the chain cable through the hawse pipes. All the stops to my windlass are aft, under the control of one man, who is sufficient to work it.

Referring to the first accident to H.M.S. Defence, the *Daily Telegraph* of the 11th April, 1883, reported a second accident to that ship, viz., "A telegram from Liverpool, dated yesterday, states that her Majesty's ship Defence parted from her moorings in the Mersey, and drifted down the river, but afterwards got to the Cunard Buoy, in the Sloyne, with the tugs Agincourt and Challenger alongside. She was subsequently docked at Birkenhead, with loss of both anchors."

Thus we have two serious accidents happening to this ship very quickly after each other. Whose windlass or capstan is fitted to her?

J. EVELYN LIARDET.

WHEELS AND TIRES.

SIR,—Sometime, about a couple of years, ago, here in Jumalpore, I saw a 5ft. steel tire burst asunder in the lathe. The wheels had not been long put in the lathe, which was standing at the time. One half of the tire flew a considerable distance, and would have killed had it struck anyone. The other half struck the slide rest, and sent it spinning off the lathe, partly broken. No doubt the bursting of the tire was due to over shrinking. In addition to the slide rest being struck, I was very much struck in another sense, at the whole idea, theory, and practice of tire shrinking. Had the tire stood until it was turned up and the wheels been finished and sent on the road, the result would probably have been death and destruction, as it has been in many cases before. Can we not introduce something more in harmony with modern ideas of safety? Shrinking on tires in the usual way is not a safe method, however much may otherwise be said in its favour.

What I would like to suggest is the desirability of our Government having a railway department, with a standing council, or committee of experts, to examine and test practically different forms and constructions of rolling stock. I think most people would agree in saying that a little public money applied in this manner would be at least as well spent as if it were blown away in gunpowder. I think as a general rule locomotive wheels ought to be turned in their journals; that is to say, instead of having them hung between centres, there ought to be a couple of plummer blocks to receive the journals, the same way as cylinders for paper mills are turned. The construction of wheel lathes could thereby be much simplified, and the wheels would be sure to be dead true with their journals. Of course in the case of the journals having to be turned up, that would have to be done in centres, but this is not often required.

H. ADIE.

Jumalpore, Bengal, May 1st.

[We fear that they have still something to learn in Jumalpore. In this country tires are bored and wheels turned to so nice a fit that the tires can be dropped on when not much hotter than boiling water, and yet they hold perfectly tight. A burst tire from initial strain is a thing practically unknown in this country.—ED. E.]

LEGAL INTELLIGENCE.

QUEEN'S BENCH DIVISION.

Wednesday, May 30th.

(*Before* Mr. Baron HUDDLESTON, *without a jury.*)

NORDENFELDT *v.* GARDNER.

THIS was an action which was founded upon an alleged infringement of the plaintiff's patent for the Nordenfeldt gun, and his Lordship was occupied for ten days hearing the case. The present sitting was for the purpose of giving judgment.

Mr. Baron HUDDLESTON said that the defendant had raised three points:—(1) That the plaintiff's specification was bad; (2) that there was want of novelty in the invention; and (3) that there had been no infringement of it. It was said that the specification was bad as not distinguishing what was old from what was new; but what the plaintiff really claimed was a combination of various things, and this combination was new. The objection therefore failed. Then it was said by the defendant that the provisional specification did not describe accurately the plaintiff's invention; but he—Mr. Baron Huddleston—thought that from it an ordinarily skilled workmen could make the gun, and that the objection to the specification failed. He also thought that the objection upon the ground of novelty must also fail. Then came the question of infringement, and he was satisfied that the plaintiff had made out that there had been an infringement. There would therefore be judgment for the plaintiff, and for an injunction to restrain further infringement against the company and also against Captain Gardner, and with costs against both the defendants.

His LORDSHIP, after some discussion, certified that the validity of the patent had come in question, and that the plaintiff had proved its validity. He also stayed execution to enable the defendant to appeal.

Mr. BOUSFIELD said that the defendants were now supplying the British Government with four or five guns a week; and the Government had also set up a plant at Enfield to make the guns themselves.

His LORDSHIP ordered that the work done for the Government might go on pending the appeal, the proceeds to be paid to a receiver. As to the shorthand writers' notes, which had been printed from day to day, he said that but for them the case would have lasted as long again, and then there would have been another Court complaining of the length of the trial. There had been an agreement that the parties should pay the cost of the notes between them, and therefore he should make no order as to these notes.

Judgment for the plaintiff.

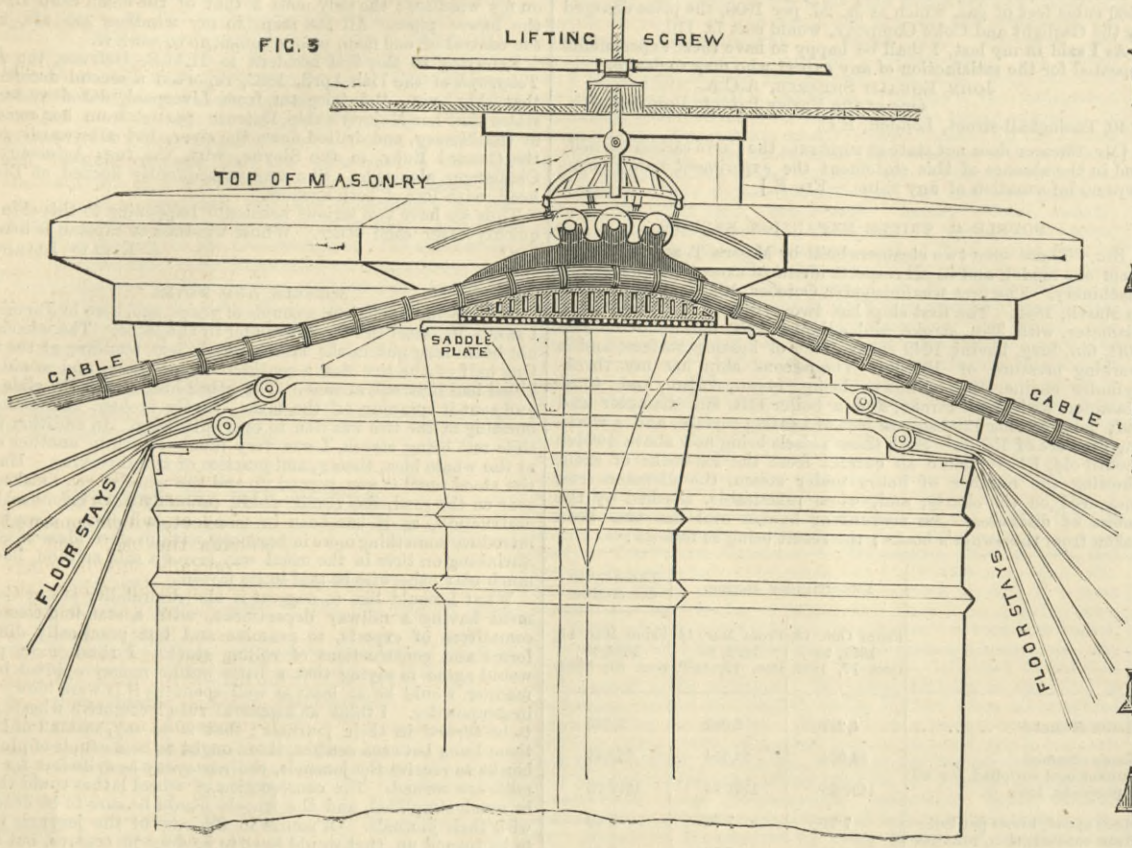
THE INSTITUTION OF CIVIL ENGINEERS.—Mr. Brunlees held the annual President's *conversazione* of the Institution of Civil Engineers in the South Kensington Museum on Wednesday evening. It was attended by more than 2600 guests, and was in every respect a perfect success.

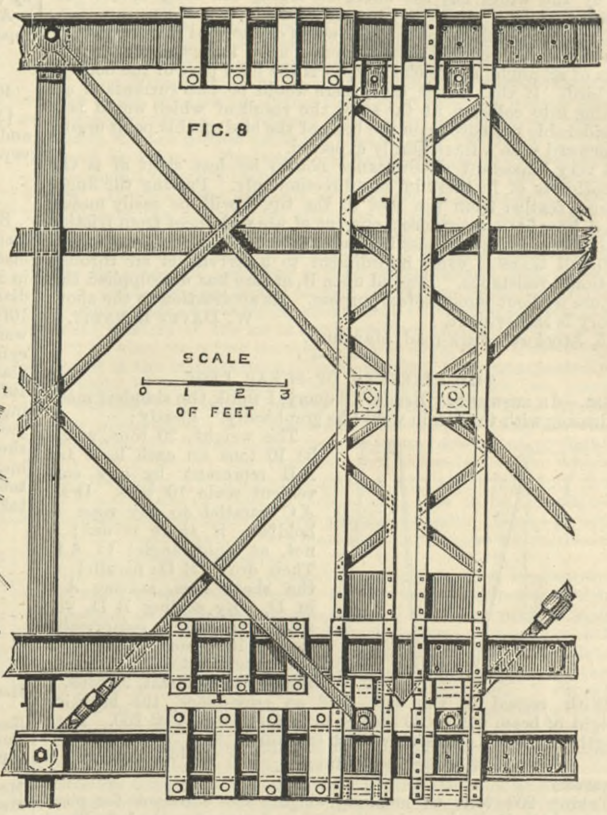
CHESTERFIELD AND DERBYSHIRE INSTITUTE OF MINING, CIVIL, AND MECHANICAL ENGINEERS.—The annual general meeting will this year be held in Nottingham, on Thursday, 7th June. The election of officers for the year 1883-4 will be determined. New members elected by ballot will be announced. The general report of the Council, and their finance report, with abstract of the accounts of the past year, will be presented for approval. The following proposed addition to the rules, at end of Article 5, Section vii., recommended by the Council, and of which notice was given at the April meeting, will be submitted, viz.:—"Except that, members of any class, elected in January in any year, and thereupon paying entrance fee and subscription, shall not be required to pay any further subscription until the 26th of March in the year following; but they shall not be entitled to "Transactions" of a date prior to that of their completion of membership." The following papers will be open for discussion:—Mr. Sydney F. Walker's paper "On the Electric Light and Transmission of Power by Electricity."·(*a*) Electric lamps; (*b*) dynamo-electric machines; (*c*) accumulators. Mr. T. G. Lees' paper "On a Self-acting Arrangement for Unloading and Loading Colliery Cages (Fisher's patent)." The following papers will be read or taken as read:—"The Kœpe System of Winding at the Bestwood Collieries," by Robert Wilson, Assoc. M. Inst. C.E.; communicated by Mr. Howard Allport, "Buckett's Caloric Engine," by Mr. John Oliver.

THE BROOKLYN SUSPENSION BRIDGE.

MESSRS. JOHN A. ROEBLING AND WASHINGTON A. ROEBLING, ENGINEERS.

(*For description see page 417.*)





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PARIS.—Madame BOYVEAU, *Rue de la Banque.*
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NEW YORK.—THE WILLMER and ROGERS NEWS COMPANY, 31, *Beekman-street.*

TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion, we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must, in all cases, be accompanied by a large envelope legibly directed by the writer to himself, and bearing a 1d. postage stamp, in order that answers received by us may be forwarded to their destination. No notice will be taken of communications which do not comply with these instructions.*

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*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, must be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever will be taken of anonymous communications.*

W. R. (Parker's Vice).—*Letters lie at our office for this correspondent.*

C. D. (Packing Peat).—*A letter for this correspondent awaits his application.*

ALPHA.—*The statement as made in our impression of the 27th ult. is the correct one. The other statement was not made by us, but by Mr. T. Adams, as you will have seen.*

E. D. (South Kensington).—*You can only obtain such a berth as you require by interest. There is no open competition, and the pay is so small that the appointment is not worth having.*

ROLLER.—*We do not know of the existence of any work which will be of use to you. If you will say what it is you want to know, we shall do our best to supply you with the required information.*

J. K.—*We presume that you mean patent by the word "register." A patent would enure for fourteen years if you kept up the stamp duties. Registration applies only to design—that is, form or shape.*

AN IRONWORKER.—*Kircaldy's treatise on the strength of iron, a treatise on steel, by Knut Styffe, and Percy's "Metallurgy—Iron and Steel," will probably answer your purpose. You can obtain these books from Messrs. Spon, Charing Cross.*

WHEEL MOULDING MACHINES.

(*To the Editor of The Engineer.*)

SIR,—We beg to inquire through your columns for the address and circulars of makers of wheel moulding machines, and shall feel obliged by replies.

J. STANIAR AND CO.

Manchester, May 29th.

HYDRAULIC RAMS FOR RAISING SEA-WATER.

(*To the Editor of The Engineer.*)

SIR,—I shall be glad to hear from any of your readers who have fixed rams for the above purpose, if it is always necessary for a man to start the valve after each low tide, when worked by the tide?

Dorchester.

E. R. D.

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MEETING NEXT WEEK.

SOCIETY OF ENGINEERS.—Monday, June 4th, at 7.30 p.m., a paper will be read "On the Value of Exhibitions as Aids to Engineering Progress," by Mr. Samson Barnett, jun., the leading features of which are as follows:—(1) Assistance rendered to important inventions by immediately bringing them under the notice of those most interested in their adoption. (2) Statistics of patents, and increase of engineering business since the Exhibition of 1851. (3) The value of engineering exhibitions for imparting practical knowledge to students.

THE ENGINEER.

JUNE 1, 1883.

THE LAWS OF MAGNETISM.

PROFESSOR HUGHES' paper, read on the 24th of May before the Society of Telegraph Engineers, is a remarkable contribution to the literature of molecular physics. The text of the paper will be found in another place, and we commend it for attentive perusal to our readers. Its interest is by no means confined to electricians; on the contrary, it contains much that concerns metallurgists and even chemists, to say nothing of the large class who find in the study of molecular physics an attraction ever growing in intensity. The paper illustrates very clearly how little we really understand of what goes on around us; and it is a direct blow to those compilers of text-books who persistently employ the dogmatic "we know" instead of the tentative "we think." We can name several works, for example, in which Ampère's theory of magnetism is put forward as a theory scarcely, if at all, open to question. We may add that those who had really studied the subject knew that Ampère's views, as well as those of Coulomb and Poisson, were entirely inadequate to explain many phenomena; but, nevertheless, examinations have been passed, and well passed, in science by men who accepted Ampère's views as quite sound, and who had taken in a great deal of equally dogmatic and equally erroneous teaching as perfectly accurate. Professor Hughes has framed a consistent theory, and he has devised means of practically illustrating it; and this theory is not only so elegant, but so consistent with itself and with the various phenomena of magnetism, that it is impossible to do otherwise than accept it as wholly true. We hold, however, that the title of the paper has been injudiciously selected. Professor Hughes is as far as any of his predecessors from explaining what is the *cause* of magnetism. He explains what is the cause of certain magnetic phenomena, but this is a very different thing.

The deductions to be drawn from Mr. Hughes's statements are extremely remarkable and suggestive; but before directing attention to them it will be well to state here very briefly the principal features of the theory Professor Hughes has propounded. According to him every bar or piece of magnetic metal, such as iron, steel, and nickel, is built up of molecules, which must in no way be confounded with the chemical and physical atoms, which again are far from being identical—the atom of Professor Tyndall, for example, being a very different thing from the atom according to Dalton. Now each of these molecules is a magnet, having, to use popular phraseology, a north and a south pole; and it is always, and under all circumstances, a magnet, and one whose magnetism cannot be taken away. Why it is a magnet no one knows. Magnetism is as much inherent in iron as weight is. It is just as certain that a molecule is magnetic as that a plate of iron one foot square and one inch thick weighs 40 lb. Its magnetism is as inseparable from it as its weight. Why this should be the case Professor Hughes does not attempt to tell us. The origin of the phenomenon is as inscrutable as the origin of gravitation. So long as the metal is left to itself, the molecules move among themselves, rotating apparently on themselves, presenting contrary poles to each other, and so producing what Professor Hughes terms a closed circuit of magnetic force. Under these conditions no external magnetism is apparent, but magnetism is there nevertheless. It is latent. If now we compel the molecules to turn over so as to present opposite poles to each other, or in any way to break the closed circuit, external magnetism at once becomes apparent. Professor Hughes illustrated this by a very beautiful experiment. Fine iron filings may be taken to represent molecules, although of course on a gigantic scale. He put a quantity of such filings into a test tube, and passed the tube over the pole of a magnet. Each filing then became a magnet, with a north and south pole, and the whole test tube was competent to play the part of an ordinary magnet; but a slight shake sufficed to rearrange the filings so that their polarities neutralised each other as far as external influence was concerned, and the test tube and its contents were no longer a magnet. He went on to show that it was only necessary to secure the filings in position by pouring in some melted resin, and motion among the molecules being prevented, the test tube remained magnetic even when shaken. We have here a direct and most satisfactory explanation of the reason why steel is persistently magnetic and soft iron is not. In the latter the molecules retain their mobility; in the harder steel they are unable to rotate and close the circuit. Even the softest iron will, however, retain external magnetism if it be not shaken or exposed to the influence of the earth's magnetic field. But it is only necessary to tap it with a mallet and the internal movement at once takes place and external magnetism disappears.

What a picture is here presented to the mind's eye! A bar of soft iron is, after all, not more stable than a rope of sand. It is nothing but an aggregation of tiny grains, capable of moving among themselves with great ease. They are, as it were, suspended in a jelly-like fluid, to use Professor Hughes's words, which retains them in proximity. We seem, as we read his paper, to have lifted a corner of the veil which hides the mysteries of the universe from us. A bar of iron is no longer a bar of iron, and nothing more — it is a world of molecules bound and tied together by something external to themselves. The omnipresent ether? Who can say? A flood of light is let in on us, and the whole of the phenomena of so-called crystallisation, which appear when a metal dies of fatigue, are explained. In a mass so mobile as iron nothing is more likely to occur than a rearrangement of the molecules under continued, ever-varying strains. Professor Tresca long since enunciated the theory of the flow of solids. He showed that nothing more was needed than long continued steady heavy pressure to force a punch through a thick mass of iron, and he proved by sections subsequently made and brought up by an acid, that the metal quietly flowed away from the steel punch. This is precisely what we might expect of a bar built up of numerous hard particles agglomerated in a jelly-like fluid. A rough imitation of the iron bar may be produced by mixing up iron filings with pitch and moulding the whole into a stick. We can do with such a stick much that can be done with an iron bar. It can be made to "flow" slowly under pressure, or it can be broken with a sharp conchoidal fracture by sudden violence. It can be drilled, and hammered into shape. It can be made magnetic, and it can be welded by heating the broken ends and bringing them together. Have we here an explanation of the theory of welding? In the welding of the pitch bar the iron filings take no part, for obvious reasons. Are we sure that in welding a real bar the molecules operate between themselves? Is it not more likely that union is obtained between the parts of the jelly-like fluid. We are treading here on the borders of that unseen world which exists everywhere around us—a world whose wonders dwarf into utter insignificance all that we can see; and it is impossible to do more than speculate concerning it. But that the ether has a positive existence, and that to it all the phenomena of cohesion can be traced, becomes more and more an article of faith with those who know most. Professor Lodge has shown in a series of lectures recently given, that to the shearing of the ether, a continuous, all-pervading, imponderable fluid, may be due all the phenomena of electricity. Professor Hughes's discoveries and theories seem to render the existence of an ether absolutely indispensable. It may, however, be well to point out that, given certain forms of attraction and repulsion, inherent in a mass of free molecules, and nearly all the phenomena peculiar to a fluid can be reproduced. There remains, however, the overwhelming difficulty of assuming that matter *per se* can exert any force, attractive or repulsive. If it can, then it is certain that the law of conservation of energy must be materially modified.

We are glad that Professor Hughes proposes to extend his researches. In his hands the molecular theory may be made to play an important part. His skill as an experimenter; his caution as a framer of theories; his inventive resources as an experimenter; and the breadth of his views as a man of science, eminently fit him for his self-imposed task; and it is possible that ere many months have elapsed he will be able to give us something more than a suggestion concerning the cause of many puzzling metallurgical phenomena. As for example, the brittleness of steel in frost; the cause of tempering; the reason why oil acts to strengthen steel quenched in it; and the prolonged cracking of steel armour-plates after shot has struck them. There is plenty of room for inquiry and discovery. Professor Hughes is rapidly placing himself in the front rank as an inquirer and a discoverer.

TORPEDO PROOF SHIPS.

HISTORY repeats itself. In the famous "Orfeus C. Kerr Papers," published during the last American Civil War, we have an account of the Mackerel Fleet, which consisted of gunboats plated inside. "What's the use," said the admiral in command, "of platin ironclads outside, where there ain't no men to be hurt; plate 'em inside where the men is and it'll be some use." We do not know whether Sir E. J. Reed has read the "Orfeus C. Kerr Papers" or not; but he has carried out the idea, and has secured provisional protection for an ironclad ship plated inside instead of out. Sir E. J. Reed and his patent agent presumably alone know what the contents of the provisional specification are. But either one or other of them has communicated to the *Times* a very full description indeed of the ironclad of the future; so full a description, in fact, that if anyone thought proper to "race for the seal" he might even now forstall Sir Edward and secure a patent before him. It is, indeed, not a little curious that Sir Edward did not file a complete specification at once. Ironclad ships are hardly the subjects for provisional protection, because it is extremely unlikely that Sir Edward Reed or anyone else can gather sufficient experience with them in four months to be enabled to modify a provisional with advantage. However, this is Sir Edward Reed's affair, not ours; and we would not have referred to the circumstances at all but that they seem to denote that after all Sir Edward has not immense faith in his own invention. It looks as though his confidence in it might be measured by a ten-pound note, but not by three or four such sums.

There is no difficulty whatever in gathering from the *Times* an accurate idea of what Sir Edward's war ship of the future will be. In another place will be found cross sections of such a ship elaborated out of our own internal consciousness, aided by the description in the *Times.* It will be seen that Sir Edward wants to keep torpedoes at arm's length, and to do this he virtually turns his ship inside out. We have the double bottom of the modern ironclad; but the space between the two skins will be much wider than it is now, and the inside skin will be armour-plated. The idea in its simplified form is shown in our first sketch. We have here two armour-plate decks, with a space between them in which guns can be fought. The sides, top, bottom, and ends are impenetrable. This structure must be able to support itself in water under any circumstances; but to render it properly buoyant and seaworthy it is carried, so to speak, on top of a light steel hull. This hull can be destroyed by torpedoes, but the flat raft-like portion will float. It will be seen, however, that this scheme includes all possible disadvantages, with few or no good points. Fig. 2 shows us a different structure. We have an ironclad ship fixed in what may be termed a caisson or floating dock, and even if this last be filled with water, the former will float and carry both. It is well known that what may be a very stable ship when properly loaded, may become crank and unstable to the last degree when she contains much water. To maintain the stability of his ship Sir Edward Reed fits her with great projections or sponsons, which under ordinary circumstances may or may not touch the water, until she springs a leak; then these sponsons when she has sunk a little will maintain her stability and her buoyancy. In a word, Sir Edward Reed takes an Ericsson monitor, and fits her inside of an enlarged hull, as may be gathered from our sketch.

Sir Edward Reed has the reputation of knowing more about ironclads than any other man save Mr. Barnaby, Chief Constructor, and Mr. White, of Sir W. Armstrong and Company. What these three gentlemen do not know about ironclads is probably not worth knowing. It is for this reason that Sir Edward Reed's proposal deserves an amount of attention which would not be conceded to an amateur if he had patented the same scheme. So much has to be thought of in designing a modern ironclad, that it is almost impossible to say whether Sir Edward Reed's ideas are feasible or not in the full sense of the word. In the first place we have weight to deal with; and so far as can be seen, the weight of armour required will be enormously augmented. In the existing ironclad we have an armoured citadel, and the crew live forward and aft of the citadel in comparatively light structures, the destruction of which is a matter of no importance. We gather that the upper works of Sir Edward Reed's ship will in all respects resemble the existing man-of-war. We are to have an armour-clad citadel and "light superstructure;" below all this will come the "armour-plated dome," or inner hull. This will take the place of the armour which would otherwise extend below the water-line some six or seven feet. Presumably it will be made to taper away in thickness as it approaches the keel, but we suppose that it will nowhere be less than four inches thick. Thinner plates could not be trusted to deal with a torpedo; but the weight of this plating must be very great indeed, and it is easy to see that not a few structural difficulties will have to be overcome in securing it to the inner ribs and fixing outer ribs in turn to it. It is even open to question whether an armour plate "dome," as the *Times* calls it, is needed at all; for with a wide space between the outer and inner skin, it would seem as though the torpedo could not get close enough while unexploded to do much harm to the inside of the ship. Sir Edward proposes that in some cases the crank shafts shall be outside, or rather under the armoured inverted dome, the piston-rods working through stuffing boxes in the latter. We venture to assert that this idea will never be carried into practice.

The question which most prominently suggests itself at present is, Cannot the same result be obtained more easily in another way? Assuming for the moment that it cannot, we may go on to consider what the condition of the ship would be after a torpedo had exploded below her. That she would at once take a very large quantity of water into her cellular bottom is certain—how would this affect the steering and speed? Furthermore, it would appear that the accommodation provided on board a ship of really very large external dimensions must be small. The space between the inner and outer skins would be too small to be utilised for carrying coals, men, or provisions; and the displacement and resistance of the ship would be large. We have further to consider the whole problem of steadiness in a sea way, and first cost. It will be easily seen that there is a very long way indeed to be traversed between the filing of a provisional specification for an improved ironclad and the construction of such a ship. Sir Edward has, however, by making his views public, courted criticism, and it is to be hoped that he will receive it. For ourselves, we are not slow to admit that the scheme seems to have a great deal to recommend it; but disappointment must not be felt if a ship built on Sir Edward Reed's plan does not turn out quite like any other man-of-war.

THE CARBONIC ACID IN THE ATMOSPHERE.

An important paper on this subject, written by E. H. Cook, has recently appeared in the *Philosophical Magazine*. Taking the polar diameter of the earth as 7899 miles, the equatorial diameter as 7925·5 miles, and the height of the homogeneous atmosphere at 26,214ft.—nearly five miles—the cubical content of the homogeneous atmosphere is found to be 591,647,337 cubic miles, or in round numbers 592,000,000 cubic miles. If the average amount of carbonic acid in the atmosphere be taken as 4 vols. in 10,000, the total amount of carbonic acid is 236,800 cubic miles, and the total weight 4287 billions of pounds, or 1,913,685,908,480,000 kilos. These numbers differ considerably from those given by Dumas and Boussingault, and from that given in Roscoe and Schorlemmer's "Chemistry." The first of these is nearly 40 per cent., and the second about 33 per cent. too high. Recent investigations, however, show that the proportion of carbonic acid in the atmosphere is not so high as 4 vols. in 10,000. Fittbogen and Hasselbarth found 3·4 vols. in 10,000, Farsky 3·4 vols., and Reiset 2·942 vols.; and if the mean of these be taken, the total weight of the carbonic acid in the atmosphere is nearly 1545 billions of kilogrammes. The average amount of coal raised annually in the world during the last three years is about 280,000,000 tons. Assuming that this contains 75 per cent. of carbon, 10 per cent. of which is thrown away with the ash, 182,000,000 tons of carbon are annually converted into carbonic acid, which gives a daily production of 1,800,000 tons, or nearly 1,800,000,000 kilos. Assuming that one-third more is produced by the combustion of wood, peat, oil, &c., the total daily production by combustion is 2,400,000,000 kilos. The present population of the world is about 1,500,000,000, and each individual produces on an average a kilogramme of carbonic acid in twenty-four hours. Assuming that twice as much carbonic acid is produced by the respiration of the lower animals as by man, the total amount produced by respiration is 4,500,000,000 kilos. per day. The amount produced by the decay of animal and vegetable matter may be taken as equal to that produced by the respiration of man, and the amount sent into the air from subterranean sources may be fairly assumed to be five times as great as the total amount derived from all the other sources together. This gives about 40,000,000,000 kilos. per day. Adding all these quantities together it is found that the total amount of carbonic acid daily added to the atmosphere is at least 50,000,000,000 kilos., from which it follows that if no compensating influence were at work the proportion of carbonic acid would be doubled in about 100 years. The causes which remove carbonic acid from the air are fixation of carbon by plants, removal of the acid by zoophytes, and absorption of the acid by inorganic chemical action. In the first case alone is oxygen returned to the atmosphere; in the other two cases the carbonic acid is absorbed as a whole. The total area of the land surface of the globe is, according to Saunders, 57,600,000 square miles. Of this 8,200,000 square miles are in Arctic and Antarctic regions, thus leaving 49,400,000 square miles on which vegetation might flourish. A considerable portion of this area is, however, occupied by barren mountains, cities, and rivers. Estimating the total area of leaf-surface as 50 per cent. of the area of plant-bearing land, it follows that 24,700,000 square miles, or 63,973,000,000,000 square metres of leaf-surface, are engaged in the work of removing carbonic acid. Since each square metre of leaf-surface decomposes about 1 litre of carbonic acid per hour, it follows that 63,973,000,000,000 litres of the gas are decomposed every hour. Taking into account the fact that sunlight, on the average, lasts only ten hours per day, and allowing 25 per cent. for diminution of the action during winter, the average amount of carbonic acid decomposed per day is 479,000,000,000 kilolitres, or more than 900,000,000,000 kilos. A considerable portion of the carbon thus removed is, however, returned to the air when the leaves decompose in the autumn; and allowance must also be made for the fact that some plants give off carbonic acid in the dark. On this point, however, there is no data on which to base any calculation, and the evolution of carbonic acid by the nocturnal respiration of plants may be much greater than is usually supposed. From the numbers given it would appear that the vegetable life of the globe is of itself sufficient to maintain the purity of the atmosphere. The removal of carbonic acid from sea water by low forms of animal life takes place on a gigantic scale, but the carbonic acid thus removed exists in the sea and not in the atmosphere, and a very large proportion of it must be derived from submarine volcanic eruptions. In all probability the influence of this action is felt only after many years, and so far as the atmosphere is concerned, it cannot be compared to plant life in point of activity. Large quantities of carbonic acid are removed by inorganic chemical changes, as, for example, in the conversion of orthoclase into kaolin—Sterry Hunt, *Amer. Jour. Sc.*, May, 1880—but any estimate of the rate of this action is impossible. These calculations seem to show that the causes which remove carbonic acid from air are more powerful than those which add the gas to the air. Its proportion, must, therefore, be gradually decreasing, but there are no trustworthy data on which to base any calculations on this point. As to the source of the enormous quantities of carbonic acid already fixed in the form of limestone, we have no knowledge. Either at one time the atmosphere surrounding the earth must have been much richer in carbonic acid than it is at present, or, as Sterry Hunt supposes, there must be a universal atmosphere similar to our own, from which the carbonic acid now fixed in the earth's crust has been derived.

ELECTRIC LIGHTING ON BOARD THE CUNARD STEAMSHIP AURANIA.

This fine vessel, which has just been handed over to the Cunard Company by her builders, Messrs. J. and G. Thomson, is lighted throughout by electricity on the incandescent system. The installation, which comprises over 600 lamps, is the largest yet fitted up on board ship, and in the work advantage has been taken of the most recent improvements in electric lighting. Messrs. Siemens Brothers and Co., have executed this important work, Swan lamps and Siemens' dynamos being used. The current is produced by four dynamos, each driven by a separate steam engine. The two large machines, which run at the rate of 650 revolutions per minute, are driven by means of rope gearing from a pair of Shanks' horizontal engines, regulated by Pickering governors. These two machines are shunt wound, each magnet coil being wound with thick and thin wire, so arranged that any number of lamps in the circuit can be turned on or off without in any way affecting the brilliancy of the remainder. In addition to these there are two smaller dynamos, each driven by a vertical Tangye steam engine. The machines are mounted on a cradle above the driving axle of the engine, and motion transmitted through paper pulleys, which rest on the fly-wheels of the engine, the necessary friction being maintained partly by the weight of the dynamo and cradle and partly by screwed clamps. The smaller machines are wound like the larger pair. The lamps, which are Swan's new type of high resistance, are all arranged in parallel circuit, and are each provided with a safety bridge to automatically lower the current should the supply become so great as to endanger the safety of the lamps or leads. In addition to these, safety bridges are inserted in various parts of the circuit automatically to cut out any group of lamps should the currents from any cause become too strong. As indicating the extent of the ramifications of the leading wires, it may be stated that two miles and a-half of cable are laid down in this vessel, and this, notwithstanding the fact that the steel hull of the boat itself is utilised as the return "earth." The saloon is brilliantly lighted by twenty-six beautiful silver-plated pendants hanging from the roof, as well as by a number of quadrant bracket lamps fixed to the pillars. The music room overhead is fitted with fourteen lamps enclosed—as is the universal case throughout the installation—in opal globes, while the ladies can recline in their pretty boudoir by the light of eight lamps. Every state-room is fitted with a handsome silver pendant lamp, the light from which can be turned on or off at the will of the passenger. The engine-room and stokehole are illuminated by thirty lamps, some being portable to enable the machinery to be better examined. No part of the ship has been left to the mercy of the oil lamp, but passages, companions, bath-rooms, lavatories, galleys, butchers', bakers', barbers' shops, sculleries, hospitals, chart room, all the officers' rooms, all the engineers' rooms, wheel-house, smoke-room, doctors' and pursers' and stewards' rooms, officers' mess, engineers' mess, are alike bathed in a flood of light. The whole installation, which, as already stated, is the largest yet attempted at sea, consists of over 600 lamps, the beautiful pendants, quadrants, and brackets being designed by Mr. Raworth, of Manchester, the marine agent for Messrs. Siemens Bros., the resident electricians being Mr. Holmes and Mr. Dorman.

THE NORTH-EASTERN COAST LINE.

There seems some probability that there will be a speedy completion now, almost entirely, of the coast line from Hull to Berwick. At the present time the missing link is the stretch of country from Scarborough to West Hartlepool. Out of this the line from Scarborough to Whitby is now in course of construction, and that from Whitby to Saltburn is completed, and may be early opened, but the Tees is the obstacle to the making of the remaining link, and from the reply recently given by the directors of the North-Eastern Railway to the Hartlepool Chamber of Commerce, it seems there is no probability of that link being forged by the company. Otherwise there would have been from Hull to Berwick a magnificent coast run, which would have materially lessened the time between the coast towns. It is fair to acknowledge that that time has been much reduced of late, and that by the line now under construction Scarborough will be brought within a comparatively short journey of Whitby and Saltburn. But there is the obstacle that the river Tees interposes to the junction of the North Yorkshire lines with those of Durham, and it is much to be desired that that obstacle could be removed as well for the quicker service of the passenger traffic as for the cheaper transit of the mineral traffic from Yorkshire to the many smelting furnaces in Durham. The latter county supplies, too, the whole of the coal and coke for the mines, furnaces, and works of Cleveland; and though the additional bridge across the Tees, now brought into use, has added to the traffic facilities, yet there is a need with the growth of the industries—such as that of salt—in South Durham for the provision not only of additional facilities, but of crossings of the river lower down, and nearer to the great centres of the traffic. All the ironstone from Cleveland which passes up the district to that point of crossing might, in many cases, cross with greater readiness, and with saving of time and change, lower down, and thus relieve the block that is sometimes still felt at the one point of the crossing of the river Tees. As we have said, there seems to be no present intention to increase the facilities in the North at that place, but it may be hoped that the question will be kept in view, and that in some early future there may be a commencement of the construction of what will be soon the one missing link in the chain of coast line communication.

THE RHONDDA AND SWANSEA BAY RAILWAY.

The preamble of the Rhondda and Swansea Bay Railway Company's extension to Swansea Bill has been passed by the Committee of the House of Commons entrusted with its consideration. Not only is this short extension line of great commercial importance, but it marks a new development of engineering science. The great feature of the line is a subaqueous tunnel under the estuary of the river Neath. A great portion of this tunnel is to be constructed on the pneumatic system, so long employed for bridge cylinders and other similar works, but hitherto confined to such operations; but there appears no practical reason why it should not be applied to this useful object. Some portion of the work will be constructed under the navigable river by the ordinary process, so as not in any way to interfere with the navigation. It is not to be supposed that this Bill was passed without a severe contest and the hostile opinion of several very eminent engineers, but Mr. Yockney, the engineer to the company, and Mr. H. Law, of Thames Tunnel experience, who advised the method of construction, are to be congratulated in having entrusted to them the construction of a work which, successfully carried out, will mark a new sphere of usefulness for the profession.

LITERATURE.

The Explosive Act, 1875, *and Orders in Council*, 1883: *Their Prejudicial Effect on Mining and Quarrying, and the Encouragement they give to Fenians.* Blundell, Garlick-hill, E.C.

This pamphlet first describes briefly the occasion and circumstances of the Acts passed in 1869 and 1875, and points out that owing to the value of Nobel's invention not being understood, dynamite remained under unfair restrictions, being treated as nitro-glycerine between 1869 and 1875. This very fact, however, caused its qualities to be discussed and statements on high authority to be made as to its safety. Sir F. Abel and Colonel Majendie, the chiefs of the two Government Departments which are concerned with explosives, have given strong opinions in favour of the use of dynamite when well made. It seems idle to add anything to the simple fact that these two high official authorities who have so much responsibility have thus spoken. Their interest must be to recommend the safest kinds of explosives. The pamphlet then goes on to complain that the recent Orders in Council compel every quarryman to depend on the recommendation of police, presumably in many cases in subordinate positions, for the power to use dynamite. The obstruction thus caused to legitimate business and the uselessness of the Orders as restrictions to malicious persons is pointed out. Finally, the outrageous character of the recent Order to guard all magazines day and night is spoken of with a calculation that 36,000 men will be required to carry it out. On this most important question a leader will be found in The Engineer, of May 18th, in which many of the points noticed in this pamphlet are discussed. It is well, however, to notice any features which are presented in another aspect.

The inconvenience to the quarrymen is, we think, exaggerated; because it is by no means necessary that every man that uses dynamite should have a certificate. What is necessary is that any of it left over after use should be returned into a certificated store, or, if under 10 lb., kept by a certificated private person. This we believe can be arranged, and ought to be managed in most places without serious difficulty. As pointed out by us, it is not the restriction of actual use in mines, but the injury to trade that we apprehend to be the chief evil of the Orders in Council.

With regard to the prevention of outrages, those who wish to commit them undoubtedly mean to break the law. A new law, then, cannot be expected to influence them if escape is possible. How do the Orders in Council stand as to this? Clearly it is very difficult for any one to avoid observation who is employing explosives in a legitimate open way in ordinary blasting, but a conspirator would not so expose himself to detection. He would conceal his explosive agent until the time for its use had arrived. This would surely be an easy thing to do; in some respects rather more easy in the case of dynamite than powder, as it is a stronger explosive bulk for bulk, and any charge required therefore occupies less space; and although powder does not call for a licence, a man who means to use it for a wrong purpose is likely to wish to conceal it. The memorandum directing vendors of explosives to be careful as to the purchasers, is more likely to be beneficial than the Orders in Council; for though it is very probable that conspirators would make their own explosives, the purchase of ingredients might possibly attract suspicion. Altogether, we agree with the conclusion of the pamphlet that Fenians may well be gratified at finding "that her Majesty has, on the advice of her Privy Councillors, been induced to concur in the issue of Orders which cannot possibly harm them, or interfere with their miserable proceedings, but must tend to fetter some of the most important industries of the country, and harass and annoy peaceful and loyal citizens." The order to guard all magazines and stores is read by the writer of the pamphlet to mean what we pointed out, namely, that a watch is actually to be kept day and night in all such buildings. The writer's calculation that 36,000 men will be required for this duty is, we believe, an over-estimate, because most of the buildings given by him as registered premises are shops. There is no question, however, that the matter is sufficiently serious to call for a vigorous protest. Indeed, we do not contemplate the Order being obeyed by any one until the whole question has been tried in a court of justice.

Electric Light: Its Production and Use. By J. W. Urquhart, Electrician. Edited by F. C. Webb, M.I.C.E., M.S.T.E. Second Edition. Crosby Lockwood and Co. 1883.

The world is becoming excessively lenient in these latter days. Adverse criticism is reserved for the unsuccessful, This has been a successful book, and hence, we think, has proved its title to be praised. It ought to be a good book, seeing it has reached two editions. It is altogether a misnomer to style Mr. Urquhart the author of this book; he is, however, an admirable compiler, while the angularities which must arise from this kind of authorship have been well rounded off by Mr. F. C. Webb. The book is built from materials obtained from contemporary literature, the sources not always being acknowledged; and from the price lists and descriptions of electrical apparatus makers. It is merely descriptive, with, however, occasional expressions of opinion which no doubt will vary with each edition.

Various batteries, both primary and secondary, are described and illustrated, but the most important part of the book is that devoted to the description of the more modern electric light apparatus. Here the reader will find fairly accurate illustrated descriptions of most of the dynamos which have been prominently before the public. This is, in fact, just the sort of information wanted by hundreds of people who, from business or other motives, wish to know something about these various machines. Men whose lives have have been spent in work in other directions are now called upon to learn something about electrical apparatus. They come to the subject ignorant of scholastic electricity, and only wish to know generally how the machines go, and in what respect the one differs from the other. Mr. Urquhart has shown a great aptitude for editorship by the way he has selected his matter—in what has been given, and in what has been left out. Theoretical investigations are relegated elsewhere, they have no place here, where the information is confined to hard facts. We notice, too, that although the tendency is rather to place too much faith in the newer machines, a qualifying sentence is now and then inserted, such as "It is claimed that, &c." The ordinary reader should particularly notice such sentences, and not allow himself to be carried away by a flattering statement. Frequently the only reply to a question is the cautious formula "It is claimed, &c." The results claimed as being obtained from many of the newer machines have never been corroborated by independent testimony. Indeed, when tested out of the hands of the promoters of companies, many machines never come up to the expectations derived from prospectuses. The treatment of electric lamps is as good as that of the machines. An attempt is made to notice every lamp of repute, but in some cases the description is of an old form of lamp, and not of the latest development. The investigations of Hopkinson, Preece, Fitzgerald, Schwendler, &c., of the Franklin Institute, &c., are used and acknowledged. From the standpoint whence we have viewed this book we hardly like to make a suggestion, because we think the work has been well done; yet we hold it would be better for English readers, at any rate, to have one system of measurements throughout. As it is, we have a delightful admixture of carcels and standard candles, of pounds sterling and francs, of cubic metres and cubic feet, and so on. The book is well printed.

MR. JAY GOULD'S STEAM YACHT ATALANTA.

THE iron steam yacht built at Philadelphia for Mr. Jay Gould, of New York, by William Cramp and Sons, may fairly claim superiority of model over every other pleasure craft in the United States; and she is certainly the strongest vessel of her size ever built in any country, this having been the principal object aimed at in her construction. Up to the present time the largest yacht enrolled in the American fleet is Mr. Bennett's Namouna; but Mr. Gould's yacht is longer and deeper, with the same beam, and has less draught. There is not, however, any great difference in the dimensions of these two boats, both being a great advance in size over the largest yacht built previously. The new yacht of Mr. Gould is pronounced by competent judges far superior in model to the Namouna, and as likely to prove a far better sea-boat. Her floor is long, extending well forward, and it has considerable dead rise, although not quite as much as Mr. Bennett's yacht, and the ends are fined down forward and aft to the extreme of sharpness, giving her a very easy entrance and a long and peculiarly handsome run. She has a slow and easy turn to the bilges, and the plating, carried uniform to the top of the bulwarks, which are higher than ordinary, adds materially to her apparent size. The keel rises forward in a graceful curve to the forefoot, the continuing stem running up with a good deal of rake to the extreme point met by the bulwarks, which are run clear forward in harmony with the sheer of the yacht. This gives to her bow above the water a peculiarly rakish appearance and adds materially to her over all measurement. She has scarcely any sheer, her long, straight rail curving aft to a graceful ellipse, the bulwarks raking aft in the line of her counter. Her overhang aft is considerable, quite as much as if not more than that of the Namouna; but she has a much handsomer stern, at least to an American eye, than the square stern of Mr. Bennett's yacht, which was copied from the style at present fashionable in Great Britain. It is conceded also, that in the elliptical stern there is greater strength, and that it is also less dangerous when running before a very heavy sea. The extent of the overhang, which, as has been said, is considerable at both ends, may be judged by the following figures, giving her exact dimensions: From knight-head to taffrail she is 230ft. 3in.; upon deck her length is 225ft.; on water line, 213ft. 3in.; extreme beam, 26ft. 4in.; moulded depth amidships, 16ft.; load line draught, 13ft. The upper deck of the new yacht, which, by the way, is to be called the Atalanta, is flush, and for its whole length is unbroken save by a narrow house that extends for 80ft. of its space amidships, by a steam capstan windlass forward, by the necessary companion ways and skylights to give access and light to the quarters below, and by four handsome ventilator tops to supply air to the engine and fire-rooms. She will have two sets of boat-davits on each side. Upon the port side, and just forward of the main mast, will be hung a steam launch, 32ft. long; abaft her—in fact, well on the quarter—on the same side, is to be hung the dingy, or working boat, 18ft. long. On the starboard side, abreast of the steam launch, is a six-oared cutter, 32ft. long, and abaft her and abreast of the dingy is to be a whale-boat, United States pattern, 38ft. long, which will row five oars, and which Mr. Gould will use for his gig. Mr. Cramp boasts considerably of the superior excellence and finish of these boats, which he challenges New York to equal. They are built of seasoned cedar, fitted with mahogany trimmings and nickel-plated throughout. The gig is a marvel of beauty and lightness, and her extreme length, combined with her faultless model, will make her very speedy. The launch is to be supplied with an engine of the newest and most approved pattern, and the cost of this one boat would, it is said, be sufficient for the purchase of a good-sized sailing yacht. The Atalanta is to be rigged as a three-masted schooner, with standing gaffs and lug sails. She will have a squaresail yard on the foremast, and a short bowsprit and jibboom. The furnaces of her two boilers will discharge into one smoke-stack, and she will carry her colours upon a staff at taffrail. The bridge will cross the house previously mentioned, and will have an elliptical-shaped pilot-house just abaft it, which may be entered either from the inside of the house or from the outside. Along the combings of this house, which is elliptically-shaped at the forward part, is to be run an ornamental brass railing, the space thus enclosed being intended for a fine-weather promenade for Mr. Gould's guests. It will make a space about 30ft. long by 12ft. wide, and will form a nice promenade, the bridge and pilot-house being sufficiently elevated to permit the officer of the deck and helmsman an uninterrupted view over the heads of the promenaders. This house is partly of iron, being built solidly into and forming an integral part of the iron deck, so that such a thing as carrying it away by a sea will be an impossibility. The keel of the Atalanta was laid upon the 10th of last December. It is of the best hammered iron, 8in. in depth and 2in. thick. At the forefoot and stem it is increased in thickness to 2½in., the other dimensions remaining the same. The stern post is heavier, being 4in. by 8in., and the rudder post is the same in dimension. The frames are all of the best quality of angle iron, 3½in. by 3in., and extend in one piece from the keel to the top of the rail, the portion above the stringers being of course lighter, and that above the plank-sheer forming the bulwark stanchions. Each frame has a reverse 2½in. by 2½in. These frames are spaced much closer than is customary in vessels intended simply for pleasure cruising, and are as close as if the boat were intended for the heaviest work of the Atlantic trade. Along each bilge is a keelson or strake, very heavy, as are also the stringers above, and the longitudinal strength of the boat is still further enhanced by two bulkheads which extend fore and aft, one on each side, from one end of the enclosed boiler and engine space to the other, and from the skin of ship to the upper deck. Across from one bilge strake to the other and upon each frame are the floors, of ½in. iron and of varying depth, being amidships full 30in. The stern frame is a marvel of neatness and strength; the cants, of the same size as the rest of the frame, are placed fan-shaped to form the ellipse and as close together at the bottom as possible. Then a very heavy solid rolled iron keelson is run along under the shaft casing, the casing itself being stayed in all directions, so that, literally, this boat, for a space of 15ft. or 20ft. forward of the stern post, is a solid mass of iron, and Mr. Cramp feels confident that he will be able to turn the screw up to and even above 100 revolutions without the least fear of weakening her after construction. Forward and aft of the engine and boiler space are heavy transverse bulkheads, joined together, as has been stated, by two other longitudinal bulkheads, thus forming an oblong space entirely isolated from the rest of the interior of the yacht, and into which, as these four bulkheads extend from skin to deck, no water, except from the top, can possibly enter, within which no fire is possible, as there is nothing combustible there, and into which no fire from the outside can penetrate. Besides these bulkheads there is a heavy collision bulkhead forward and a lighter one in the after hold. The interior of the yacht is therefore separated into seven water-tight compartments. The one at each side, abreast of the engine and boiler space and between the longitudinal bulkhead and the skin, will be utilised for coal bunkers, and an additional supply of coal will be carried forward under the saloon deck, the whole capacity of the bunkers being 170 tons. Abaft of the engine space and below the lower deck will be the water tanks, capable of containing a liberal supply of this necessary article, which can at any time be replenished by a powerful condensing apparatus run by the donkey engine, making from the water of the ocean fresh water, perfectly pure and admirable for cooking or bathing purposes, and which, if allowed to stand a month in the iron tanks to obtain the proper supply of air and other components, becomes the finest drinking water that can be had. Before leaving the hold of the yacht it may be stated that, owing to her great depth, the lower deck is placed high enough to give ample space in the lower hold proper for the stowage of all luggage and stores. The deck beams are of bulb iron of the very best quality, and are 6in. in depth. The skin or plating is $\frac{7}{16}$ of an inch in thickness, with the sheer strakes double that, or $\frac{14}{16}$ of an inch thick. From keel to water-line the plates are lapped at the edges, the rivet heads on the outside being countersunk. Above the water-line the plates are laid flush and banded upon the inside, the rivet heads countersunk on the outside, making a surface perfectly smooth. The neat manner in which this work has been done deserves especial mention. So close and true have the edges of the plates been brought that scarce any caulking was necessary, although, of course, each seam has been thoroughly and perfectly caulked. The plating continues right to the top of rail, no break for plank sheer being visible, which, of course, gives her a bold high side out of the water, and as the bulwarks are higher than ordinary, this increases her apparent size, and when, as is proposed, a heavy solid mahogany rail is put upon this, the effect will be very fine. Her decks, both upper and lower, are to be laid—in fact, this part of the work is finished—with $\frac{5}{16}$in. sheet iron, but upon this, on the upper deck, is to be laid a course of clear, white pine, 3½in. by 3½in. Outside of this the water-ways and plank sheer are to be solid mahogany, and the iron bulwark stanchions will be hidden from view on the inside by a light sheeting of the same wood, laid in panels to enhance the effect.

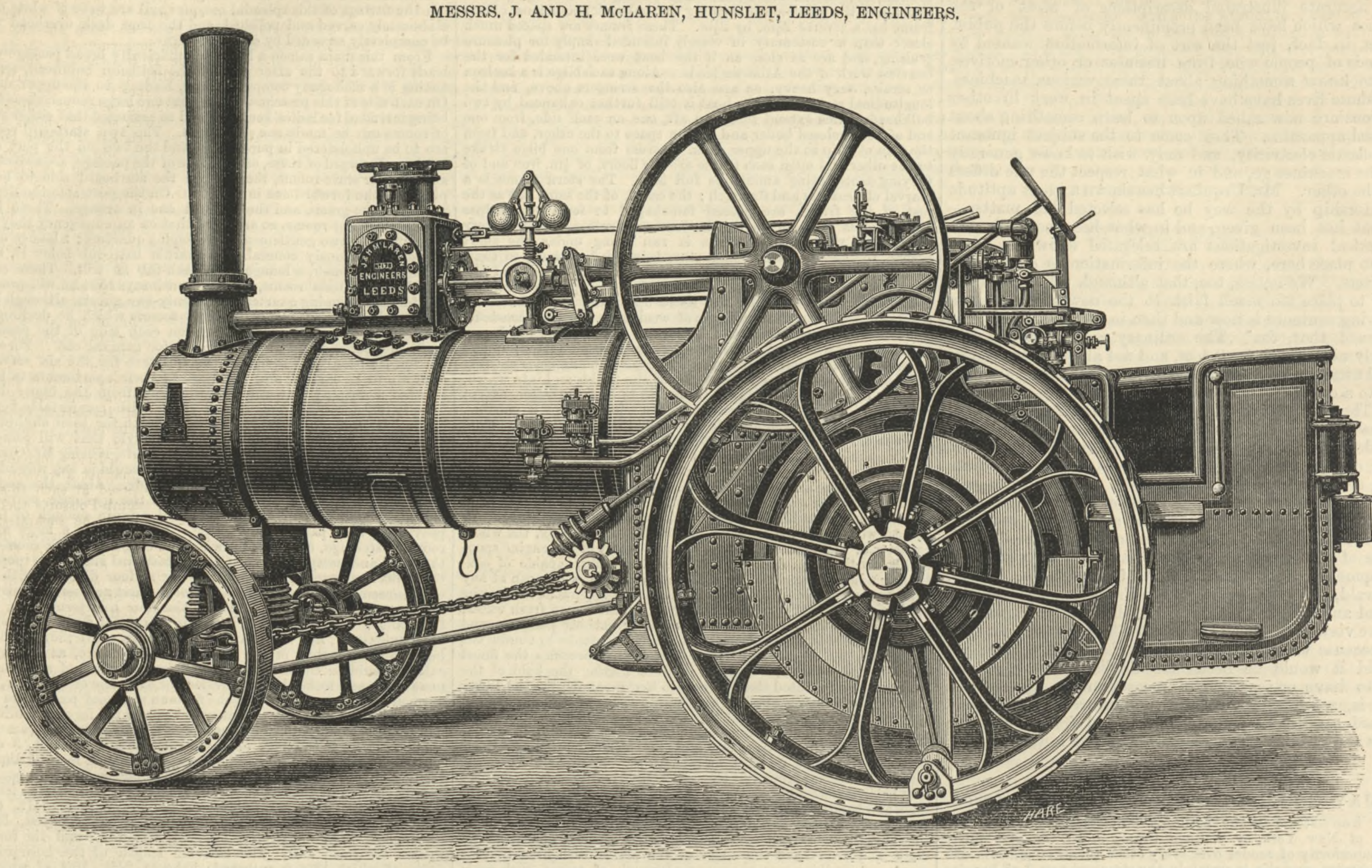
On the lower deck there is something to be attempted that has not been tried before, and that is the inlaying of all kinds of hard wood in designs pleasing to the eye, so that when upon an ocean voyage the carpets perforce are removed and snugly stowed away below, there may still remain something more beautiful than the ordinary pine deck. This and all the other joiner and upholstery work below is by W. W. Smith, of Philadelphia, who was so successful in his fittings of the cabins of the steam yachts Corsair and Stranger two years ago, and it is perhaps a betrayal of his confidence to have told this much of his designs, for he intends that the internal fittings of this vessel shall be unique and original throughout, and will not let his plans be known for fear some envious rival may pirate his patterns. "I have instructed Mr. Cramp," said he, "to lock me and my workmen below while this cabin is fitting and to allow no one to enter. I don't know that I will allow Mr. Cramp himself or the owner of the boat to come in until I have it all complete. I intend it to be a genuine surprise. As to style," he continued laughing, "call it the American Renaissance. It will be entirely original, and I may as well coin an expression to designate it." However, as to this lower deck there will be used maple, butternut, cedar, California laurel, sycamore, and other native woods. The sides of the house on deck will be, as has been said, of iron, sheathed with mahogany panels, with beams of yellow pine and a deck of narrow white pine. It begins about 25ft. abaft the foremast and extends aft 80ft., or to a point about the same distance abaft the mainmast. Its forward part is to be a most elegant apartment, upholstered elaborately for use as a social hall or smoking-room. The steam drum, of course, is enclosed within it, and a large space just abaft this is to be used as a kitchen, the galley stove pipe coming up and entering the smoke stack, thus disposing of all the kitchen odours, which, from the position of the cooking apparatus on Mr. Bennett's yacht, has been found very objectionable. It will communicate with the lower deck by a companion-way, and a passage along the port side will lead to the steward's pantry, the position of which will be shown hereafter. Abaft this is the engine-room, and in the extreme afterpart of this house is to be the room for the captain of the yacht, where will be kept the chronometers, charts, and nautical instruments. The social hall will be entered by doors at either side in the after part of it, and immediately under the bridge, which will thus form a portico to them, sheltering the entrances to this apartment in rainy weather. From the after part of the social hall a broad staircase of mahogany leads below and terminates in a large vestibule, in the centre of which is to be an elegant cabinet armoury, which will be supplied with every description of the most approved pattern of small arms—rifles, pistols, cutlasses, &c. On each side of this will be a door leading to the main saloon, and on each side of the vestibule another door, the starboard one leading to Mr. Gould's room, the port one to the steward's pantry, both of which will also open into the main saloon. The owner's room is an apartment 13½ft. long and 9½ft. wide. At its forward end a recess is built towards the middle of the ship 4½ft. wide by 7ft. long, and in this is to be placed the bedstead, which will be entirely out of sight on entering the room, whose whole extent is thus left clear. This room will be finished entirely in mahogany and will be furnished with all that art can suggest in the way of beauty or convenience. Opening out of it abaft will be a large toilet and bath room. Upon the port side of the stairway leading to the vestibule is the steward's pantry, of the same length as the owner's room, but not quite so wide, with a door at its after end opening into the passage-way above mentioned, by which direct communication may be had with the kitchen. The main saloon is a grand apartment, embracing for 21ft. 3in. the entire width of the yacht, lighted by a large skylight of mahogany and plate glass, and further ventilated by four air ports on each side. In this apartment there will be two massive sideboards, a silver locker, a cabinet library, and a piano. The extension table in the centre will be made double, so that it can be separated and made into two, thus enabling two dining tables to be spread one on either side, so as to accommodate a large number of guests when occasion requires. All the fittings of this splendid banquet hall are to be of white oak, elaborately carved and polished, and the iron deck overhead will be completely screened by artistic designs.

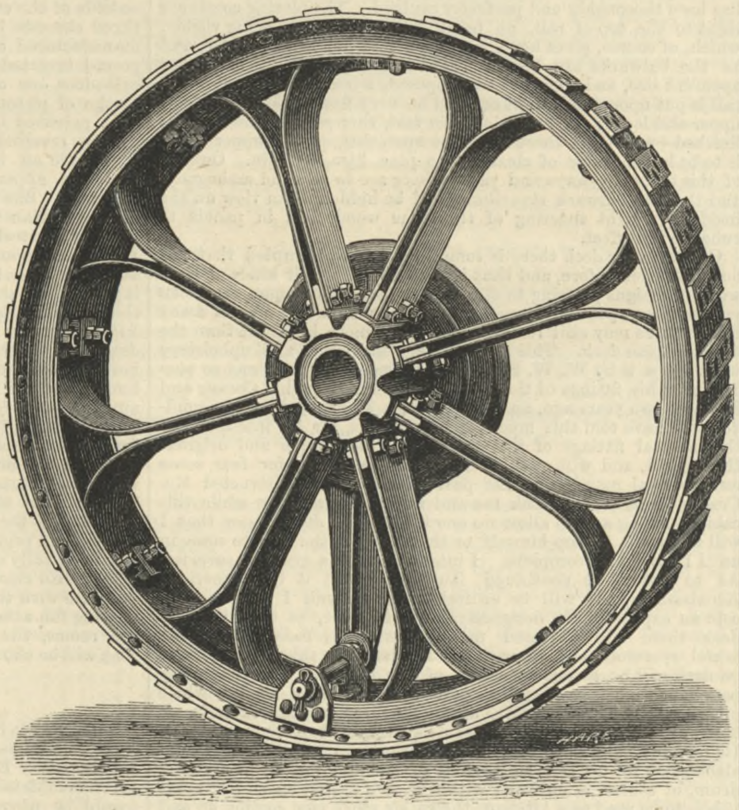
From this main saloon a long and sufficiently broad passage-way leads forward to the after part of the collision bulkhead, terminating in a mahogany companion way, leading to the upper deck. On each side of this passage-way are, first two large rooms, these four being intended for ladies' boudoirs, and so arranged that either suite of rooms can be made one apartment. The two starboard rooms are to be upholstered in pure white, and the two on the port side in blue. Forward of these, on each side of the passage, are two other and smaller state-rooms, the first on the starboard side to be in pink and the forward one in maroon. On the port side the first is to be in olive green, and the forward one in orange. These four are independent rooms, so arranged that on an emergency they can accommodate two gentlemen with sleeping quarters; a lounge upon the side ingeniously concealing a marble bath-tub below it, thus serving as a couch, a lounge, or a bath-tub at will. These eight are the only guests' rooms, but Mr. Smith says that he will provide comfortable sleeping quarters for twenty-two guests, although how he intends to do it is one of the state secrets which he declines to divulge. Forward of these rooms, on each side of the passage-way, is a large toilet and bath-room for general use. Forward of the collision bulkhead are the quarters for the six servants that are to be carried, and entrance to their apartments is from another mahogany companion-way leading from the upper deck. This is fitted in black walnut and cedar, with comfortable berths—three on each side—and lockers underneath for their clothing, a convenient mess table, and, in fact, in a style that will compare very favourably with the cabins of many yachts, it being Mr. Gould's orders that nothing was to be omitted which could in any way add to the comfort and convenience of his people. Abaft the engine-room bulkhead, and placed amidships, is the ice-house, or rather ice-room, for it is of great size, and will contain enough of fresh provisions for a passage to Europe. Abaft this is a large mess-room or steerage, opening into which on either side are rooms for the chief and petty officers. On the starboard side is the room of the chief engineer, communicating by a door directly with the engine-room. Here also are rooms for the first and second assistant engineers, first and second mates, the four quartermasters, and four oilers. Access to these rooms is from the deck by another companion-way, and a similar one leads down abaft the after bulkhead to the quarters of the crew. This aft-castle, as it may be called, would be considered a palace for the cabin of a coaster, a neat berth and locker being provided for each one of the crew, the seamen being on one side and the fireman and coal passers on the other. The whole ship's company to be provided for are as follows:—1 captain, 2 mates, 4 quartermasters, 2 boatswains, 18 seamen, 1 chief engineer, 2 assistant engineers, 3 oilers, 6 firemen, 3 coal-passers, 1 steward, 3 cooks, and 6 servants, in all, 52 men. Although the Atalanta will depend for her propelling power entirely upon her engine, she will still be able to spread considerable canvas, the length of her spars being as follows:—The foremast is 71ft. 6in.; foretopmast, 38ft.; mainmast, 61ft. 6in.; maintopmast, 38ft.; mizenmast, 57ft. 6in.; mizen-topmast, 32ft. 6in.; and the fore or square sail-yard, 49ft. The extreme length of the bowsprit is 24ft., of which 18ft. is outboard; jibboom, 24ft., 16ft. of which is outside of the cap. She will be rigged with the best charcoal wire, three shrouds to a side, and her sails will be made from canvas manufactured expressly for her. She will be propelled by a compound inverted direct-acting surface-condensing engine, with two cylinders, one of 30in. and one of 60in. in diameter, with 30in. stroke of piston. The engine is fitted with the steam-reversing gear patented by the Cramps, by means of which it can be immediately reversed from full speed ahead to full speed astern. It will have an independent circulating pump, and the pumping and fire apparatus is as ample as in the largest passenger steamers. She has also patent steam steering apparatus, and a steam capstan windlass. To supply all this power she has two cylindrical steel boilers, on which she is to be allowed to carry 125 lb. of steam to the square inch. They are 11ft. by 10ft., and have each 120ft. of grate surface. Her nominal horse-power is 1000, but she can work up to much more than that. The shaft is 8½in. in diameter, and carries a four-bladed propeller of 10½ft. diameter and 15ft. pitch. The propeller blades are independent and screwed to the hub. Steaming at the top of her speed, her consumption of coal will be about 20 tons in twenty-four hours; but for ordinary steaming she will only require half that amount, and for an ocean passage she could be run with still less. She will therefore carry in her bunker seventeen days' fuel. Her smoke-stack will be double, and will extend 19ft. 3in. above the drum. The space between the inner and outer shells will be 2in., and the diameter of the outer shell will be 6ft. 2in. The object of thus doubling the stack is to prevent the heat from burning off the paint. She will be lighted throughout by electricity, and probably by the Edison patent, although that has not yet been fully determined upon, and each state-room will be furnished with electric bells communicating with the steward's pantry, and also with the servants' quarters forward. By means of a ventilating fan attached to the engine, and connected by pipes with all the rooms, the air in them will be kept constantly fresh. Her cost will be about 250,000 dols.—*The U.S. Nautical Gazette.*

THE PATENTS FOR INVENTIONS BILL.—Mr. Chamberlain, in reply to a deputation on Monday, stated that when the Patents for Invention Bill came before the Grand Committee on Trade, matters of detail would be thoroughly sifted, and the Government would be prepared to accept such amendments as commended themselves to the majority of the committee. They must, however keep separate what they considered matters of detail and questions of principle. Among the questions of principle, he at once said, was the examination for novelty, such as had been frequently suggested. He was not at all satisfied that the system which obtained in Germany and America was a satisfactory system. In America not only was an immense number of inventions allowed to pass which were not properly subjects for patents, but good inventions were prevented from being patented by reason of this preliminary examination. The Commissioners had to delegate their functions to more than 100 Assistant Commissioners, who were generally badly paid, were not always independent, and were subject to very considerably pecuniary temptations. The decisions of these Assistant Commissioners were very frequently appealed against, and the result was that a patent was a dearer thing than in England. As to the question of fees, he could not admit that they were bound to assert as a principle that the fees should in no case cover more than the expenses of the office. It was provided in the Bill that hereafter the fees might be diminished at the instance of the Board of Trade by means of a mere Parliamentary resolution. As to the method of the payment of the fees—whether they should be paid in three several payments or annually—any annual payment to which he could assent would make the real payment larger than he intended it to be. For instance, in order to obtain the £150 required, £11 annually for 14 years would have to be paid. The poorer classes of inventors, who, under the Bill, would get a four years' patent for £4, would not be able to pay £11, or perhaps even £5 per annum. Dealing with the proposed duration of a patent, he said the feeling of the House of Commons was adverse to extending it. Lastly, there was the question of the Government claim to inventions, which was merely a re-stating and renewal of the claim already established by the great departments of the State, especially the Army and Navy, and that was based upon considerations of public security and public interest. He suggested to the deputation that they should lay their views on this subject before the Admiralty and the War-office. The deputation then withdrew.

TRACTION ENGINE WITH ELASTIC WHEELS.

MESSRS. J. AND H. McLAREN, HUNSLET, LEEDS, ENGINEERS.





IN this journal we have persistently advocated the use of spring-fitted traction engines. A great many attempts have been made at various times to mount engines on springs, but these have always failed because it was difficult to make the motion of the spring accommodate itself to the action of gearing. But very successful spring-fitted chain gear engines were made as much as twenty-five years ago. The most promising scheme for spur-geared engines consists in putting the elastic medium into or on the wheel. The late Mr. Thomson did this with india-rubber tires, and Mr. Bridges Adams suggested putting a ring of india-rubber between the felloes of the wheel and the tire, and this plan was carried out in certain "steam sappers" by Messrs. Aveling and Porter; but india-rubber is very expensive, and the tendency which it always displays to creep round a wheel wears it out. In the engine which we illustrate above, Messrs. McLaren have made a new departure, and produced, in our opinion, the best solution we have met with of the entire difficulty. The engravings go far to explain themselves. It will be seen that the ordinary spokes are replaced by steel plates 8in. wide by ½in. thick. They are bent at the ends, and loosely secured to the inside of the tire by a clamp and two nuts and bolts. In an experimental wheel made on this system the spokes were in continuous pairs—that is, each loop, as we may call it, was in a single piece, as in Fig. 1—but they broke at the point A, and to obviate this they are cut in two, as in the sketch, Fig. 2, and the result has been quite satisfactory. Several of these engines are at work, and one has run over 2000 miles without the slightest evidence of wear. The springs are of crucible cast steel, specially rolled and bent for the purpose, and tempered in oil.

On Friday we watched the performance of one of these engines—the property of Messrs. Bagge and Co., of Newbury—on a trip from Newbury to the new railway works at Tothill, on the line from Didcot to Southampton now being carried out by Messrs. Falkner and Tancred, contractors. The distance from Newbury to a skew bridge being built across the line is four miles, and the road is very hilly. The gross load taken—two wagon loads of bricks—was about 24 tons, but this is much less than the engine

Fig. 1

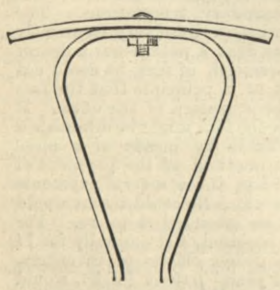
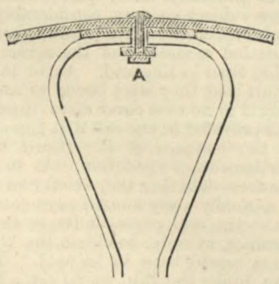


Fig. 2



can take. The trip was made in one and a-half hours, much delay being incurred in waiting for horses to pass and taking in water. No attempt was made to run more quickly than usual. The spring wheels, while not possessing too much elasticity, give great softness of movement. There is none of that jarring vibration—enough, as drivers say, "to shake one's teeth out"—experienced with the ordinary type of engine. A poker may be laid across the tender and will not be shaken off, and the engine is spared an immense number of strains and jars. Nothing can be more satisfactory than the performance of these wheels. It remains to be seen if they will be durable—that is to say, will the springs stand? Experience alone can settle this definitely, but we have no doubt on the point. The question is one for the steel maker, however. There is no undue strain put on the metal, and if the steel is of the right kind it will stand. If it is bad it will crack. It must be understood that no twisting strains are brought on the spokes, for the motion is communicated to the wheel by a long arm keyed on the main shaft and pins. The dimensions of the engine are as follows:—The steam-jacketted cylinder is 9in. diameter by 12in. stroke, and is fitted with a phosphor-bronze slide valve and piston rings; the piston-rod, slide spindle, and other rods are of mild steel. All the working gear is of Yorkshire iron thoroughly case-hardened. The crank shaft is bent out of a bar 4in. diameter, and turned down at the ends to 3¾in; the second motion shaft is 4¼in. diameter of mild steel; the main axle is 5½in. diameter, also of steel; the gearing throughout is Hadfield's cast steel. The engine is fitted with two speeds for the road, viz., ratio of slow speed, 27·4 crank shaft revolutions to 1 of road wheels; ratio of fast speed, 12·4 revolutions to 1 of road wheels. The driving road wheels are 6ft. 3in. diameter by 16in. wide, fitted with hard steel diagonal cross plates 3½in. by ¾in., with 2¾in. spaces between the cross plates. The front wheels are 3ft. 9in. diameter by 10in. wide, fitted with extra long chilled bushes. The axle ends are casehardened. The front end of the engine is carried on a front turning bracket fitted with two of Timmis's springs; the steering is done by worm and chain steerage worked from the foot-plate. The boiler has 152 square feet of heating surface, viz., fire-box, 38 square feet; tubes and front tube plate, 114 square feet; grate area, 6·6 square feet. The width of the engine over all is 7ft. 7⅝in., length from centre to centre of front and back wheels 9ft. 11in. The engine is fitted with a very powerful brake on the second motion shaft, a winding drum and steel rope for hauling heavy loads out of awkward places, and differential gear on the main axle for turning sharp corners, both pump and injector for boiler feeding, a water lifter for filling the tank, and a spring draw hook for pulling the wagons.

THE CAUSE OF EVIDENT MAGNETISM IN IRON STEEL, AND OTHER MAGNETIC METALS.*

By PROFESSOR D. E. HUGHES, F.R.S.

THE extreme sensitiveness of the induction balance to all molecular changes in the structure of metals was remarked in my first paper on this subject to the Royal Society;† and in the case of iron and steel it is most remarkable, as the addition or subtraction of $\frac{1}{5000000}$th part, or the addition of the smallest iron filing to an already large balanced mass of iron, is at once rendered evident and measurable. Possessing such an invaluable instrument of research, I was desirous of investigating the molecular construction of iron and steel; but at once I met with a difficulty, viz., that magnetism itself completely changed the character of any piece of iron under investigation. Consequently, finding no help or explanation of the effects produced from any accepted theories of magnetism, I was forced to investigate, by means of the induction balance, the whole question of magnetism as existing in the interior of a magnet, and to determine the particular structure for each case—such as neutrality and polarity.

In a recent paper to the Royal Society upon the theory of magnetism,‡ I described the use of, and demonstrations obtained by, the induction balance. In this paper I propose to confine myself to demonstrations that can be repeated without it, and whose effects can be observed by the aid of ordinary magnetic direction needles. That magnetism is of a molecular nature has long been accepted; for it is evident that, no matter how much we divide a magnet, we still have its two poles in each separate portion; consequently we can easily imagine this division carried so far that we should at last arrive at the molecule itself, possessing its two distinctive poles; consequently all theories of magnetism attempt some explanation of the cause of this molecular polarity, and the reason for apparent neutrality in a mass of iron.

Coulomb and Poisson assume that each molecule is a sphere containing two distinct magnet fluids, which in the state of neutrality are mixed together, but when polarised are separated from each other at opposite sides; and, in order to explain why these fluids are kept apart as in a permanent magnet, they had to assume again that each molecule contained a peculiar coercive force, whose functions were to prevent any change or mixing of these fluids when separated. There is not one experimental evidence to prove the truth of this assumption; and as regards coercive force, we have direct experimental proof opposing this view, as we know that molecular rigidity or hardness, as in tempered steel, and molecular freedom or softness, as in soft iron, fulfil all the conditions of this assumed coercive force.

Ampère's theory, based upon the analogy of electric currents, supposes elementary currents flowing around each molecule, and that in the neutral state these molecules are arranged haphazard in all directions, but that magnetisation consists in arranging them symmetrically. The objections to Ampère's theory are numerous. (1) We have no knowledge or experimental proof of any elementary electric currents continually flowing without any expenditure of energy. (2) If we admit the assumption of electric currents around each molecule, the molecule itself would then be electro-magnetic, and the question still remains, what is polarity? Have the supposed electric currents separated the two assumed magnetic fluids contained in the molecule, as in Poisson's theory? or are the electric currents themselves magnetic, independent of the iron molecule? In order to produce the supposed heterogeneous

* Paper read before the Society of Telegraph Engineers and of Electricians.

† "On an Induction Current Balance, and Experimental Researches made therewith."—"Proceedings" Royal Society, March 29th, 1879, Page 56.

‡ "Proceedings" Royal Society, May 10th, 1883.

arrangement of neutrality, Ampère's currents would have either to change their position upon the molecule, and have no fixed axis of rotation, or else the molecule, with its currents and polarities, would rotate, and thus be acting in accordance with the theory of De la Rive. (3) This theory does not explain why—as in the case of soft iron—polarity should disappear whenever the exciting cause is removed, as in the case of transient magnetisation. It would thus require a coercive force in iron to cause exactly one-half of the molecules to instantly reverse their direction, in order to pass from apparent external polarity to that of neutrality.

The influence of mechanical vibrations and stress upon iron in facilitating or discharging its magnetism, as proved by Matteucci, 1847, in addition to the discovery by Page, 1837, of a molecular movement taking place in iron during its magnetisation, producing audible sounds, and the discovery by Dr. Joule, 1842, of the elongation of iron when magnetised, led De la Rive, in his remarkable "Treatise on Electricity," 1853, to give his theoretical views upon magnetism in the following remarkable words: "The whole of the magnetic molecular phenomena that we have been studying lead us to believe that the magnetisation of a body is due to a particular arrangement of its molecules, originally endowed with magnetic virtue, but which in the natural state are so arranged that the magnetism of the body that they constitute is not apparent. Magnetism would therefore consist in disturbing this state of equilibrium, or in giving to the particles an arrangement that makes manifest the property with which they are endowed, and not in developing it in them. The coercitive force should be the resistance of the molecules to change their relative positions."

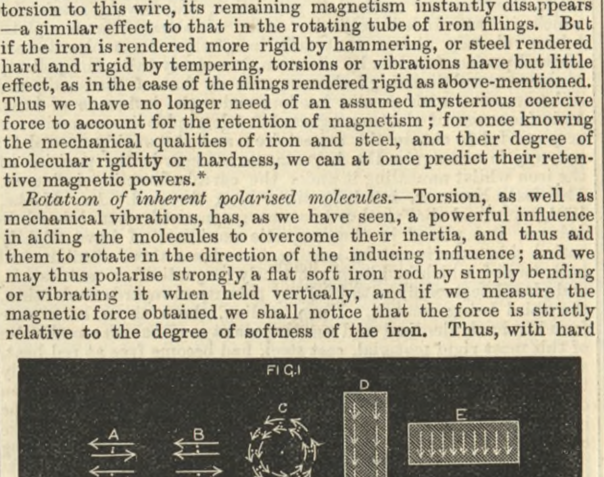
Wiedermann, in 1861, gives the theory in which he admits the fluids of Poisson, or the elementary currents of Ampère, as the cause of polarity of the molecule, but believes that the molecules are turned in a general direction in the case of polarity, and that in neutrality, like Ampère's, the magnetic axes of the molecules are turned in all directions.

Maxwell, in his remarkable treatise on "Electricity and Magnetism," 1881, page 75, gives the following *résumé* of Weber's theory: "Weber's theory differs from Poisson's in assuming that the molecules of the iron are always magnets, even before the application of the magnetising force, but that in ordinary iron the magnetic axes of the molecules are turned indifferently in every direction, so that the iron, as a whole, exhibits no magnetic properties." And again, page 429, Maxwell says he agrees with Weber's views, and that neutrality, or unmagnetised iron, has the axes of its molecules placed indifferently in all directions, and that the act of magnetisation consists in turning all the molecules so that their axes are either rendered all parallel to one direction, or at least deflected in that direction. I have quoted these several theories which admit of the inherent polarity of the molecule, and in that respect they entirely agree with my own; but the induction balance at once shows that they are erroneous in the most important part, for my researches have proved that neutrality is perfectly symmetrical, that there is no case of neutrality where the axes of the molecules are turned indifferently in all directions, and that we cannot obtain perfect neutrality except when the molecules form a complete closed circuit of attraction.

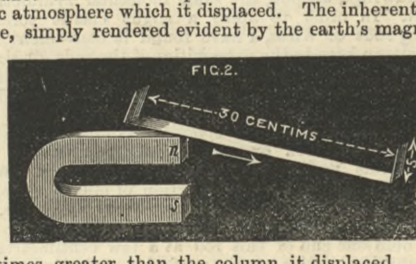
I believe that a true theory of magnetism should admit of complete demonstration, that it should present no anomalies, and that all the known effects should at once be explained by it. From numerous researches I have gradually formed a theory of magnetism entirely based upon experimental results, and these have led me to the following conclusions:—(1) That each molecule of a piece of iron, steel, or other magnetic metal is a separate and independent magnet, having its two poles and distribution of magnetic polarity exactly the same as its total evident magnetism when noticed upon a steel bar-magnet. (2) That each molecule, or its polarity, can be rotated in either direction upon its axis by torsion, stress, or by physical forces such as magnetism and electricity. (3) That the inherent polarity or magnetism of each molecule is a constant quantity like gravity; that it can neither be augmented nor destroyed. (4) That when we have external neutrality, or no apparent magnetism, the molecules, or their polarities, arrange themselves so as to satisfy their mutual attraction by the shortest path, and thus form a complete closed circuit of attraction. (5) That when magnetism becomes evident, the molecules or their polarities have all rotated symmetrically in a given direction, producing a north pole if rotated in that direction as regards the piece of steel, or a south pole if rotated in the opposite direction. Also, that in evident magnetism, we have still a symmetrical arrangement, but one whose circles of attraction are not completed except through an external armature joining both poles. (6) That we have permanent magnetism when the molecular rigidity, as in tempered steel, retains them in a given direction, and transient magnetism whenever the molecules rotate in comparative freedom, as in soft iron.

Experimental evidences.—In the above theory the coercive force of Poisson is replaced by molecular rigidity and freedom; and as the effects of mechanical vibrations, torsion, and stress upon the apparent destruction and facilitation of magnetism is well known, I will, before demonstrating the more serious parts of the theory, cite a few experiments to prove that molecular rigidity fulfils all the requirements of an assumed coercive force. The influence of vibrations, torsion, or stress of any kind upon a magnetised steel or iron rod may be seen by striking with a wooden mallet rods of hard and soft steel, also hard and soft iron previously magnetised to a known degree. The tempered steel, owing to its molecular rigidity, will lose but 5 per cent., the soft steel 60 per cent., hard iron 50 per cent., and soft Swedish iron 99 per cent. of its magnetism, the amount of loss depending not so much upon whether the metal be steel or iron, as upon its degree of hardness and softness; and as hard steel requires far more power to magnetise it to the same force than iron, it is possible to imagine a steel so hard that its molecules could not rotate, and that consequently no magnetism could be manifested from a given inducing cause, while a perfectly soft iron would give the maximum effect, and instantly return to its previous state. From this we might in error suppose that soft Swedish iron could not retain its magnetism, and that its natural state would be zero or neutrality. The apparent disappearance of magnetism, however, is here due to the extreme freedom of motion of its molecules allowing them at once to follow the comparatively feeble directing force of the earth's magnetism. We can demonstrate this by feebly magnetising a rod of soft iron held vertically, so that its north pole is at the lower portion. Upon removing the inducing magnet, or electro-magnetic coil, we find that the rod retains a powerful north polarity; but if magnetised in a contrary sense, then we have only traces of magnetism left upon the withdrawal of the inducing cause. To succeed in this experiment, as in all others where soft iron is mentioned, we should use the best Swedish charcoal iron, thoroughly annealed at high temperature. We find, again, that rods of steel or iron will lose far less magnetism when vibrated in the magnetic dip, or vertically when their north poles are at the lowest extremity than when horizontal, or still less than when their poles are contrary to those of the earth's field, and also that they will acquire their maximum magnetism from a given exciting cause when held vertically as described, and the molecules allowed greater freedom of motion to obey the directing influence by vibrations, torsion, stress, or blows upon the iron. Any influence that would tend to give greater freedom of motion, such as heat or mechanical trepidations, gives a far higher magnetic force to the iron than could be obtained without these aids. In order to render visible the effects of motion upon magnetism, we may take two glass tubes, or ordinary phials, of any length or diameter, say ten centimetres in length by two centimetres in diameter. If we now put iron filings in these tubes, leaving about one-third vacant, so as to allow complete freedom in the filings when shaken, we find that each tube, when magnetised, retains an equal amount of residual magnetism, and that this all disappears upon slightly shaking the tube. We are thus imitating the effects of vibration. But if in one of these tubes we pour melted resin—in fact, any slightly viscous liquid, such as petroleum, suffices—we then render these filings more rigid, and then we can no longer produce by shaking the disappearance of its residual magnetism. In pouring in petroleum we have apparently been introducing a strong coercitive force; but we know that it can only have the mechanical effect of rendering the iron filings less free to turn, and so comparatively rigid. If we desire to see the effect of torsion, we have only to shake the filings so that when the tube is held horizontally the vacant space is above, and rotate it slightly, but without shaking, about a horizontal axis. Its remaining magnetism instantly disappears upon rotation, although we evidently have not changed the longitudinal position of its particles. A similar effect takes place upon a soft iron rod; for if we magnetise it, and observe its remaining magnetism, we find that, upon giving a slight torsion to this wire, its remaining magnetism instantly disappears—a similar effect to that in the rotating tube of iron filings. But if the iron is rendered more rigid by hammering, or steel rendered hard and rigid by tempering, torsions or vibrations have but little effect, as in the case of the filings rendered rigid as above-mentioned. Thus we have no longer need of an assumed mysterious coercive force to account for the retention of magnetism; for once knowing the mechanical qualities of iron and steel, and their degree of molecular rigidity or hardness, we can at once predict their retentive magnetic powers.*

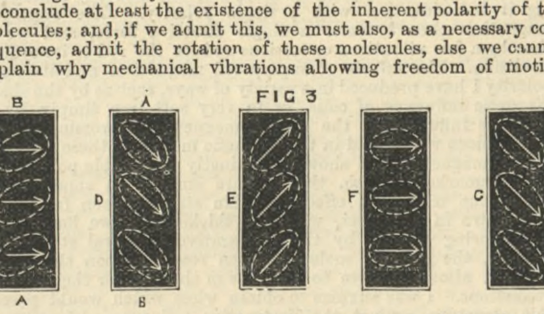
Rotation of inherent polarised molecules.—Torsion, as well as mechanical vibrations, has, as we have seen, a powerful influence in aiding the molecules to overcome their inertia, and thus aid them to rotate in the direction of the inducing influence; and we may thus polarise strongly a flat soft iron rod by simply bending or vibrating it when held vertically, and if we measure the magnetic force obtained we shall notice that the force is strictly relative to the degree of softness of the iron. Thus, with hard



steel we should obtain only traces of polarisation, whilst with extremely pure soft Swedish iron we obtain the maximum of force. The bar of iron or steel, being held in the earth's magnetic field, of infinite size compared with the bar, and infinitely homogeneous, cannot deflect or weaken its surrounding field. Its lower portion being north, apparently strengthens it by its reaction, whilst its upper, south, apparently weakens the field; but, as Maxwell has shown, "the two poles of each molecule are equal and opposite, consequently the sum of each molecule and the whole mass must be zero." We have a far greater induced polarity in iron or steel when the iron is in thin bars or small wires, and this we should expect, as the external molecules rotate directly under the influence of the earth's magnetism, whilst those forming the interior of the bar either rotate feebly, or, as in the case of very thick bars, actually act as an armature, preventing, by their influence, free rotation of the exterior molecules. Thus, as the sum of the two and equal polarities in a bar of iron is zero, it is evident that its polarity must be inherent. I have some remarkably pure soft Swedish iron wire, one millimetre in diameter, and as its inherent polar force seemed great when held vertically in the earth's magnetic field, I measured in the induction balance this force compared with a similar column of the magnetic atmosphere which it displaced. The inherent polarity of this wire, simply rendered evident by the earth's magnetism, was



15,600 times greater than the column it displaced. We cannot, either by induction, conduction, or concentration, produce a greater force in another body of similar displacement or size, otherwise we could easily create power from a feeble source. Thus the enormously greater magnetic power observed in iron than the same column of air which it displaces must be due to the inherent polarity of its molecules. Amongst numerous bars of iron upon which I have experimented, one of ordinary hoop iron, 2 centimetres wide, 40 centimetres long, and $1\frac{1}{2}$ millimetre thick, not softened, possesses sufficient molecular rigidity to be apparently uninfluenced by earth's magnetism. When this rod is rendered neutral, we have but feeble polarity—mere traces when it is held vertically under the earth's magnetic influence; but if we apply a few successive torsions or vibrations to it when thus held, we have at once several thousand times greater polarity than before. Now, if iron had the power of deflecting or concentrating the earth's magnetism upon itself, it should not require the mechanical aid to molecular rotation given to it by these torsions or vibrations. Thus we are forced to conclude at least the existence of the inherent polarity of the molecules; and, if we admit this, we must also, as a necessary consequence, admit the rotation of these molecules, else we cannot explain why mechanical vibrations allowing freedom of motion



should always produce the polarity in accordance with the directing cause. I have already shown that torsion and vibration *per se* are apparently destructive of magnetism; consequently in this case Poisson's two fluids and Ampère's parallel currents should, according to their theory, be mixed or heterogenous, whilst according to the views I am sustaining, the polarised molecules should obey, as compass needles, any magnetic directing cause whenever sufficient molecular freedom of motion allows free rotation. The inherent polarity of iron may again be observed by drawing a flat rod of soft iron over one or both poles of a permanent magnet. This rod will then be powerfully magnetised, its remaining magnetism, when separated from the magnet, being sufficiently powerful to strongly deflect a suspended direction needle. A few slight torsions or vibrations will then completely discharge it. Now, suppose this operation repeated successively many thousand times, if there was no inherent polarity we should have gradually drawn all the polarity out of the magnet, and discharged it into the atmosphere. Nothing of the kind takes place. The molecules of the iron are simply rotated each time, and the only energy in work expended or lost comes from the arm of the experimenter, and the energy required would be strictly in accordance with the molecular freedom, or softness and hardness of the iron and steel: thus, whilst soft iron could be easily polarised and discharged by mechanical torsions, hard-tempered steel would require a far greater amount. Dr. Warren de la Rue, F.R.S., kindly aided me in this part of the research by passing a current from his well-known chloride of silver battery through iron and steel wires. A condenser of 42·8 microfarad capacity, charged by 3 360 cells, was used. We passed this enormous electric charge longitudinally through the wires, and observations were made as to whether any change whatever was produced in their quality or inherent polarity, the result being that these wires gave exactly the same magnetic polarity from a given directing or inducing cause as before, being similar in nature and degree, consequently this enormous electric force had not changed or destroyed the original inherent polarity. If the molecules possess inherent polarity and rotate upon their axes, similar to a series of compass needles having a slight degree of frictional rigidity, then, upon passing one pole of a magnet above them, they would turn symmetrically in one direction, and drawing the same pole of the magnet in the contrary direction would rotate them, and they would then remain symmetrically in the opposite direction. A precisely similar effect takes place in a soft iron rod, placed east and west a few inches above a direction needle. Upon drawing the south pole of a powerful natural magnet at a few centimetres distance above the wire from east to west, the north polarities of the molecules successively turn in the direction of west, following the attraction of the south pole, as previously seen on the small compass needles. The rod is now magnetised with its north pole west, as indicated by the direction needle below any portion of this rod. Upon passing the same south pole of the natural magnet in a contrary direction the molecules all rotate, their north poles still turning successively to the south pole of the permanent magnet until its arrival at the end from which the first magnetisation commenced. The rod has now entirely changed its polarity and its north pole is east. The phenomenon is well known in the ordinary magnetisation of rods, where care is taken to draw the magnet always in a similar direction, or the poles would be reversed at each to-and-fro drawing. To account for this, on Coulomb-Poisson's theory, it would be requisite that, first, all the fluids be separated with their north fluids symmetrically in one direction, but on drawing back the magnet these fluids would have to mix together, the north fluid passing through its south fluid to be finally opposite to its previous position, its coercive force doing the double work of allowing both fluids to mix and pass through each other, and finally keeping them entirely apart. Ampère's theory would require that from a haphazard arrangement the molecules should become symmetrically arranged upon the first passage of the magnet; then upon its reversed direction one half of the electric elementary currents should successively revolve in a contrary direction to arrive at neutrality before, finally, the other half followed the direction of the first half, and now all these currents would be revolving in the opposite direction to that upon the first magnetisation. We thus see that both these theories, whilst resting altogether upon assumption, are extremely complicated and improbable. We might suppose, from the theory which I am advocating, that upon the rotation of the molecules there would be some disturbance or mechanical trepidation; and such is found to be the case, as first observed by Page, and afterwards verified by Dr. Joule and De la Rive, in the molecular sound produced in iron upon its magnetisation. Reis's first telephone was founded upon these sounds, and Du Moncel has made numerous researches upon this subject. In the last of my experiments cited the sounds are too feeble to be heard, but by the application of the microphone these trepidations at once become audible. That molecules of iron and other metals rotate with time, whose period becomes shortened by mechanical vibrations, is well known in metallurgy, the ultimate result being generally the passage from a fibrous condition, as in iron wires, to a high degree of crystallisation. For many years I employed a circular vibrating spring as the regulator of speed of my printing telegraph instrument, and although this spring was so regulated by means of a frictional brake, or "Frein," as not to surpass its limits of elasticity, these springs were constantly breaking after a few days' use, and, as a matter of urgent necessity, I made special researches into the cause of this breaking after a few days' constant vibratory action. I found at the point of rupture a high state of crystallisation. Fibrous iron would thus become thoroughly crystallised and break in one day; the number of vibrations for an instrument in constant use during twenty-four hours being 1,209,600. Thus we could roughly estimate the life of iron in the form of one of these springs at one million vibrations. Copper crystallised in one hour, and all metals and alloys were inferior to steel, except aluminium bronze. The latter springs would stand six weeks' constant use, or some fifty millions of vibrations. I finally resolved this problem by spreading the amount of vibrating work over a spiral spring containing three metres of steel rod wound into the same space as previously held by the straight rod of thirty centimetres; by this means the average life of these springs has become five years. Evidently the molecules of these fibrous springs must have rotated under the vibrations, in order to produce crystals. The same phenomenon is observed in axles of carriages receiving constant trepidations, large crystals being always found at the point of fracture. Again, if we rapidly magnetise and demagnetise an iron rod, we have the production of evident heat, due to the constant motion of its molecules. Maxwell describes an experiment of Beetz, in which an exceedingly small filament of iron was deposited by electrotype, under the influence of a strong magnetic field, in order to arrive at the inherent polarity of comparatively few molecules, and, as its magnetic force was very great, he regards the experiment as conclusive. My own experiments show that we have far less external magnetic force from a solid bar than from a thin tube or flat bar of the same surface exposed to a limited exciting cause. We know that magnetism does not penetrate to a very great depth, and we also know that, if to a thin steel permanent magnet we place another piece unmagnetised, or, better still, a rod of soft iron, its external polarity is greatly reduced; consequently the external evidence of polarity is not a direct measure of the degree of rotation, nor of the total inherent polarity of its mass. We may have a great superficial external rotation superposed upon rotations of an opposite nature, as will be seen later; and thus the internal molecules of a magnet often act more or less as an external armature in closing its circle of attractions. I have stated my belief that the molecule itself possesses its inherent polarity, which, like gravity, is an endowed quality for which we have no more reason to suspect the cause to be elementary electric currents than that elementary currents should be the cause of gravity, chemical affinity, or cohesion and its polar power of crystallisation, most of which are affected by an electric current. We have a certain analogy between electric currents and magnetism, but not so great as the analogy between the magnetic polarity of a molecule and its other endowed qualities. Magnetism, like chemical affinity, cohesion, and crystallisation, has its critical points. Faraday discovered that at red-yellow heat iron instantly lost its apparent polar magnetic power, to be as instantly restored at red heat, the critical point varying in iron steel, &c., and being the lowest in nickel. This would be difficult to explain upon Ampère's theory, as we should have to admit the instant destruction or cessation of the elementary currents to be again restored at a few degrees less temperature. It would be equally difficult to explain under my view, if it did not belong to a whole class of phenomena due to the possession by the molecules of various endowed qualities, of which chemistry and all our means of research can only teach us their critical points, without attempting to explain why, for instance, iron has a greater affinity for oxygen than gold. We know that it is so; we know that the molecules of all matter are endowed with certain qualities having certain critical points, and I can see no reason for separating their magnetic inherent polarity from their numerous other qualities.

Neutrality.—The apparatus needed for researches upon evident external polarity requires no very great skill or thought, but simply an apparatus to measure correctly the force of the evident

* "On the Molecular Rigidity of Tempered Steel," by Professor D. E. Hughes, F.R.S.—"Proceedings" Institution of Mechanical Engineers, pages 72-79, January, 1883.

repulsion or attraction; in the case of neutrality, however, the external polarity disappears, and we consequently require special apparatus, together with the utmost care and reflection in its use. From numerous researches previously made by means of the induction balance, the results of which I have already published, I feel convinced that in investigating the cause of magnetism and neutrality I should have in it the aid of the most powerful instrument of research ever brought to bear upon the molecular construction of iron, as indeed of all metals. It neglects all forces which do not produce a change in the molecular structure, and enables us to penetrate at once to the interior of a magnet or piece of iron, observing only its peculiar structure and the change which takes place during magnetisation or apparent neutrality. The induction balance is affected by three distinct arrangements of molecular structure in iron and steel, by means of which we have apparent external neutrality. Fig. 1 shows several polar directions of the molecules as indicated by the arrows. Poisson assumed, as a necessity of his theory, that a molecule is spherical, but Dr. Joule's experimental proof of the elongation of iron by $\frac{1}{720000}$ of its length when magnetised, proves at least that its form is not spherical; and, as I am unable at present to demonstrate my own views as to its exact form, I have simply indicated its polar direction by arrows—the dotted oval lines merely indicating its limits of free elastic rotation. In Fig. 1, at A, we have neutrality by the mutual attraction of each pair of molecules, being the shortest path in which they could satisfy their mutual attractions. At B we have the case of superposed magnetism of equal external value, rendering the wire or rod apparently neutral, although a lower series of molecules are rotated in the opposite direction to the upper series, giving to the rod opposite and equal polarities. At C we have the molecules arranged in a circular chain around the axis of a wire or rod through which an electric current has passed. At D we have the evident polarity induced by the earth's directive influence when a soft iron rod is held in the magnetic meridian. At E we have a longitudinal neutrality produced in the same rod when placed magnetic west, the polarity in the latter case being transversal. In all these cases we have a perfectly symmetrical arrangement, and I have not yet found a single case in well-annealed soft iron in which I could detect a heterogeneous arrangement, as supposed by Ampère, De la Rive, Weber, Wiedermann, and Maxwell. We can only study neutrality with perfectly soft Swedish iron. Hard iron and steel retain previous magnetisations, and an apparent external neutrality would in most cases be the super-position of one magnetism upon another of equal external force in the opposite direction, as shown at B, Fig. 1. Perfectly soft iron we can easily free, by vibrations, from the slightest trace of previous magnetism, and study the neutrality produced under varying conditions. If we take a flat bar of soft iron, of 30 or more centimetres in length, and hold it vertically—giving while thus held a few torsions, vibrations, or, better still, a few slight blows with a wooden mallet, in order to allow its molecules to rotate with perfect freedom—we find its lower end to be of strong north polarity, and its upper end south. On reversing the rod and repeating the vibrations, we find that its lower end has precisely a similar north polarity, Thus the iron is homogeneous, and its polarity symmetrical. If we now magnetise this rod to produce a strong south pole at its lower portion, we can gradually reverse this polarity, by the influence of earth's magnetism, by slightly tapping the upper extremity with a small wooden mallet. If we observe this rod by means of a direction needle at all parts, and successively during its gradual passage from one polarity to the other, there will be no sudden break into a haphazard arrangement, but a gradual and perfectly symmetrical rotation from one direction to that of the opposite polarity. If this rod is placed east and west, having first, say, a north polarity to the right, we can gradually discharge or rotate the molecules to zero, and as gradually reverse the polarity by simply inclining the rod so as to be slightly influenced by earth's magnetism; and at no portion of this passage from one polarity to neutrality, and to that of the opposite name, will there be found a break of continuity of rotation or haphazard arrangement. If we rotate this rod slowly, horizontally or vertically, taking observations at each few degrees of rotation of an entire revolution, we find still the same gradual symmetrical change of polarity, and that its symmetry is as complete at neutrality as in evident polarity. In all these cases there is no complete neutrality, the longitudinal polarity simply becoming transversal when the rod is east and west. F, G, H, I, J, Fig. 1, show this gradual change, H being neutral longitudinally, but polarised transversely. If, in place of the rod, we take a small square soft iron plate and allow its molecules freedom under the sole influence of the earth's magnetism, then we invariably find the polarity in the direction of the magnetic dip, no matter in what position it may be held, and a sphere of soft iron could only be polarised in a similar direction. Thus we can never obtain complete external neutrality whilst the molecules have freedom and do not form an internal closed circle of mutual attractions; and whatever theory we may adopt as to the cause of polarity in the molecule, such as Coulomb's, Poisson's, Ampère's, or Weber's, there can exist no haphazard arrangement in perfectly soft iron, as long as it is free from all external causes except the influence of the earth; consequently these theories are wrong in one of their most essential parts. We can, however, produce a closed circle of mutual attraction in iron and steel, producing complete neutrality as long as the structure is not destroyed by some stronger external directing influence. Oersted discovered that an external magnetic needle places itself perpendicular to an electric current; and we should expect that, if the molecules of an iron wire possessed inherent polarity and could rotate, a similar effect would take place in the interior of the wire to that observed by Oersted. Wiedermann first remarked this effect, and it has been known as circular magnetism. This circle, however, consists really in each molecule having placed itself perpendicular to the current, simply obeying Oersted's law, and thus forming a complete circle in which the mutual attractions of the molecules forming that circle are satisfied, as shown at C, Fig. 1. This wire becomes completely neutral, any previous symmetrical arrangement of polarity rotating to form its complete circle of attractions, and we can thus form in hard iron and steel a neutrality extremely difficult to break up or destroy. We have evident proof that this neutrality consists of a closed chain, or circle, as by torsion we can partially deflect them on either side; thus from a perfect externally neutral wire, producing either polarity by simple mechanical angular displacement of the molecules, as by right or left-handed torsion. If we magnetise a wire placed east and west, it will retain this polarity until freed by vibrations, as already remarked. If we pass an electric current through this magnetised wire, we can notice the gradual rotation of the molecules, and the formation of the circular neutrality. If we commence with a weak current, gradually increasing its strength, we can rotate them as slowly as may be desired. There is no sudden break or haphazard moment of neutrality; the movements to perfect zero are accomplished with perfect symmetry throughout. We can produce a more perfect and shorter circle of attractions by the superposition of magnetism, as at B, Fig. 1. If we magnetise a piece of steel or iron in a given direction with a strong magnetic directing power, the magnetism penetrates to a certain depth. If we slightly diminish the magnetising power, and magnetise the iron in a contrary direction, we may reduce it to zero by the superposition of an exterior magnetism upon one of a contrary name existing at a greater depth; and if we continue this operation, gradually diminishing the force at each reversal, we can easily superpose ten or more distinct symmetrical arrangements; and as their mutual attractions are satisfied in a shorter circle than in that produced by electricity, it is extremely difficult to destroy this formation when once produced. The induction balance affords also some reasons for believing that the molecules not only form a closed circle of attractions—as at B—but that they can mutually react upon each other, so as to close a circle of attractions as a double molecule—as shown at A. The experimental evidence, however, is not sufficient to dwell on this point, as the neutrality obtained by superposition is somewhat similar in its external effects. We can produce a perfectly symmetrical closed circle of attractions of the nature of the neutrality of C, Fig. 3, by forming a steel wire into a closed circle, 10 centimetres in diameter, if this wire is well joined at its extremities by twisting and soldering. We can then magnetise this ring by slowly revolving it at the extremity of one pole of a strong permanent magnet; and, to avoid consequent poles at the part last touching the magnet, we should have a graduating wedge of wood, so that whilst revolving it may be gradually removed to greater distance. This wire will then contain no consequent points or external magnetism; it will be found perfectly neutral in all parts of its closed circle. Its neutrality is similar to C, Fig. 3; for if we cut this wire at any point we find extremely strong magnetic polarity, being magnetised by this method to saturation, and having retained—which it will indefinitely—its circle of attractions complete. I have already shown that soft iron, when its molecules are allowed perfect freedom by vibration, invariably takes the polarity of the external directing influence, such as that of the earth, and it does so even with greater freedom under the influence of heat. Manufacturers of electro-magnets for telegraphic instruments are very careful to choose the softest iron and thoroughly anneal it; but very few recognise the importance as regards the position of the iron whilst annealing it under the earth's directing influence. The fact, however, has long since been observed. Dr. Hooke, 1684, remarked that steel or iron was magnetised when heated to redness, and placed in the magnetic meridian. I have slightly varied this experiment by heating to redness three similar steel bars, two of which had been previously magnetised to saturation, and placed separately with contrary polarity as regards each other, the third being neutral. Upon cooling, these three bars were found to have identical and similar polarity. Thus the molecules of this most rigid material, cast steel, had become free at red heat, and rotated under the earth's magnetic influence, giving exactly the same force on each; consequently the previous magnetisation of two of these bars had neither augmented nor weakened the inherent polarity of their molecules. Soft iron gave under these conditions by far the greatest force, its inherent polarity being greater than that of steel. I have numerous other experiments bearing upon the question of neutrality, but they all confirm those I have cited, which I consider afford ample evidence of the symmetrical arrangement of neutrality.

Superposed magnetism.—Knowing that by torsion we can rotate or diminish magnetism, I was anxious to obtain by its means a complete rotation from north polarity to neutrality, and from neutrality to south polarity, or to completely reverse magnetic polarity by a slight right or left torsion. I have succeeded in doing this, and in obtaining strong reversal of polarities, by superposing one polarity given whilst the rod is under a right elastic torsion, with another of the opposite polarity given under a left elastic torsion, the neutral point then being reached when the rod is free from torsion. The rod should be very strongly magnetised under its first or right-hand torsion, so that its interior molecules are rotated, or, in other words, magnetised to saturation; the second magnetisation in the contrary sense and torsion should be feebler, so as only to magnetise the surface, or not more than one-half its depth; these can be easily adjusted to each other so as to form a complete polar balance of force, producing, when the rod is free from torsion, the neutrality as shown at B, Fig. 1. The apparatus needed is simply a good compound horseshoe permanent magnet, fifteen centimetres long, having six or more plates, giving it a total thickness of at least three centimetres. We need a sufficiently powerful magnet, as I find that I obtain a more equal distribution of magnetism upon a rod or strip of iron by drawing it lengthwise over a single pole in a direction from that pole, as shown in Fig. 2; we can then obtain saturation by repeated drawings, keeping the same molecular symmetry in each experiment. In order to apply a slight elastic torsion when magnetising rods or wires, I have found it convenient to attach two brass clamp keys to the extremities of the rods, or simply turn the ends at right angles, as shown in the following diagram, by which means we can apply an elastic twist or torsion whilst drawing the rod over the pole of the permanent magnet. We can thus superpose several and opposite symmetrical structures, producing a polar north or south as desired, greatly in excess of that possible under a single or even double magnetisation, and by carefully adjusting the proportion of opposing magnetisms, so that both polarities have the same external force, the rod will be at perfect external neutrality when free from torsion. If we now hold one end of this rod at a few centimetres distance from a magnetic directive needle, we find it perfectly neutral when free of torsion, but the slightest torsion right or left at once produces violent repulsion or attraction, according to the direction of the torsion given to the rod, the iron rod or strips of hoop iron which I use for this experiment being able, when at the distance of five centimetres from the needle, to turn it instantly 90 deg. on either side of its zero. The external neutrality that we can now produce at will is absolute, as it crosses the line of two contrary polarities, being similar to the zero of my electric sonometer, whose zero is obtained by the crossing of two opposing electric forces. This rod of iron retains its peculiar powers of reversal in a remarkable degree, a condition quite different to that of ordinary magnetisation, for the same rod, when magnetised to saturation under a single ordinary magnetism, loses its evident magnetism by a few elastic torsions, as I have already shown; but when it is magnetised under the double torsion with its superposed magnetism, it is but slightly reduced by variations or numerous torsions, and I have found it impossible to render this rod again free from its double polar effects, except by strongly remagnetising it to saturation with a single polarity. The superposed magnetism then becomes a single directive force, and we can then by a few vibrations or torsions reduce the rod to its ordinary condition. The effects of superposed magnetism and its double polarity I have produced in a variety of ways, such as by the electro-magnetic influence of coils, or in very soft iron simply by the directive influence of the earth's magnetism, reversing the rod and torsions when held in the magnetic meridian, these rods when placed magnetic west showing distinctly the double polar effects. It is remarkable, also, that we are enabled to superpose and obtain the maximum effects on thin strips of iron from $\frac{1}{4}$ to $\frac{1}{2}$ millimetre in thickness, whilst in thicker rods we have far less effect, being masked by the comparatively neutral state of the interior, the exterior molecules then reacting upon those of the interior, allowing them to complete in the interior their circle of attractions. I was anxious to obtain wires which would preserve this structure against the destructive influence of torsion and vibrations, so that I could constantly employ the same wires without the comparatively long and tedious process of preparation. Soft iron soon loses the structure, or becomes enfeebled, under the constant to-and-fro torsions requisite where we desire a constant change of polarity, as described later in the magnetic cells. Hard steel preserves its structure, but its molecular rigidity is so great that we obtain but mere traces of any change of polarity by torsion. I have found, however, that fine cast drill steel, untempered, of the kind employed by watchmakers, is most suitable: these are generally sold in straight lengths of 30 centimetres. Wires one millimetre in diameter should be used, and when it is desired to increase the force, several of these wires, say, nine or ten, should be formed into a single rod or bunch. The wire as sold is too rigid to give its maximum of molecular rotation effect. We must therefore give it two entire turns or twists to the right, and strongly magnetise it on the north pole of the magnet whilst under torsion. We must again repeat this operation in the contrary direction, after restoring the wire to its previous position, giving now two entire turns to the left and magnetising it on the south pole. On restoring the wire to its original place, it will be extremely flexible, and we may now superpose several contrary polarities under contrary torsions, as already described. The power of these wires, if properly prepared, is most remarkable, being able to reverse their polarity under torsion, as if they were completely saturated; and they preserve this power indefinitely if not touched by a magnet. It would be extremely difficult to explain the action of the rotative effects obtained in these wires under any other theory than that which I have advanced; and the absolute external neutrality that we obtain in them when the polarities are changing, we know, from their structure, to be perfectly symmetrical. I was anxious to show, upon the reading of this paper, some mechanical movement produced by molecular rotation, consequently I have arranged two bells that are struck alternately by a polarised armature put in motion by the double polarised rod I have already described, but whose position, at 3 centimetres distance from the axis of the armature, remains invariably the same. The magnetic armature consists of a horizontal light steel bar suspended by its central axle; the bells are thin wine glasses, giving a clear musical tone loud enough, by the force with which they are struck, to be clearly heard at some distance. The armature does not strike these alternately by a pendulous movement, as we may easily strike only one continuously, the friction and inertia of the armature causing its movements to be perfectly dead-beat when not driven by some external force, and it is kept in its zero position by a strong directive magnet placed beneath its axle. The mechanical power obtained is extremely evident, and is sufficient to put the sluggish armature in rapid motion, striking the bells six times per second, and with a power sufficient to produce tones loud enough to be clearly heard in all parts of the hall of the Society. As this is the first direct transformation of molecular motion into mechanical movement, I am happy to show it on this occasion. There is nothing remarkable in the bells themselves, as they evidently could be rung if the armature was surrounded by a coil, and worked by an electric current from a few cells. The marvel, however, is in the small steel superposed magnetic wire producing by slight elastic torsions from a single wire, one millimetre in diameter, sufficient force from mere molecular rotation to entirely replace the coil and electric current.

Elastic nature of the ether surrounding the magnetic molecules.—During these researches I have remarked a peculiar property of magnetism, viz., that not only can the molecules be rotated through any degree of arc to its maximum, or saturation, but that, whilst it requires a comparatively strong force to overcome its rigidity or resistance to rotation, it has a small field of its own through which it can move with excessive freedom, trembling, vibrating, or rotating through a small degree with infinitely less force than would be required to rotate it permanently on either side. This property is so marked and general that we can observe it without any special iron or apparatus. Let us take a flat rod of ordinary hoop iron, 30 or more centimetres in length. If, whilst holding this vertically, we give freedom to its molecules by torsions, vibrations, or better still, by a few blows with a wooden mallet upon its upper extremity, we find, as is well known, that its lower portion is strongly north and its upper south. If we reverse this rod we now find it neutral at both extremities. We might here suppose that the earth's directing force had rotated the molecules to zero or transversely, which in reality it has done, but only to the limit of their comparatively free motion; for if we reverse the rod to its original position, its previous strong polarity reappears at both extremities; thus the central point of its free motion is inclined to the rod, giving by its free motion great symmetrical inclination and polarity in one direction, but when reversed the inclination is reduced to zero. In Fig. 3, D shows the bar of iron when strongly polarised by earth's magnetic influence, under vibrations, with a sufficient force to have rotated its elastic centre of action. C shows the same bar with its molecules at zero, or transversal, the directing force of earth being insufficient without the aid of mechanical vibration to allow them to change. The dotted lines of D suppose the molecule to be in the centre of its free motion, whilst at C the molecules have rotated to zero, as they are prevented from further rotation by being at the extreme end of its free motion. If, now, we hold the free rod vertically, as at C, giving neutrality, and give a few slight blows with a wooden mallet to its upper extremity, we can give just the amount of freedom required for it to produce evident polarity, and we then have equal polarity, no matter which end of the bar is below, the centre of its free rotation here being perfect, and the rod perfectly neutral longitudinally when held east and west. If, on the other hand, we have given too much freedom by repeated blows of the mallet, its centre of free motion becomes inclined with the molecules, and we arrive at its first condition, except that it is now neutral at D and polarised at C. From this it will be seen that we can adjust this centre of action, by vibrations or blows, to any point within the external directing influence. We can perceive this effect of free rotation in a limited space in all classes of iron and steel, being far greater in soft Swedish iron than in hard iron or steel. A similar phenomenon takes place if we magnetise a rod held vertically in the direction of earth's magnetism. It then gives greater polarity than if magnetised east or west, and if magnetised in a contrary sense to earth's magnetism, it is very feebly magnetised, or, if the rod is perfectly soft, it becomes neutral after strong magnetisation. This property of comparative freedom, and the rotation of its centre of action, can be demonstrated in a variety of ways. One remarkable example of it consists in the telephone. All those who are thoroughly acquainted with electro-magnetism, and know that it requires measurable time to charge an electro-magnet to saturation—about one-fifteenth of a second for those employed in telegraphy—were surprised that the telephone could follow the slightest change of timbre, requiring almost innumerable changes of force per second. I believe the free rotation I have spoken of through a limited range explains its remarkable sensitiveness and rapidity of action; and according to this view it would also explain why loud sounding telephones can never repeat all the delicacy of timbre that is easily done with those only requiring a force comprised in the critical limits of its free rotation. This property, I have found, has a distinct critical value for each class of iron, and I propose soon to publish researches upon the molecular construction of steel and iron, in which I have made use of this very property as a guide to the quality of the iron itself. The elastic rotation—in a limited space—of a molecule differs entirely from that known as mechanical elasticity. In perfectly soft iron we have feeble mechanical elasticity, whilst in tempered steel we have that elasticity at its maximum. The contrary takes place as regards molecular elasticity. In tempered steel the molecules are extremely rigid, and in soft iron its molecular elasticity is at its maximum. Its free motion differs entirely from that given it by torsion or stress. We may assume that a molecule is surrounded by continuous ether, more of the nature of a jelly than of that of a gas; in such a medium a molecule might freely vibrate through small arcs, but a rotation extending beyond its critical limit would involve a much greater expenditure of force. The discovery of this comparatively free rotation of molecules, by means of which, as I have shown, we can—without in any degree disturbing the external mechanical elasticity of the mass—change the axes of their free motion in any direction desired, has led me into a series of researches which have only indirectly any relation with the theory of magnetism. I was extremely desirous, however, of finding an experimental evidence which in itself should demonstrate all portions of the theory, and the following experiment, I believe, answers this purpose. Let us take a square soft iron rod, five millimetres in diameter by thirty or more centimetres in length, and force the molecules, by aid of blows from a wooden mallet, as previously described, to have their centres of free motion in one direction, the rod will—as already shown—have polarity at both ends when held vertically, but if reversed both ends become completely neutral. If now we turn the rod to its first position, in which it shows strong polarity, and magnetise it whilst held vertically, by drawing the north pole of a sufficiently powerful permanent magnet from its upper to its lower extremity, we find that this rod, instead of having south polarity at its lower portion, as we should expect from the direction of the magnetisation, is completely neutral at both extremities, but if we reverse the rod its fullest free powers of magnetisation now appear in the position where it was previously neutral. Thus, by magnetisation, we have completely rotated its free path of action, and find that we can rotate this path as desired to any direction by the application of a sufficient directing power. If we take a rod as described, with its polarities evident when held vertically, and its neutrality also evident when its ends are reversed in the same magnetic field, we find that its polarity is equal at both ends, and that it is in every way symmetrical with a perfect magnet. If we gradually reverse the ends and take observations of its condition through each degree of arc passed over, we find an equal symmetrical diminution of evident external polarity until we arrive at neutrality, when it has no external trace of inherent polarity, but its inherent polarity at once becomes evident by a simple return to its former position. Thus the rod has passed through all the changes from polarity to neutrality, and from neutrality to polarity, and these changes have taken place with complete symmetry. The limits of this paper do not allow me to speak of the numerous theoretical evidences as shown by the use of my induction balance. I believe, however, that I have cited already experimental evidences to show that what has been attributed to coercive force is really due to molecular freedom or rigidity; that in inherent molecular polarity we have a fact admitted by Coulomb, Poisson, Ampère, De la Rive, Weber, Du Moncel, Wiedermann, and Maxwell; and that we have also experimental evidence of molecular rotation and of the symmetrical character of polarity and neutrality. The experiments which I have brought forward in this paper, in addition to those mentioned in my paper read before the Royal Society, will, I hope, justify me in having advanced a theory of magnetism which I believe in every portion allows at least experimental evidences of its probable truth.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

JUNE finds trade in a less satisfactory condition than should mark the Midsummer month; yet most of the rolled iron makers are running pretty steadily. Purchases continue to be in small lots, and makers cannot calculate far ahead. It is, however, an indication in the right direction that they are less disposed to accept forward orders upon buyers' own terms.

On 'Change this—Thursday—afternoon bars of second and third-class qualities were in better sale than those made by the list houses, but rates were unimproved; £7 to £6 10s. was quoted for second-class bars, and £6 for common.

As to best bars, those rolled by William Millington and Co., either rounds or squares, were quoted :—$\frac{7}{16}$in. to 2½in., £7 10s. per ton.; $\frac{3}{8}$in., £8; $\frac{5}{16}$in., No. 1 and 2, £8 10s.; ¼in., No. 3 and 4, £9; No. 5, £9 10s.; $\frac{3}{16}$in. and No. 6, £10; No. 7, 11; No. 8, £12; No. 9, £13 10s.; No. 10, £15 10s.; No. 11, £17 10s.; best bars, £8 10s.; double best bars, £9 10s.; treble best bars, £11 10s.; treble best "L.M." bars, £13 10s.; plating bars, 1in. to 4½in. wide, to 1¼in. thick, £8; best ditto, £9. Rivet iron was £8 10s.; best ditto, £8 15s.; and double best, £10 5s. Angles, 1½in. to 3in., "from piles," £8 10s.; best ditto, £9; and double best, "from blooms," £10.

Bars made by Messrs. John Bagnall and Sons, were quoted :—1in. to 6in. flat and from $\frac{7}{16}$in. to 3in., round and square, £7 10s.; 6½in. to 9in. flat and 3¼in. to 3½in., round and square, £8; 4⅛in. and 4¼in. ditto, £8 10s.; 4⅜in. and 4½in. ditto, £9; 4⅞in. and 5in. ditto, £10; 5⅛in. and 5¼in. ditto, round only, £10 10s.; 5⅜in. and 5½in. ditto, £11; 5⅝in. and 5¾in. ditto, £11 10s.; 5⅞in. and 6in. ditto, £12; 6¾in. and 7in., £14; 7¼in. and 7½in. ditto, £15. Horse-shoe and turning iron was £7 10s., and plate and fullered shoe and angle bars, £8. Best rivet iron was £9, and double best £10. Hoops of 14 to 19 w.g. were quoted £8.

Girder, angle, tee, rivet, and similar iron for constructive purposes is in active consumption in this district, and a fair tonnage is being sent to other parts of the kingdom. Prices of reliable angles and rivet iron will be gathered from the foregoing lists.

Hoops keep in steady demand for the United States and other export markets, and also for home cooperage purposes; £6 10s. to £6 12s. 6d. easy are the average quotations.

Tin-plate makers report a steady but not great business with Australia, Canada, the United States, Germany, and one or two other European markets. They do not regard without much interest the circumstance that a petition is now circulating among iron trade circles in the United States to ask the next Congress to place the duty on tin-plates at 2½c. per lb., instead of 1c. as provided in the new tariff, and 1·1c. as fixed by Treasury rulings, and now in force.

Makers considered themselves very fortunate when the recent proposal to largely increase the duty broke down. Such a duty as is now suggested would be sufficient to ensure tin-plate manufacture in the States.

Foundry pigs are being used up in large quantities by local founders, and pig-makers generally are anticipating a revived demand, since June generally brings an improvement. Best hematites are nominal at 62s. 6d. to 65s., while less favourite brands are selling at 60s. Other prices are unchanged.

A few days ago three blast furnaces, known as the Deepfield's furnaces, together with 100-horse power blast engines, blowing cylinders and blast service, two hot-air ovens, cinder frames, and other requirements for the manufacture of pig iron, were publicly offered for sale in Birmingham, but the attendance was small, and no bid was made.

Current prices of coal are :—Best deep coal, 10s.; deep one way, 9s.; deep cobbles, 8s.; deep rough slack, 5s. 6d.; fine slack, 3s. 6d. Second-class firms are selling at lower rates than the above by 1s. on coal and 6d. on slack. In the shallow seams prices of the best firms are :—Best shallow 9s.; shallow one way, 8s.; shallow cobbles, 7s.; shallow rough slack and fine slack, 2s. 6d. Here, again, prices of second-rate firms are less by 1s. and 6d. respectively.

The casting of fly-wheels for ironworks' use mainly is a fairly active branch of the heavy foundries in South Staffordshire. Few finer pieces of work of this class have been executed hereabouts than a wheel of over 70 tons which has just been run by Messrs. Taylor and Farley, of the Summit Foundry, West Bromwich, for driving a plate mill at the Consett Iron Company's Works, Durham. Hardly less noteworthy was the wheel cast some weeks back by Messrs. Turley, at Deepfields, for Messrs. Isaac Jenks and Sons, of the Minerva Iron and Steel Works, Wolverhampton.

In the present condition of the steel market the Corporation of Birmingham are expecting to obtain 1000 tons of Bessemer tramway rails which they require upon terms that will confirm them in the wisdom of the policy of themselves constructing the tramways in the borough. The rails will be of girder sections, partly 7in. and partly 6in. deep, 98 lb. and 92 lb. to the yard. The fish-plates are to be of steel, but iron is to be the material of the bolts, nuts, and tie rods. The points, some 120 in number, are to be of cast steel, 4 cwt. apiece, ten of them with movable tongues. Good work is to be put into the crossings, of which there are sixty. They are to be planed out of solid rails, cold, and will be supplied by the Corporation.

The Corporation of Walsall desire to pump the sewage on the portion of their farm to 18ft. above its natural level, and with this object they have determined to erect a turbine in the river Tame, at a point close to the farm, to be worked by a weir. The turbine will be purchased from Ireland at a cost of some £200 or £300; but the most expensive part of the scheme is the laying in of the foundations. The bed of the river course, both above and below the weir, is to be shedded with brickwork. The total cost is officially estimated at about £700, but some members of the Council who believe that the employment of steam would be much more serviceable, estimate that the expenditure will be considerably in excess of £700. The Sewerage Committee, however, lay great stress upon the economy in maintenance effected by water compared with steam power.

The Walsall Corporation have this week resolved to purchase a new steam roller at a cost of £500.

There is no indication of the colliers' strike in North Staffordshire coming to an end at present. The strike hands profess to be as determined as ever, and the unionists are receiving 10s. each and 1s. per child per week as strike pay.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The resumption of business after the holidays has not developed any increased animation in the iron trade of this district. All through, the market continues in a depressed condition, and low prices do not stimulate buying beyond absolute requirements. So far as pig iron is concerned makers are getting anxious for orders. At the local furnaces old contracts are rapidly running out, and as there have been very few new orders coming in recently to replace these, stocks are accumulating. Finished iron makers appear to be in a better position than the pig iron makers. Although the amount of actual new business offering in manufactured iron is only small, there are comparatively few of the local forges that are not kept going, and some of the principal makers are fairly busy. The result is that whilst pig iron shows a decidedly weakening tendency, finished iron is generally being held firmly for late rates.

A very quiet tone characterised the Manchester iron market on Tuesday. In pig iron very few transactions were reported, and sellers were open to book orders at lower prices than those ruling last week. Nominally quotations for Lancashire pig iron remain on the basis of 45s. for forge and 46s. for foundry less 2½, delivered equal to Manchester; but makers finding that these prices do not bring forward business, are now open to entertain offers from buyers. District brands, so far as any actual competition for business is concerned, are still represented solely by Lincolnshire makes, which continue the lowest price iron in the market. In this iron there has during the week been a giving way of 6d. per ton on forge qualities, No. 4 being now quoted at 44s. 4d. less 2½ delivered here, and on this basis moderate sales have been made; but if the reports I hear can be relied upon this figure does not represent the lowest price some sellers are prepared to take to secure business. Foundry qualities remain at 45s. 10d. less 2½, with a small business doing.

In the finished iron trade there is no material change. Although in one or two cases makers report orders coming forward more freely, business generally is dull. The leading manufacturers show no disposition to yield in price, and £6 5s. remains the basis for good local bars delivered into the Manchester district. Buyers do not pay this price very readily, and in some cases decline to place out orders, except at a lower figure, but it is only from one or two of the local makers that bars can be bought for less. For hoops quotations average £6 12s. 6d. for delivery equal to Manchester or Liverpool, with sellers here and there at £6 10s. per ton.

The engineering trades generally continue fairly busy. The indications of a decrease in the quantity of new business noticeable prior to the holidays do not seem to have developed into any serious falling off in trade. I hear of fairly good inquiries in the market, and except that prices have to be cut very fine to secure new orders, the prospects as to continuing activity in trade are not unsatisfactory.

There is certainly no present prospect of any falling off in the activity which characterises the locomotive building trade of this district. I hear of one large firm turning out fourteen locomotives per month, with plenty of work in hand for some time to come. A large proportion of the work in this district is for abroad, and includes a considerable number of engines of special design, to some of which I have referred in previous notices. Messrs. Nasmyth, Wilson and Co., of Patricroft, amongst recent new work, have received orders from the United States for a number of locomotives, which are to be constructed strictly on the American principle, with bar frames, cast iron wheels, steel boilers, and tenders resting upon two bogies. They have also in hand the construction of several specially dssigned locomotives for tramway work abroad. These engines are more powerfully constructed than is usual with tramway locomotives in this country, and weigh about ten tons each. They are made with 10in. cylinders, and are fitted with condensing apparatus, so as to avoid any nuisance from the exhaust steam in passing through the streets. All the valve gear is fixed outside the cylinders, so that it may be readily accessible when required, and the engines are cased in throughout down to the level of the line, all the moving parts being thus concealed, and the ends are rounded to enable the engines, which are of metre gauge, to turn within the space of an ordinary tram car.

The application of hydraulic power to the heavy class of machine tools is being developed in various directions, as its advantages over the ordinary gearing recommend it for different classes of work. A description has already been given of the recent introduction of this method of driving at the works of Sir Joseph Whitworth and Co., for powerful slotting and boring machinery, and Messrs. Nasmyth, Wilson, and Co., have now in hand a shearing machine for cutting steel ingots 20in. by 6in., which will probably be the most powerful machine of the kind yet constructed to be driven by hydraulic power. The same firm have also in hand a pair of hydraulic pumping engines, which are being specially made for the Calcutta International Exhibition, and are designed to work in India in connection with the hydraulic cotton presses. The engines, which will be of 75-horse power combined, are constructed with the multiple pumps patented by Messrs. Nasmyth, Wilson, and Co.

Following the recent Gas, Electric, and Engineering Exhibition in the St. James's Hall, Manchester, a building trades' exhibition, laid out on precisely the same lines as the one in London, is to be held during the ensuing autumn, and the Mayor of Manchester—Alderman Hopkinson—has consented to preside at the opening proceedings. I understand the applications for space already ensure a successful exhibition being held.

An interesting subject for mining engineers is promised at the meeting of the Manchester Geological Society next Tuesday, when Messrs. Fleuss, Duff, and Co., of London, will exhibit in working order their breathing apparatus and lamp for penetrating noxious and inflammable gases, as used in the re-opening of the Seaham Colliery after the explosion of 1880, and which has recently been recommended by the Secretary of State for adoption in mining districts. A general discussion is also to take place on the use of breathing apparatus for exploring mines after explosions.

During the week a miners' conference, claiming to represent all the coal-producing districts of the country, has been sitting in Manchester, and on Wednesday the question of restricting the output was under discussion. A letter had been addressed from the Miners' National Conference, held last month in Birmingham, to the Mining Association of Great Britain, asking that a meeting might be convened for "discussing the desirability of arranging some means of regulating the output and production of coal;" but the council of the association replied that they were unable to accede to the request. This refusal of the masters to combine with the men in restricting the output of coal was received with anything but satisfaction by the conference, and resolutions were passed regretting the action of the Mineowners' Association, especially as "the latent power of production constantly at the disposal of the owners has resulted, and is now resulting, in commercial loss and insufficient wages for workmen," and that over-production being, in the opinion of the meeting, the bane of the coal trade, which, unless some steps were taken to prevent the same, ruinous competition would continue, profits would remain stationary, and wages in a low condition, the conference therefore decided to "recommend all miners in the United Kingdom to restrict the output of coal, the same to be brought about by each district in the best possible way."

In the coal trade business generally is quiet, and many of the pits are not working more than four days a week. The demand both for house fire and manufacturing classes of fuel is only very moderate, but the restriction of the output, caused by the recent stoppages for the holidays, has prevented any great pressure of supplies upon the market. With the exception of a little giving way in a few cases on the extreme list rates for some classes of round coals, prices are fairly steady, and the month closes without any material alteration in the actual selling rates. At the pit mouth best coal averages 9s.; seconds, 7s. to 7s. 6d.; common coal, 5s. 6d. to 6s. 3d.; burgy, 4s. 9d. to 5s.; best slack, 4s. to 4s. 3d.; and common, 3s. to 3s. 6d. per ton.

Shipping continues quiet, with Lancashire steam coal delivered at the high level, Liverpool, and the Garston Docks offering at 7s. to 7s. 6d. per ton.

Barrow.—There is no change to note in the hematite pig iron trade of this district. A general quietness reigns, and there does not seem any immediate prospect of a revival. Trade is much duller than was anticipated at this time of the year, especially on Continental and American account. The output of the furnaces is fully maintained, and there does not seem to be any disposition on the part of smelters to reduce it. Stocks are accumulating, but a very large proportion of the metal produced is being used by steel makers. Prices have declined slightly; No. 1, 51s. 6d., No. 2, 50s. 6d., No. 3, 49s. 6d. Steel makers are experiencing a much better time of it than iron smelters, as they hold orders which will keep them going for the remainder of the season. Certainly some of the orders are not what might be considered very remunerative. So long as the activity is maintained in the steel-making departments it will be so much the better for the iron trade. Pig iron has suffered a slight reduction. Tin-plates are in fair request, Steel is quoted at £4 15s. to £5 per ton at works. The engineering. ironfounding, and other industries are quiet but steady.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

DR. WEBSTER, the United States Consul, in his report of the year ending September 30th, 1882—the American commercial year always closes on this date—gives some interesting information in regard to the effect of American competition on Sheffield trades. Dr. Webster states that the year has been a prosperous one in the Sheffield trades generally, the total value of exports to America having been greater than that of any year since 1874. The great bulk of the Sheffield trade with the United States is in the three great industries of Bessemer rails, steel, and cutlery. The aggregate amount of the three for 1882 is 5,268,594·58 dols., against 949,154·96 dols. for all other exports. The greatest amount in value of Bessemer rails sent to the United States in any one year was in 1874, being 2,146,555·56 dols. The amount for 1882 is 2,011,720·80 dols. During the years 1876 to 1878 inclusive this trade was entirely suspended, and it was then considered probable that from that time America would be able to supply their own demand. But the figures show that the export of rails for 1882 nearly equals 1874, the year of largest export of this material, and as Bessemer rails are at this moment less by more than one-half than in the year 1874, the quantity taken in 1882 must be at least double that of 1874. This very large demand for Sheffield rails, in addition to the immense production of American mills, indicates the present vast expansion of railway building in the United States. Turning to steel, affairs are different. In 1873 the value of steel exported to America was 3,267,879·66 dols., against 1,959,782 dols. in 1882—a large decrease. The price of steel is almost the same now as in 1873, and the conclusion Dr. Webster draws is that in fine steels, which have hitherto been supposed to be procurable in Sheffield only, the United States manufacturers are showing increasing ability to compete in quality with the best makers in the world. This implies a rapidly growing independence of a foreign market, and he finds a further indication in this direction as regards cutlery. The amount in value of cutlery of all kinds exported to the United States in 1873—the year of greatest trade—was 1,392,083·95 dols., as against 1,297,091·61 dols. in 1882, showing a difference in favour of the United States of 94,992 dols. Dr. Webster adds:—"As there has been no increase in our demand for Sheffield cutlery during the last ten years, notwithstanding our great growth in population, and wealth, and consequently ability to purchase the best of the world's products, it seems certain that our cutlery manufacture must have greatly extended and improved in quality. It is evident that home makers are more largely supplying the home market. Still the fact remains that our country calls for Sheffield cutlery to the amount of more than 1,000,000 dols. annually. Now, unless the demands of the American people upon our own manufactures are so great that they cannot be supplied, as is the case with Bessemer rails, then the indication is there is a quality and finish in Sheffield cutlery that a large portion of American buyers prefer and will have."

In the file trade there is no change. The men are still on strike, and there seems no chance of their getting re-employed on the old terms. In fact, a leading file manufacturer told me this week that it was the best thing that could happen for him to have his men "out." During the languid season he had been making more files than he wanted, with the result that stock had greatly accumulated; and he is now supplying his customers from the shelves, and can continue to do so for six months. Nor is his case an exceptional one.

At Barnsley a meeting of the miners' representatives has resolved on carrying out the policy of restriction of output. This resolution has so frequently been resolved upon in the cold weather when restriction was possible, that it is hard to see why it should again be passed now that the warm weather is daily restricting the demand, and thus necessarily restricting the output to meet it. What is really aimed at is not restriction of quantity so much as an increase of pay for what is raised. It will take the colliers all their time to keep the 10 per cent. they got last year.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade has been exceedingly dull during the past week. Very few sales have been effected, though merchants have been pressing iron on the market at 6d. per ton less than the rates which have ruled for two months. Makers are not anxious to sell, having orders on their books which will keep them going for a few weeks. At the market held at Middlesbrough on Tuesday the tone was a little more cheerful, as exports during the last few days have been excellent; and it is now thought likely that stocks will show a decrease at the end of the month. Merchants offered No. 3 g.m.b. at 39s. 6d. per ton for prompt and forward delivery, but makers would not take less than 39s. 9d., and some of them were firm at 40s. per ton. But little business was done even at the lower figure, consumers' price being for the most part only 39s. 3d. per ton.

There are no transactions to report in warrants, though some holders are now anxious to sell. The price is nominally 39s. 6d. per ton f.o.b.

The stock of Cleveland pig iron in Messrs. Connal's Middlesbrough store has declined only 109 tons during the past week.

The May exports from the Tees up to Monday night were as follows:—Pig iron, 76,851 tons; manufactured iron and steel, 24,569 tons. In the corresponding period of May last year 65,047 tons of pig iron were shipped.

There is no new feature to report in connection with the finished iron trade. The mills are working steadily under the restriction arrangement, but so far it has not improved prices at all. Fresh orders are scarce, and market values less than before. Ship plates are quoted at £6 2s. 6d. to £6 7s. 6d.; angles, £5 12s. 6d. to £5 15s.; and common bar iron, £5 12s. 6d. to £6 per ton, according to specification, all free on trucks at maker's works, less 2½ per cent. discount.

The whole of the plant at the Ferryhill Colliery was sold by auction on the 23rd ult., and brought good prices; merchants and colliery owners from all parts of the country being present. This colliery has been ilde for some years, owing to the slacknees of trade.

A meeting of representatives of the Chambers of Commerce and Shipowners' Societies of the ports of Middlesbrough, Stockton, Whitby, and Hartlepool, was held at Stockton on the 25th ult., to take into consideration "Lloyd's" proposition to increase the number of members on the general committee. As at present constituted, the committee consists of forty-one representatives from all the ports in the United Kingdom. The number is to be increased to fifty, and it is proposed to allot the above ports collectively two representatives instead of one as at present. The delegates discussed the matter very fully, and decided to inform Lloyd's committee that they consider the importance of the district now entitles it to three representatives—that is, two additional.

The men employed by the North-Eastern Railway Company at their Gateshead Works have applied for an advance of wages. The manager, after taking time to ascertain the rates paid at similar works in the district, says he would not be justified in recommending that the advances should be given. The men are extremely dissatisfied, asserting that they are paid less than the current rates at neighbouring works. They have not yet decided on their future course of action.

The strike at the Eston Steel Works of Messrs. Bolckow, Vaughan, and Company, still continues. There has been some talk of submitting the question to arbitration, but nothing definite has been settled. The men seem to be as determined as ever not to go to work at the reduced rates, and a good many of the best workmen have left the district to find work elsewhere.

The North-Eastern Steel Works at Middlesbrough are now about ready to start. A quantity of basic pig iron has already been made for them by Messrs. B. Samuelson and Co., and Messrs. Stevenson, Jaques, and Co. are meditating entering into the same special trade. But, unfortunately, the prices for steel rails are so low, that they can only be made at a loss, even by the basic process. Whether the directors of the new company will make a start, and so help to run down the price still more, or whether they will be content to allow their new works to remain idle until trade improves, is not yet known. The latter course would be very tantalising to the shareholders, but perhaps might prove the wisest in the long run.

The mill men employed by Messrs. Dorman, Long, and Co., of Middlesbrough, are still working on Mondays, notwithstanding the restriction arrangement agreed to by the Board of Arbitration and adopted both by the Iron Manufacturers' and the Ironworkers' Associations. The puddlers still continue to refuse to work on Mondays. The price paid by the firm to their millmen for the concession is said to be an extra ½d. per ton above country price on all tonnage rates. The result is considered by many a considerable blow to the authority of the Ironworkers' Union, inasmuch as it appears much less able to enforce its decrees than was previously supposed.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

The Glasgow pig iron market has been quiet during the greater part of the week, and prices have ruled low, the lowest point yet touched since the beginning of the year having, indeed, been reached. But although prices are far from satisfactory, the business done is on an extensive scale. The shipments for the past week have been very good, and there is a prospect of large quantities of iron being sent abroad in the course of the next two months. Private advices from the United States are anything but cheering. Still, the iron despatched thither during the week shows some improvement, and it is believed that fair orders will be forthcoming for delivery in July. There is an increase of 2s. 6d. in the freights for pig iron to the States. On 'Change in Glasgow there has been some talk of a work which has been idle for a number of years being started, so that the production of pig iron would in this way be still further increased. The considerable additions that have been made to the output in recent weeks will not add to the stock if the shipments should be maintained at about their present dimensions. Just now the consumption, home and foreign together, carries off the current production, and the stock in the warrant stores continues to exhibit a slight reduction.

Business was done in the warrant market on Friday at 46s. 9½d. to 46s. 8d. cash. On Monday previous transactions were effected from 46s. 7½d. to 46s. 10d. cash, also 46s. 9½d. to 47s. one month, while the quotations that afternoon were 46s. 10d. to 46s. 8d. cash, and 47s. to 46s. 11d. one month. On Tuesday forenoon business was done at 46s. 8d. to 46s. 9½d.; and in the afternoon at 46s. 8½d. to 46s. 1d. Business was done on Wednesday between 46s. 7d. and 46s. 9d. cash, and 46s. 11d. and 46s. 10d. one month. To-day—Thursday—transactions occurred at 46s. 8d. to 46s. 6½d. cash, and 46s. 8½d. one month.

The prices of makers' iron are 6d. to 1s. lower, as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 58s., No. 3, 54s.; Coltness, 62s. and 54s. 6d.; Langloan, 62s. 6d. and 54s. 6d.; Summerlee, 59s. 6d. and 51s.; Chapelhall, 58s. and 54s.; Calder, 60s. 6d. and 51s.; Carnbroe, 54s. 6d. and 49s.; Clyde, 50s. 9d. and 48s. 9d.; Monkland, 48s. and 46s. 3d.; Quarter, 47s. 6d. and 45s. 6d.; Govan, at Broomielaw, 48s. and 46s. 3d.; Shotts, at Leith, 62s. and 56s.; Carron, at Grangemouth, 50s.—specially selected, 57s. 6d.—and 48s.; Kinneil, at Bo'ness, 48s. 6d. and 47s. 6d.; Glengarnock, at Ardrossan, 54s. and 48s.; Eglinton, 48s. and 46s.; Dalmellington, 49s. 6d. and 48s. 6d.

The imports of Middlesbrough pig iron at Grangemouth to date amount to 101,938 tons, showing an increase of 9999 tons over the quantity received in the same period of last year.

There is a marked feeling of dulness in the demand for general iron manufactures, although the works are all busy on contracts formerly arranged. Prices are very moderate, and it is only with the exercise of a rigid economy that they are maintained at the paying point.

The coal trade in the West of Scotland continues active, the season turning out quite satisfactorily in a comparative sense. House coal is in better demand than is usual at this time of the year. There is an exceedingly active inquiry for steam coal at Glasgow, at firmer prices. The shipments of coals from the last-mentioned port in the course of the week include 1900 tons for Montreal, 1520 tons for Cronstadt, 800 tons for Gothenburg, 670 tons for Nantes, and 470 tons for Venice. The week's despatch of coals from Grangemouth was close upon 6000 tons, while over 5000 tons were sent away from Bo'ness.

The colliers of Fife are not satisfied with the answer of the employers to their request for an increase of 6d. per day on their wages. At a meeting of the men's Executive Board, held at Dunfermline a few days ago, Mr. Weir, the secretary, was instructed to write to Mr. Connell, the secretary of the Coalmasters' Association, pressing upon them "to at once reconsider their decision, as the men are of opinion that the prices realised for all classes of coal are such as to warrant the payment of wages at least 6d. per day higher than the present rates." It was also resolved that in the event of the coalmasters refusing to reconsider their decision, the Wages Committee should meet at Dunfermline on the 9th June to determine what further action should be taken in order to enforce the advance sought.

A threatened dispute in the engineering trade of Glasgow has been averted by a proportion of the masters conceding the demand of the men for a rise of wages, and the rest offering to compromise the matter.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

It is satisfactory to learn that the preamble of the "Rhondda Valley and the Swansea Bay Railway" Bill has been declared proven. The same success has also been gained by the Taff Vale Company with its Bill, authorising amongst other things the construction of a short line with the authorised new line of the Great Western and Rhymney to Cyfarthfa. The delay of the joint railway company in carrying out its new line has in all probability been due to this movement on the part of the Taff. Now the sooner both lines transfer their schemes from paper to sod the better.

Extreme pressure continues to characterise the coal trade, and both house and steam coal are in remarkably good demand. I am informed that in two quarters of the house coal district notice has been given of an advance of price. It is not expected to be more than 3d. per ton, but this is acceptable. If the steam coal prices could also be lifted the present rush of business would be more satisfactory. Respecting the house coal advance, speculation is rife about it. In previous cases house coals have advanced after an upward movement in iron, and it is discussed whether in this case it may not precede an improvement in that quarter.

The French coal trade is not in a flourishing condition, but this is more than atoned for in the demand from other parts, Genoa, Cronstadt, Malta, and Port Said figuring well. Over 160,000 tons of coal left Cardiff last week, and the business at other ports was proportionately good. Swansea showed a good deal of animation in patent fuel as well as coal, 7188 tons of the latter having been cleared.

The death of Mr. Shaw, late of Cwmavon, is announced. His taking of this place was a fortunate hit for himself, having realised a large sum by the undertaking. He was the first railway contractor in Greece, and an important undertaking of his was the construction of the Nile Bridge at Cairo.

Local strikes are threatened. At Plymouth the contention between the men and employers continues. At Ynysfeis, Rhondda Valley, 600 men are expected to come out on strike this week. This is a doctors' strike. There is also another threatened at the collieries of Nixon and Co., Mountain Ash. Here the colliers are divided in their selection of a doctor, over 1000 supporting one, and 150 another. The resolution now come to by the majority at a large meeting was to strike if their selection be not adopted.

Still another item of importance from the Rhondda district. The colliers are desirous of having a demonstration during the summer, and a proposition has been carried to invite Mr. Bradlaugh, or Messrs. Burt and Broadhurst to attend.

There is not much change to be seen this week in the iron and steel trades. Prospects are fair, but there is no marked animation. The most that can be said is that works are moderately busy, and some degree of improvement has been given in one or two places by the better state of the tin-plate trade. One of the American organs, the *Iron Age*, suggests a restrictive tariff on tin-plate, so as to bring the American tin-plate produce up to a higher standard than it is now. And in the same journal the English trade is charged with sending all their inferior plates to America. As regards Wales, there is a strong belief held here that the Principality is able to produce better plates than the Americans could, but it is admitted that the superior plates are now fewest. The prices given are scarcely those for the best products. The pressure to force prices down has been so persistent that I am not surprised at a cry about quality.

The difficulty at Garnant Colliery, Carmarthen, has been amicably settled.

The Dowlais tin-plate workers remain out, and at a meeting in Swansea this week it was resolved to continue relief, the impression being that if Dowlais succeeded in getting the reduction taken it would follow all round.

The Rhymney Iron Company intend sinking two pits shortly into the Brithdir seam.

The Nantyglo and Blaina Company decided at a late meeting to pay off their 10 per cent. debentures.

Great animation prevails at Cardiff. Two new steamship companies were started there this week, and a new Exchange is being floated to cost £30,000. The Welsh Liverpool was never so prosperous.

THE PATENT JOURNAL.

Condensed from the Journal of the Commissioners of Patents.

*** *It has come to our notice that some applicants of the Patent-office Sales Department, for Patent Specifications, have caused much unnecessary trouble and annoyance, both to themselves and to the Patent-office officials, by giving the number of the page of* The Engineer *at which the Specification they require is referred to, instead of giving the proper number of the Specification. The mistake has been made by looking at* The Engineer *Index, and giving the numbers there found, which only refer to the pages, in place of turning to those pages and finding the numbers of the Specification.*

Applications for Letters Patent.

*** When patents have been "communicated," the name and address of the communicating party are printed in italics.

22nd May, 1883.

2537. Preventing Animals from Falling, W. G. Kite, Romford.
2538. Scissors and Shears, A. Wheeler, Darlington.
2539. Arc Regulator Lamps, R. Crompton, London, and T. Crabb, Chelmsford.
2540. Camp Ovens, &c., J. Millington, near Wolverhampton.
2541. Knitting Machinery, H. J. Haddan.—(*W. W. Clay, Paris.*)
2542. Pencil Cases, H. J. Haddan.—(*J. Knapp, U.S.*)
2543. Incandescent Electric Lamps, B. Keeling and J. D. Mucklow, London.
2544. Manufacture of Gas, S. Pitt.—(*E. J. Jerzmanowski, New York.*)
2545. Dentistry, S. Pitt.—(*C. M. Richmond, New York.*)
2546. Hammocks, C. E. Jiester, Harrisburg, U S.
2547. Securing Chests of Drawers, &c., R. Mander, Birmingham.
2549. Saddle Bars, S. Davis, London.
2549. Tannic Black, W. G. Gard and T. H. Cobley, Dunstable.
2550. Microphones or Telephones, P. Jensen.—(*L. M. Ericsson, Stockholm.*)
2551. Fishing Reels, D. Slater, Newark-upon-Trent.
2552. Sizing Machines, J. Dugdale, Blackburn.
2553. Dynamo-electric Machines, &c., T. T. Vernon, Uttoxeter.
2554. Spinning Cotton, &c., G. A. Helliwell and J. H. Waller, Todmorden.
2555. Holding Hats, A. Pyke, London.
2556. Rivetting Shoe-lace Studs, H. H. Lake.—(*W. C. Bray, Newton, U.S.*)
2557. Barbed Wire, H. H. Lake.—(*P. Miles, Brooklyn.*)
2558. Weighing Machines, W. P. Thompson.—(*J. Stevens, Neenah, U.S.*)
2559. Feeding Bottles, A. Horne and J. Mancor, Liverpool.
2560. Hatch Covers for Barges, H. Roscoe and W. H. Dugdale, Liverpool.
2561. Operating Gas Engines, L. H. Nash, Brooklyn.
2562. Manufacture of Gas, A. M. Clark.—(*M. Gross, New York.*)
2563. Opening Doors by Electricity, G. F. Redfern.—(*A. Gautier, Cannes.*)
2564. Balling Heads of Gill Boxes, P. Smith, jun., S. Ambler, and J. Lund, Keighley.
2565. Feeding Apparatus for Carding Engines, E. Edwards.—(*A. Cremer-Pirnay et Cie., Belgium.*)
2566. Sulphate of Lime, &c., J. H. Johnson.—(*P. G. Journet, Paris.*)
2567. Preserving Food, &c., J. H. Johnson.—(*Liautand and Co., Nice, France.*)

23rd May, 1883.

2568. Extracting Paraffine from Mineral Oil, &c., J. Siddeley, Liverpool.
2569. Advertising Machines, J. Foot and R. J. Foot, London.
2570. Electric Arc Lamps, P. Jolin and J. Parsons, Bristol.
2571. Chenille, B. J. B. Mills.—(*J. Baverey, France.*)
2572. Steam Generators, G. G. Rhodes, Liversedge.
2573. Porous or Spongy Plates, F. T. Williams and J. C. Howell, Llannelly.
2574. Converting Reciprocating into Rotary Motion, H. Burt, Southampton.
2575. Indicating Movements of Trains, E. C. Warburton and R. R. Harper, London.
2576. Constructing Floorings, &c., J. Garlick, Birmingham.
2577. Celluloid, &c., Bases for Dental Purposes, C. G. Hammersley.—(*F. J. Lynam, Chili.*)
2578. Cleaning Steam Boiler Tubes, R. Sutcliffe, Idle.
2579. Electric Lighting, W. Stroudley, Brighton, and E. J. Houghton, Peckham.
2580. Expediting the Loading of Rifles, S. Pitt, Sutton.—(*H. Thronsen, Amsterdam.*)
2581. Stoppering Bottles, &c., J. G. Van-der-Kaa, London.
2582. Manufacture of Fuller's Earth, C. R. Dames, Bath.
2583. Merchant Bar Rolling Mills, G. Hardingham.—(*J. J. Roberts, Reading, U.S.*)
2584. Steam Engines, A. M. Clark.—(*W. F. Goodwin, Stelton, New Jersey.*)
2585. Spring Mattresses, W. Beck.—(*J. Soisson, Paris.*)

24th May, 1883.

2586. Corsets, J. T. Hellier, Glasgow.
2587. Sofa-bedsteads, C. A. Barber.—(*R. W. Taylor, San Francisco, and G. S. Barber, Ouray, U.S.*)
2588. Steam Engines, A. Hoyois, Clabecq, Belgium.
2589. Range Finder, F. Weldon, Farnham.
2590. Cogging Ingots, &c., D. Evans, Blaenavon.
2591. Colouring Matter, C. D. Abel.—(*Messrs. L. Durœnd and Huguenin, Bâle, Switzerland.*)
2592. Telephonic Apparatus, G. E. Gouraud, London.
2593. Steam Boilers, J. Withinshaw, Birmingham.
2594. Paper Fasteners and Files, W. J. Brewer, London.
2595. Hauling Engines, D. Greig, A. Greig, and R. H. Shaw, Leeds.
2596. Generating Steam, H. Tipping, Greenwich.
2597. Embroidering Machines, W. E. Gedge.—(*E. Cornely, Paris.*)
2598. Wrenches, H. W. Atwater, Orange, U.S.
2599. Bottle Stoppers, W. W. Macvay and R. Sykes, Castleford.
2600. Tramways, A. H. Rowan, Westminster.
2601. Fire-proof Screen for Theatres, &c., A. Clark, London.
2602. Constructing Ships, T. H. Ball, Chicago, U.S.

25th May, 1883.

2603. Ladies' Necklets, J. Mason and T. Hambleton, Macclesfield.
2604. Doubling or Twining Yarns, &c., W. H. Jones, Middleton.
2605. Chronographs, W. H. Douglas, Stourbridge.
2606. Obtaining Artificial Light and Heat, J. S. Muir, London.
2607. Spinning Mules, J. Newton and J. Leech, Oldham.
2608. Metallic Felloes for Rubber Tires, T. Fox, Sheffield.
2609. Neckties and Collars, H. G. Stiffe, London.
2610. Saddles, O. Lehmann.—(*W. Weissgerber, Verden, Hanover, Germany.*)
2611. Saddle Bars, H. Born, Hounslow.
2612. Registering Games, &c., Played at Cards, G. F. Howard, London.
2613. Traps for Flushing and Inspecting Drains, F. Newman, Ryde.
2614. Torpedo Boats, W. R. Lake.—(*W. Sims, U.S.*)
2615. Securing Candles in Candlesticks, W. R. Lake.—(*J. F. Taberlet, Paris.*)
2616. Corset, W. R. Lake.—(*I. Strouse, Connecticut.*)
2617. Automatic Lathes, F. Wirth.—(*E. H. Freter, Roedelheim, Germany.*)
2618. Producing Warmth, &c., F. Wirth.—(*M. Honigmann, Aachen, Germany.*)

26th May, 1883.

2619. Winding Yarn, &c., J. Boyd, Shettleston.
2620. Money Boxes, &c., E. A. Jahncke and H. W. Herbst, London.
2621. Extracting Sulphurous Acids from the Fumes of Furnaces, E. A. Brydges.—(*E. Hänisch and Dr. M. Schröeder, Rosdzin, Germany.*)
2622. Excavating, &c., Earth, J. F. Sang, London.
2623. Manufacture of Air Gas, G. Macaulay-Cruikshank.—(*R. C. Dixon, Sydney.*)
2624. Watches, W. H. Spence.—(*A. Droz et Fils, St. Imier, Switzerland.*)
2625. Portable Forges, W. Allday, jun., Birmingham.
2626. Moulding Clay Ware, W. Crawford, Glasgow, and P. Graham, Stockton-on-Tees.
2627. Safety Stirrup Bars, R. W. Hunt, Scarborough.
2628. Bicycles, &c., J. Ilix, London.
2629. Power Looms, S. C. Lister and J. Reixach, Bradford.
2630. Receptacles for Preparing Cattle Food, J. W. Butler, Blackheath.
2631. Reverberatory Smelting Furnaces, H. J. Haddan.—(*R. P. Wilson, Cleveland, U.S.*)
2632. Stretching and Drying Fabrics, H. B. Barlow.—(*E. Welter, Mulhouse, Alsace.*)
2633. Propellers, N. D. Spartali, Liverpool.
2634. Apparatus for Frilling, Pleating, &c., O. McC. Chamberlain, Nottingham.
2635. Couplings, A. M. Clark.—(*W. W. Fitch and E. D. Griffin, West Bloomfield, U.S.*)
2636. Lifeboat, A. M. Clark.—(*T. Hamilton, U.S.*)
2637. Explosive Materials, W. R. Lake.—(*J. Pichler and A. Fels, Vienna-Neustadt.*)

28th May, 1883.

2638. Screws, H. J. G. Halström, Köping, Sweden.
2639. Automatic Continuous Brake, L. A. Groth.—(*D. Van der Linden, Hoorn, Holland.*)
2640. Shoemakers' Lasts and Shoes, A. Stürmer, Elberfeld, Germany.
2641. Cleansing and Bleaching Cotton, &c., J. Imray.—(*H. Koechlin, Paris.*)
2642. Bill Files, C. H. Brampton, Birmingham.
2643. Furnaces, J. Elliot, jun., and T. A. Cunningham, Dalbeattie.
2644. Fastening Device, H. J. Haddan.—(*H. Brunner, Limbach-Kreuzeiche, Germany.*)
2645. Centrifugal Cream Separators, I. Hattersley, London.
2646. Breech-loading Rifles, &c., W. Field, Birmingham.
2647. Food for Infants and Invalids, W. R. Barker and A. L. Savory, London.
2648. Manufacture of Hydrate of Strontia, &c., C. F. Claus, London.
2649. Drying Rags, &c., J. Illingworth, Batley.
2650. Chilled Castings, H. H. Lake.—(*J. Parks, U.S.*)

Inventions Protected for Six Months on Deposit of Complete Specifications.

2544. Manufacturing Gas, S. Pitt, Sutton.—A communication from E. J. Jerzmanowski, New York, U.S.—*22nd May*, 1883.
2545. Dentistry, S. Pitt, Sutton.—A communication from C. M. Richmond, New York, U.S.—*22nd May*, 1883.
2546. Hammocks, C. E. Hiester, Harrisburg, Pennsylvania, U.S.—*22nd May*, 1883.
2556. Rivetting or Setting Shoe-lace Studs, &c., H. H. Lake, Southampton-buildings, London.—A communication from W. C. Bray, Newton, Massachusetts, U.S.—*22nd May*, 1883.
2583. Merchant Bar Rolling Mills, G. G. M. Hardingham, Fleet-street, London.—A communication from J. J. Roberts, Reading, Pennsylvania, U.S.—*23rd May*, 1883.
2606. Obtaining Artificial Light and Heat, J. S. Muir, Highgate-road, London.—*25th May*, 1883.
2616. Corset, W. R. Lake, Southampton-buildings, London.—A communication from I. Strouse, New Haven, U.S.—*25th May*, 1883.

Patents on which the Stamp Duty of £50 has been paid.

2111. Screw Propeller, W. H. Daniels, London.—*24th May*, 1880.
2067. Fire Lighters, &c., H. C. Hill, London.—*21st May*, 1880.
2101. Preventing Incrustation in Boilers, E. Arnaud, J. Moulet, and E. Ginoyer, Newcastle-upon-Tyne.—*24th May*, 1880.
2106. Ruling Paper, H. J. Haddan, London.—*24th May*, 1880.
2185. Machines for Crushing, &c., G. E. Sherwin, Birmingham.—*28th May*, 1880.
2217. Shaping Machines, W. R. Lake, London.—*31st May*, 1880.
2206. Closing the Mouths of Bags, L. Planche, Paris.—*31st May*, 1880.
2661. Volute Springs, T. Brown, Newburn.—*3rd June*, 1880.
2390. Working Railway Signals, G. K. Winter, Chiswick.—*12th June*, 1880.
2117. Stopping Bottles, D. Rylands, Stairfoot.—*24th May*, 1880.
2195. Looms for Weaving, W. Morgan-Brown, London.—*29th May*, 1880.
2122. Hydraulic Steering Apparatus, A. Lafargue, London.—*25th May*, 1880.
2159. Cardboard, R. Shackleton, Bradford.—*27th May*, 1880.
2164. Velocipedes, C. R. Garrard, Uxbridge.—*27th May*, 1880.
2168. Grain Weighing Apparatus, W. R. Lake, London.—*27th May*, 1880.
2175. Air Pumps, J. Miller, Langholm.—*28th May*, 1880.
2178. Raising Vessels, W. C. Brown, Sheffield.—*28th May*, 1880.
2307. Floor Cloth, C. F. Leake, Staines.—*8th June*, 1880.
2427. Converting Old Rails into Billets, &c., W. R. Lake, London.—*15th June*, 1880.

Patents on which the Stamp Duty of £100 has been paid.

2556. Direct-acting Steam Pumps, &c., T. Parker and P. A. Weston, Coalbrookdale.—*20th June*, 1876.
2193. Bottles for Aerated Liquids, H. Codd, London.—*24th May*, 1876.
2322. Combing Wool, J. H. Johnson, London.—*2nd June*, 1876.
2685. Purifying Sugar, &c., J. Duncan and B. E. R. Newlands, London.—*29th June*, 1876.
2183. Evaporating Liquids and Generating Steam, C. Roeckner, Newcastle-upon-Tyne.—*24th May*, 1876.
2199. Curling the Brims of Hats, T. Lees, Stockport.—*25th May*, 1876.
2268. Colour Printing, &c., W. Brookes, London.—*30th May*, 1876.

Notices of Intention to Proceed with Applications.

(*Last day for filing opposition, 15th June*, 1883.)

5938. Fireproof Boxes, &c., W. R. Lake, London.—Com. from M. Merrill & J. Nolan.—*12th December*, 1882.
330. Groynes for Raising Foreshores, A. Dowson, London.—*20th January*, 1883.
331. Coupling, &c., Railway Trucks, J. Darling, Glasgow.—*20th January*, 1883.
333. Foot Mats, E. P. Alexander, London.—A communication from C. Cheswright.—*20th January*, 1883.
348. Voltaic Batteries, R. H. Courtenay, London.—*20th January*, 1883.
349. Telephonic Apparatus, C. A. Teske, Wandsworth.—*22nd January*, 1883.
355. Sounding Signals, E. F. R. Boehm, Manchester. Com. from C. W. J. Blancke.—*22nd January*, 1883.
357. Dynamo-electric Machines, H. H. Lake, London.—Com. from H. R. Boissier.—*22nd January*, 1883.

359. FASTENINGS for STAY BUSKS, &c., F. R. Baker, Birmingham.—22nd January, 1883.
361. ELECTRIC LAMPS, H. H. Lake, London.—A communication from H. R. Boissier.—22nd January, 1883.
367. REMOVING VEGETABLE IMPURITIES from WOOL, H. J. Haddan, London.—A communication from G. Fernau and Co.—23rd January, 1883.
369. GAS BURNER APPARATUS, G. S. Grimston, Brockley, and A. S. Bower, Saint Neots.—23rd January, 1883.
371. ELECTRIC LAMPS, A. E. Swonnikoff, London.—23rd January, 1883.
373. INDICATING the NAMES of STATIONS in RAILWAY CARRIAGES, H. B. Palmer, London.—23rd January, 1883.
378. SPRING MOTOR APPARATUS, W. R. Lake, London.—Com. from G. Stites, R. Steel, S. Austin, J. Vannote, H. Donnelly and C. Mace.—23rd January, 1883.
455. HOLDING TICKETS, T. H. Harper, Redditch.—27th January, 1883.
463. AXLE-BOXES, F. Wirth, Frankfort-on-the-Main.—A communication from Messrs. Dick and Kirschten.—27th January, 1883.
488. SURFACE CONDENSERS, H. Guy, Isle of Wight.—29th January, 1883.
578. SAWING, &c., STONE, P. Gay, Paris.—2nd February, 1883.
610. GAS LIGHTING APPARATUS, F. A. L. de Gruyter, Amsterdam.—5th February, 1883.
647. PLATE PRINTING PRESS, H. Luetke, Berlin.—6th February, 1883.
700. RAILWAY CHAIRS, J. Lindley, Walkley.—8th February, 1883.
754. LANDAUS, W. H. Bailey, London.—10th February, 1883.
755. PREPARING COTTON SEED, F. S. Fish, U.S.—Com. from T. Taylor.—10th February, 1883.
763. TEXTILE VEGETABLE FIBRES, J. Imray, London.—A communication from E. Frémy and V. Urbain.—12th February, 1883.
773. BREAD, H. H. Lake, London.—A communication from T. Montérichard.—12th February, 1883.
820. DRESSING TEXTILE FABRICS, W. R. Lake, London.—14th February, 1883.
911. AIR, &c., MOTORS, G. M. Capell, Northampton.—19th February, 1883.
1057. GAS VALVES, H. Coley, London.—27th February, 1883.
1123. MAIZE STARCH, J. M. Harley, Paisley.—2nd March, 1883.
1437. VENTILATING FANS, E. P. Alexander, London.—Com. from L. G. Fisher, jun.—19th March, 1883.
1865. VULCANISED INDIA-RUBBER, A. H. Huth, London.—12th April, 1883.
1942. STOPPERS for BOTTLES, N. Thompson, London.—17th April, 1883.
2052. METALLIC ROOFING, &c., R. Hudson, Gildersome.—23rd April, 1883.
2088. CARPETS, H. Fawcett, Kidderminster. — 24th April, 1883.
2142. CUTTING and MINCING APPARATUS, H. Davidson, London.—27th April, 1883.
2146. WEIGHING MACHINES, C. H. Bartlett, Bristol.—27th April, 1883.
2168. ROLLERS for SPINNING TEXTILE MATERIALS, W. R. Lake, London.—Com. from E. Mehl.—28th April, 1883.
2174. ROLLING CYLINDERS of IRON, &c., B. Walker, Leeds.—30th April, 1883.
2177. BOOT PROTECTING PLATES, J. Borrett, London.—30th April, 1883.

(Last day for filing opposition, 19th June, 1883.

175. KNITTING MACHINERY, W. Morgan-Brown, London.—Com. from H. Martini.—11th January, 1883.
366. BRACELETS for GLOVES, A. Watson, London.—23rd January, 1883.
381. WIRES for CRINOLINES, &c., G. F. Smeeton, Halifax.—23rd January, 1883.
383. MOTIVE POWER, S. Hart, Hull.—24th January, 1883.
386. HATS, G. Atherton, Stockport.—A communication from G. Yule.—24th January, 1883.
393. PHOTOMETER, A. J. Beer, Canterbury.—24th January, 1883.
396. PULPING COFFEE BERRIES, W. Walker, London.—A communication from Messrs. A. Irmaos.—24th January, 1883.
399. IMPERMEABLE COATING for WATERPROOFING, L. A. Groth, London.—A communication from N. Bellefroid.—24th January, 1883.
407. OPERATING TRAMWAY POINTS, F. A. Abeleven, Amsterdam.—25th January, 1883.
410. SMOKING PIPE, R. C. Christian, Dublin.—25th January, 1883.
416. HAMMERS, F. Wirth, Frankfort-on-the-Main.—A communication from G. Speckhart and H. Wiedmann.—25th January, 1883.
417. APPARATUS for SCRAPING, &c., POTATOES, T. Marshall, London.—A communication from J. B. Carter.—25th January, 1883.
418. RAILWAY CHAIRS, W. Hopkins and C. Turner, Birmingham.—25th January, 1883.
428. FURNACE BARS, C. J. Chubb, Clifton,—26th January, 1883.
433. AIR EXTRACTING APPARATUS, T. Rowan, London.—26th January, 1883.
437. TUBE SCRAPERS, W. S. Turner, Walworth.—26th January, 1883.
447. SCREW SWAGING MACHINES, F. J. Cheesbrough, Liverpool.—A communication from S. A. Davis and R. Blake.—27th January, 1883.
448. SCREW SWEDGING MACHINES, F. J. Cheesbrough, Liverpool.—A communication from S. A. Davis and R. Blake.—27th January, 1883.
454. CIRCUITS, &c., for ELECTRIC INDICATORS, W. P. Thompson, Liverpool.—A communication from R. Hewett, jun., and C. L. Clarke.—27th January, 1883.
479. MILLS for SHELLING OATS, &c., G. Perrott, Cork.—29th January, 1883.
494. SKATES, E. K. Dutton, Manchester.—A communication from J. Sieper.—30th January, 1883.
499. AIR and GAS MOTORS, G. W. Weatherhogg, Wandsworth.—30th January, 1883.
533. KNITTING MACHINES, H. B. Barlow, Manchester.—Com. from O. Cazeneuve.—31st January, 1883.
534. STANDS for HOLDING VESSELS, F. A. Colley and J. Wingfield, Sheffield.—31st January, 1883.
565. METALLIC BEDSTEADS, H. Ferrer, Balsall Heath.—1st February, 1883.
577. MANUFACTURE of SPIRITS of WINE, M. Bauer, London.—Com. from J. A. Stelzner.—2nd February, 1883.
584. CRUCIBLES, H. L. Doulton, Lambeth.—2nd February, 1883.
596. PRESSURE REGULATORS for GAS, J. Imray, London.—Com. from H. Giroud.—3rd February, 1883.
660. COMBUSTIBLE COMPOUND of CARBONACEOUS MATERIAL, W. R. Lake, London.—A communication from J. C. Cooper.—6th February, 1883.
777. GRINDING CORN, &c., H. H. Lake, London.—Com. from H. Rounds and R. Noye.—12th February, 1883.
794. SHEEP SHEARING MACHINE, W. R. Lake, London. Com. from C. Carpentier.—13th February, 1883.
869. BREAKING, &c., TEXTILE MATERIALS, B. J. B. Mills, London.—A communication from N. de Landtsheer.—16th February, 1883.
922. FORMING CONTINUOUS PIPES, C. A. Day, London.—A communication from W. M. Campbell, E. W. Bond, R. Brown, R. D. Radcliffe, and C. Detrick.—20th February, 1883.
925. BUTTON FASTENINGS, J. Imray, London.—A communication from A. McKevit.—20th February, 1883.
981. LIFTS for WAREHOUSES, A. B. Dansken, Glasgow.—23rd February, 1883.
998. BOOTS and SHOES, W. R. Lake, London.—A communication from E. J. Le Gay.—23rd February, 1883.
1000. CRANK SHAFTS, A. Jack and H. MacColl, Liverpool.—24th February, 1883.
1116. GAS ENGINES, R. Steel and H. W. Whitehead, Leeds.—1st March, 1883.
1295. IGNITING INFLAMMABLE GASES, A. R. Molison, Swansea.—12th March, 1883.
1501. DRIVING TRAM-CARS by GAS, R. M. Marchant and T. Wrigley, London.—22nd March, 1883.
1687. RAILWAY COUPLINGS, S. Roberts, Tunbridge Wells.—4th April, 1883.
1915. COLLARS for SPINNING, W. Jackson, Kingston-upon-Hull.—16th April, 1883.
1924. ELECTRICAL HEATING APPARATUS, J. S. Sellon, London, & R. P. Sellon, Surbiton.—16th April, 1883.
2080. CLEANING FILTERS, J. E. Hodgkin and E. Perrett, London.—24th April, 1883.
2087. MEMBRANES, C. D. Abel, London.—A communication from F. Breyer.—24th April, 1883.
2120. CIRCULATION of STEAM to ENGINE POWER, R. M. Marchant, London.—26th April, 1883.
2126. FILTERING WATER, F. H. Atkins, London.—26th April, 1883.
2152. ELECTRIC LAMPS, L. G. B. Arrighi, London.—28th April, 1883.
2156. MEASURING INSTRUMENTS, W. E. Ayrton and J. Perry, London.—28th April, 1883.
2175. STEAM BOILERS, S. Pitt, Sutton.—A communication from L. Schutte.—30th April, 1883.
2544. GAS, S. Pitt, Sutton.—A communication from E. J. Jerzmanowski.—22nd May, 1883.
2545. DENTISTRY, S. Pitt, Sutton.—A communication from C. M. Richmond.—22nd May, 1883.
2546. HAMMOCKS, C. E. Hiester, Harrisburg, U.S.—22nd May, 1883.
2561. OPERATING GAS ENGINES, L. H. Nash, Brooklyn, U.S.—22nd May, 1883.
2606. OBTAINING ARTIFICIAL LIGHT, J. S. Muir, London.—25th May, 1883.

Patents Sealed.

(List of Letters Patent which passed the Great Seal on the 25th May, 1883.)

5624. OBTAINING ELASTIC FORCE, J. Graddon, Forest Hill.—27th November, 1882.
5651. COMPOSITION for WHOOPING COUGH, P. F. Vandersteenstraaten, London.—28th November, 1882.
5656. STEAM BOILER, H. Matheson, Barnes.—28th November, 1882.
5657. HEEL PARING MACHINES, F. Cutlan, Leicester.—28th November, 1882.
5662. RAISING, &c., CARRIAGE WINDOWS, E. Clennett, West Hartlepool.—28th November, 1882.
5669. MEASURING, &c., ELECTRIC CURRENTS, J. Blyth, Glasgow.—29th November, 1882.
5670. DIVIDING DOUGH to FORM LOAVES, J. Melvin, Glasgow.—29th November, 1882.
5674. GLAZING PAPER, &c., S. Wells, London.—29th November, 1882.
5679. SHIPS of WAR, J. D. Barker, Somerset.—29th November, 1882.
5683. RECEIVING MONEY APPARATUS, H. T. Davis, Newington.—29th November, 1882.
5707. WHEELS for PERAMBULATORS, J. Simpson and S. T. Fawcett, Leeds.—30th November, 1882.
5720. RAILWAY SLEEPERS, J. C. Bunten and A. Russell, Glasgow.—1st December, 1882.
5749. MANUFACTURE of CHAINS, &c., W. E. Gedge, London.—2nd December, 1882.
5754. ELECTRICAL SWITCH, G. W. Bayley, Walsall.—2nd December, 1882.
5765. TREATING SUBSTANCES CONTAINING ANIMAL and VEGETABLE MATTER, W. C. Clennell, London.—4th December, 1882.
5793. MATTRESSES, S. K. Ibbetson, Southsea.—5th December, 1882.
5805. WHEELS for RAILWAY PURPOSES, W. R. Lake, London.—5th December, 1882.
5832. STEAM GENERATORS, W. R. Lake, London.—6th December, 1882.
5867. ORDNANCE, A. M. Clark, London.—8th December, 1882.
5911. PUMPS for CONDENSING, T. F. Stenson, Handsworth.—11th December, 1882.
5935. AUTOMATIC MUSICAL INSTRUMENTS, W. R. Lake, London.—12th December, 1882.
5951. WATCHES, A. B. Cole, Coventry.—13th December, 1882.
6090. LEGGINGS, &c., F. W. Hemming, London.—20th December, 1882.
232. CARBONATE of STRONTIA, D. Urquhart, London.—15th January, 1883.
346. YARNS for WEAVING FABRICS, G. Eaton, Manchester.—20th January, 1883.
898. CONDENSING APPARATUS in STEAM SHIPS, J. Tweedy, Walker.—19th February, 1883.
1201. ROPE TRACTION TRAMWAYS, C. F. Findlay, London.—6th March, 1883.
1271. RECEPTACLES for SANITARY CLOSETS, C. K. Lawton, Manchester.—9th March, 1883.
1353. LEAD and COLOUR PENCILS, T. Lehmann, London.—13th March, 1883.
1363. MANUFACTURE of CEMENT, &c., J. Imray, London.—14th March, 1883.

(List of Letters Patent which passed the Great Seal on the 29th May, 1883.)

5698. DYEING ANILINE COLOURS, L. Heppenstall, jun., Milnsbridge.—30th November, 1882.
5708. PAPER PULP, &c., P. Jensen, London.—30th November, 1882.
5712. DREDGING APPARATUS, G. E. Vaughan, London.—30th November, 1882.
5714. LUMINOUS PAPER, W. C. Horne, Old Charlton.—30th November, 1882.
5725. TUBE STOPPERS, D. J. Morgan, Cardiff.—1st December, 1882.
5726. WINNING COAL, &c., E. Warre and T. W. Salmon, Eton.—1st December, 1882.
5731. ACTIONS for PIANOFORTES, T. C. Dauncey, Stroud.—1st December, 1882.
5756. BRICKS, &c., W. Foot, Wellington.—2nd December, 1882.
5757. INSULATED ELECTRIC CONDUCTORS, E. T. Truman, London.—2nd December, 1882.
5759. SMALL FIRE-ARMS, T. Gilbert, London.—2nd December, 1882.
5786. FLUID GLUE, L. A. Groth, London.—5th December, 1882.
5787. EXTRACTING OIL from FISH, &c., L. A. Groth, London.—5th December, 1882.
5788. PREPARING EXTRACT from FISH, &c., L. A. Groth, London.—5th December, 1882.
5812. FILTERS, H. Rawlings, London.—6th December, 1882.
5823. GLOBE HOLDERS for LAMPS, T. Carpenter, Birmingham.—6th December, 1882.
5876. VENTILATING BUILDINGS, T. H. Thompson, Manchester.—9th December, 1882.
5913. MAGNESIA SALTS from SULPHO-ACIDS, F. Wirth, Frankfort-on-the-Main.—11th December, 1882.
5940. TRICYCLES, W. H. Thacker and J. T. Green, Nottingham.—13th December, 1882.
5941. SURFACING MACHINE, C. Pieper, Berlin.—13th December, 1882.
6068. OPEN STOVES, E. R. Hollands, London.—19th December, 1882.
6095. CUTTING PILE FABRICS, &c., C. D. Abel, London.—21st December, 1882.
6098. SEWING MACHINES, B. J. B. Mills, London.—21st December, 1882.
6100. CULTIVATING LAND, D. Greig, Leeds, and G. Greig, Edinburgh.—21st December, 1882.
6110. CUSHIONS for PERMANENT WAY, W. P. Thompson, Liverpool.—21st December, 1882.
6144. WATER HEATERS, &c., I. S. McDougall, Chadderton.—23rd December, 1882.
6198. COVERS of CARDING ENGINES, W. Hurst, Rochdale.—28th December, 1882.
70. CRANK SHAFTS, G. Allibon and T. Turton, Liverpool.—5th January, 1883.
188. VALVES and VALVE GEAR, J. Aimers and J. Tinline, Galashiels.—12th January, 1883.
574. TRICYCLES, A. Burdess, Coventry.—2nd February, 1883.
1124. STEERING GEAR to VELOCIPEDES, A. Burdess, Coventry.—2nd March, 1883.
1154. SMOKELESS STOVES, R. E. Cox, London.—3rd March, 1883.
1262. ADJUSTING AXLES to BEARINGS, J. A. A. Buchholz, London.—8th March, 1883.
1304. HORSESHOES, H. J. Haddan, London. — 12th March, 1883.
1331. MECHANISM for CONVERTING MOTION, S. Pitt, Sutton.—13th March, 1883.
1338. BUTTON HOLE FEEDING MECHANISMS for SEWING MACHINES, A. W. L. Reddie, London.—13th March, 1883.
1371. COMMUTATORS, S. Z. de Ferranti and V. S. Szezepanowski, London.—14th March, 1883.
1407. TREATING ORES, T. Bowen, London.—16th March, 1883.
1415. LAYING OUT LINES AROUND CURVES, A. Haman, San Francisco, U.S.—17th March, 1883.
1509. IRON and STEEL, T. Griffiths, Abergavenny.—22nd March, 1883.
1564. DISINTEGRATING MACHINES, W. R. Lake, London.—27th March, 1883.
1616. PNEUMATIC SIGNALS for RAILWAYS, E. M. Chase, U.S.—30th March, 1883.

List of Specifications published during the week ending May 26th, 1883.

3746, 6d.; 4539, 2d.; 4547, 4d.; 4631, 6d.; 4641, 2d.; 4649, 8d.; 4651, 2d.; 4662, 4d.; 4666, 4d.; 4672, 2d.; 4673, 6d.; 4674, 6d.; 4675, 2d.; 4677, 2d.; 4680, 2d.; 4681, 2d.; 4682, 2d.; 4685, 2d.; 4694, 6d.; 4695, 6d.; 4696, 2d.; 4697, 10d.; 4698, 10d.; 4700, 2d.; 4702, 2d.; 4704, 6d.; 4709, 2d.; 4710, 2d.; 4711, 2d.; 4712, 6d.; 4713, 6d.; 4715, 6d.; 4716, 2d.; 4719, 2d.; 4721, 6d.; 4723, 2d.; 4724, 6d.; 4726, 6d.; 4727, 6d.; 4730, 6d.; 4733, 6d.; 4734, 4d.; 4736, 2d.; 4737, 4d.; 4739, 2d.; 4740, 1s.; 4741, 2d.; 4742, 6d.; 4744, 4d.; 4745, 6d.; 4747, 2d.; 4748, 2d.; 4750, 2d.; 4751, 2d.; 4752, 6d.; 4756, 2d.; 4757, 6d.; 4758, 6d.; 4759, 8d.; 4760, 6d.; 4766, 2d.; 4769, 8d.; 4770, 6d.; 4774, 4d.; 4779, 6d.; 4788, 6d.; 4908, 6d.; 4913, 4d.; 5057, 6d.; 5505, 4d.; 5517, 4d.; 5605, 10d.; 12, 6d.; 215, 6d.; 289, 4d.; 358, 6d.; 380, 6d.; 575, 6d.

*** Specifications will be forwarded by post from the Patent-office on receipt of the amount of price and postage. Sums exceeding 1s. must be remitted by Post-office order, made payable at the Post-office, 5, High Holborn, to Mr. H. Reader Lack, her Majesty's Patent-office, Southampton-buildings, Chancery-lane, London.

ABSTRACTS OF SPECIFICATIONS.

Prepared by ourselves expressly for THE ENGINEER *at the office of Her Majesty's Commissioners of Patents.*

3746. DYEING, SIZING, AND WRINGING HANKS, *S. Spencer, Radcliffe Bridge.*—5th August, 1882. 6d.

The object is to effect the rotation dwell and reversal of the rotating hooks, and to effect the removal of the hanks from the hooks. A double internal spur wheel, with spur segments on each side concentric with the axis, is employed, and the internal and external segments alternately gear with pinions on the hook's spindles, which are thereby caused to rotate in opposite directions to twist and untwist the hanks. The hooks are caused to dwell after each movement by means of curved surfaces, which prevent the rotation of the pinions. The hank is removed from the hooks by fingers attached to a travelling apron.

4539. MANUFACTURE OF IRON, *W. Clarke, Birmingham.*—23rd September, 1882. 2d.

The object is to treat iron while in the puddling furnace so as to clean it from all impurities, improve its quality, and increase its bulk. For this purpose a mixture, consisting of 3 lb. Tafna ore, 3 lb. of iron pyrites, 4 oz. of wood sawdust, and 8 oz. bay or rough salt, is added during the puddling.

4631. CRANK FOR BICYCLES, &c., *F. G. Kinnaird, Primrose Hill.*—29th September, 1882. 6d.

This consists of an extending lever crank. The ordinary crank is shortened, and a lever fixed by a bearing to its upper end, while the upper part of the lever is extended and receives the pedal. The lower part of the lever is a segment of a circle, which runs freely in a slot or between rollers, the slot being held by a projection from the end of the fork.

4641. ORNAMENTAL PILE FABRICS, *T. F. Firth and F. Farrand, Heckmondwike.*—20th September, 1882.—(*Not proceeded with.*) 2d.

A heated roller, with any desired pattern engraved thereon, is pressed on to the pile fabric, and the parts not pressed down are afterwards cut off. The depressed parts are then caused to rise again by the action of liquid or vapour.

4649. ORNAMENTAL FRILLINGS, *C. Jackson, Nottingham.*—30th September, 1882. 8d.

The machinery for producing frillings with scolloped or other edges. A brass roller is mounted in bearings, and heated by gas, and above it is a presser roller, the two being forced together by set screws, springs, and nuts. Behind the brass roller is a pair of flanged gas-heated rollers, and in front of it are bearings connected by a plate sliding in a grooved bed, and carrying two double excentric shafts, each of which alternately operates a frame sliding in bearings, and carrying a pair of blades, each frame being knuckle-butt jointed. The shafts revolve in opposite directions, and beneath them are guides, each carrying a stud or truck traversed by a grooved pattern roller.

4651. ARTIFICIAL LIGHT APPARATUS FOR PHOTOGRAPHING, &c., *J. Y. McLellan, Glasgow.*—30th September, 1882.—(*Not proceeded with.*) 2d.

This consists in burning pieces of magnesium in a closed globe filled with oxygen.

4662. COUPLING AND UNCOUPLING RAILWAY CARRIAGES, &c., *J. Richardson and C. Greenwood, Harrogate.*—30th September, 1882.—(*Not proceeded with.*) 2d.

This relates to the use of a pivotted hook with an inclined surface, which, coming in contact with an eye on the next vehicle, raises the hook until its nose passes such eye, when the hook drops therein. Side levers serve to remove the hook for uncoupling.

4666. LOOMS FOR WEAVING CARPETS, VELVETS, PLUSH, &c., *J. B. Alliott, Nottingham.*—(*A communication from J. Wade, New York.*—(*Not proceeded with.*) 2d.

This relates, First, to an improved wire motion, whereby control is obtained over the wires from the point of withdrawing them from the fabric to the re-insertion into the open shed or wire box; Secondly, to driving looms by friction gearing; Thirdly, to an improved roller for taking up the woven fabric.

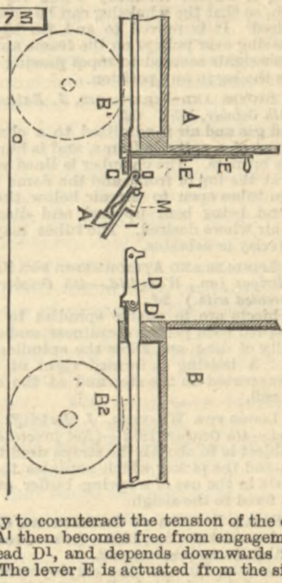
4672. PEAT FUEL, *G. Wilson, Kent.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

The peat is dried in an oven, where it is subjected to the action of stirrers, and is then mixed with pure peat charcoal, to which a solution of silicate of soda, alum, glue, or other glutinous body is added, and the whole formed into spherical balls in a suitable press.

4673. COUPLING FOR RAILWAY VEHICLES, *R. Stone, Bristol.*—2nd October, 1882. 6d.

At one end of the vehicle A is a coupling hook A^1 hinged to the draw bar B^1. Below the hinge O is a plate C pivotted to the draw bar B^1, and capable of being so operated by the lever E pivotted at E^1 to the end wall of the vehicle A as either to bend against the underside of, and bring to a horizontal position, the coupling hook A^1, according as the lever E^1 is moved inwards or outwards. To the vehicle B, as also to one end of each vehicle opposite to that at which the coupling hook is carried, is attached a crosshead or claw D hinged at D^1 to the draw bar B^2. On the sufficiently close approach of the vehicles one towards another, the coupling hook A^1, being in the position shown, the outward end of the crosshead or claw D enters the recess I formed in the split flap or tappet M hinged to the coupling hook A^1, and the vehicles remain uncoupled. To connect the vehicles the lever E is actuated to cause the plate C to raise the coupling hook A^1 to a horizontal position, and on the sufficiently close approach of the vehicles, the crosshead or claw D is moved upward on the hinge D^1 by contact of its outer end with the hook A, over the end of which the said outer end of the crosshead D passes, and guided in the split flap or tappet M, engages with the coupling hook A. To disconnect the vehicles the plate C is moved back to the position shown, and the vehicles are made to momentarily approach each other, still

4673



more nearly to counteract the tension of the coupling. The hook A^1 then becomes free from engagement with the crosshead D^1, and depends downwards from the hinge O. The lever E is actuated from the side of the vehicle.

4675. KEYLESS OR STEM-WINDING WATCHES, *T. Waller, Coventry.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

A small piece of steel is attached inside the case to the winding stem and acts as a lever upon the moving bar, whereby the usual nail piece is dispensed with. By drawing out the winding button the hands are moved in either direction, and upon releasing it the button returns to its normal position.

4677. RAILWAY BRAKES, *J. Bickle, Fitzroy-square.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

This relates to a brake block which acts partly on a portion of the periphery of the wheel and partly upon the rail.

4681. DOUBLING OR TWISTING YARNS, *E. Dyson, near Huddersfield.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

This relates to improvements in doubling or twisting machines for facilitating "piecing up" when the cops are empty, and it consists in the use of two or more creels in mules and arranging them so that the cops are vertical.

4682. LOOMS FOR WEAVING, *J. H. Pickles, Burnley.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

The object is, First, to put into cloth the same number of picks per inch throughout all its length, and it consists in the use of mechanism for causing all the weft threads to be beaten up equally by the slay, by causing the cloth to slacken when the loom is stopped. This also relates to the taking-up mechanism, and to means for preventing the oil for lubricating the crank shaft getting on the surface of the brake pulley.

4685. LATHES FOR TURNING SHAFTS, *W. Allan, Sunderland.*—2nd October, 1882.—(*Not proceeded with.*) 2d.

Two headstocks can move along and be locked in any desired positions on a bed, and between them is placed the mechanism to revolve the shaft to be turned. Two or more tool slides are mounted upon the bed, so that both ends of the shaft can be operated upon simultaneously.

4697. MAKING GAS, *A. Wilson, Staffordshire.*—3rd October, 1882. 10d.

This relates to gas producers in which a central tuyere is used in conjunction with a solid hearth, and with which the inventor combines mechanism for automatically removing ashes and other incombustible residue from the apparatus. According to one arrangement screws are arranged above the hearth, which has an extension with an inclined side, so as to form a chamber which is charged with water, in which the screws are submerged. Into the water a plate dips to form a trap, so that while the ashes are forced up and over the inclined side of the chamber, escape of gas or vapour from the producer is prevented by the water. To more effectual diffuse blast of steam and air the central tuyere may be caused to revolve.

4698. TRICYCLES, *H. C. Bull, New York.*—3rd October, 1882. 10d.

This relates to a tricycle with a collapsible frame and seat-supporting device, and provided with differential driving gear, consisting of reducing gear and a disc connecting clutch. Also to an efficient brake device consisting of two discs, and an efficient steering device.

4700. STOVES, FIREPLACES, AND KITCHEN RANGES, *S. Sturm, Cologne.*—3rd October, 1882.—(*Not proceeded with.*) 2d.

This consists in the use of gratings in the flues of stoves, &c., in place of the usual dampers, the object being to prevent loss of heat through excessive draught.

4702. BEDSTEADS, SPRING MATTRESSES, BOLSTERS, AND PILLOWS, *G. Lowry, Salford.*—3rd October, 1882.—(*Not proceeded with.*) 2d.

This consists in introducing suitable springs between the laths and the bedsteads, so as to render the use of spring mattresses unnecessary.

4704. METALLIC FRAMES FOR FURNITURE, &c., *B. J. La Mothe, M.D., New York.*—3rd October, 1882. 6d.

The frames are made of tubes and bars of metal jointed at the places where they fold. One feature relates to a hinge formed with straps, one of which passes into the end of the tubular leg frame, and the other passes into the tubular rail, and is rivetted. The rail rests upon the leg when the parts are open. A second feature is a spring bottom for beds, and which is also applicable as the bottoms or backs of chairs or sofas.

4709. CONCENTRATING SULPHURIC ACID, *A. J. Boult, London.*—3rd October, 1882.—(*A communication from J. Gridley, Brooklyn, U.S.*)—(*Not proceeded with.*) 2d.

The object is to enable sulphuric acid to be concentrated in cast iron vessels in such a manner that the iron is not acted upon by the acid. The invention is based upon the fact that sulphuric acid of 66 deg. Beaumé at 60 deg. Fah. has little or no action on cast iron.

4710. RAILWAY WAGON OR CARRIAGE COUPLING, *W. Johnson, Liverpool.*—3rd October, 1882.—(*Not proceeded with.*) 2d.

The coupling has one or more joints with a stop preventing the links rotating beyond 180 deg. The carriages are coupled by throwing back one coupling, so that it stands up against the wagon, and on coming in contact with another wagon it will be caused to fall on to and engage with its coupling. A bar over the buffer serves to knock up the link for uncoupling.

4711. TRICYCLES, *W. Briscall, Liverpool.*—3rd October, 1882.—(*Not proceeded with.*) 2d.

This relates to velocipedes with one large wheel in front and the other wheels in the rear, the object being to enable them to be easily ridden round corners, and to so form the same that the equilibrium of the rider will not be disturbed in passing over uneven ground. The axle of the hind wheels is jointed to the backbone, so that it may stand at any angle thereto.

4713. Elevators for Loading and Unloading Vessels, &c., *W. Clark, London.—3rd October*, 1882. —(*A communication from A. D. Fox, New York.*) 6*d.*

This relates to endless chains of buckets, and consists in means for adjusting, balancing, and giving direction to the elevator leg and its appurtenances. This leg is slotted vertically when its shaft passes through, so that the whole leg can be raised or lowered as desired. It is moved to and fro by means of a rope passing over pulleys on the frame and on the leg. Counterweights secured to ropes passing over pulleys balance the leg in any position.

4715. Stoves and Fireplaces, *J. Bateman, Holborn. —4th October*, 1882. 6*d.*

Mixed gas and air is admitted to a chamber in the lower part of a suitable frame, and is burned through suitable burners. The chamber is lined with fireclay, except at the top or front, and the flame is caused to act upon tubes open to the air below the flame, the other end being bent upward and discharging the heated air where desired. The tubes may be covered with fireclay or asbestos.

4716. Spindles and Attachments for Spinning, &c, *J. Briggs, jun., Wakefield.—4th October*, 1882.—(*Not proceeded with.*) 2*d.*

The objects are to enable spindles to be run at a higher speed with perfect steadiness, and also to obtain regularity of drag, and allow the spindles to be made lighter. A bearing is formed right at top, besides being supported in the step and at the collar in the spindle rail.

4719. Looms for Weaving, *J. Ratcliffe, Great Harwood.—4th October*, 1882 —(*Not proceeded with.*) 2*d.*

The object is to abolish the straps used to check the shuttle, and the picker which actuates the same, and it consists in the use of a spring buffer attached to a bracket fixed to the sleigh.

4721. Steam Boilers or Generators, *G. F. Redfern, London.—4th October*, 1882.—(*A communication from C. P. G. Sack, Sweden.*) 6*d.*

This consists, First, in the employment, in a steam generator of the spiral tube F in combination with the perforated tube K and the surrounding tube L, so that the steam mingled with water coming from the tube F, is dried in the tube L, and if required, may be

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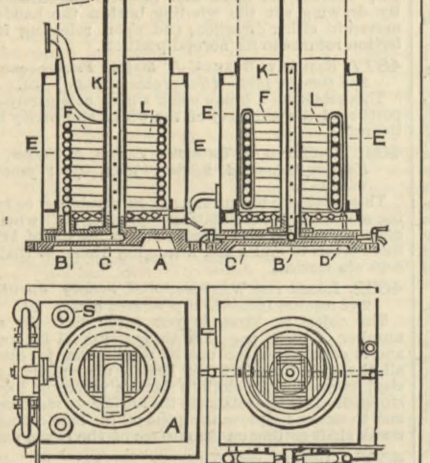


superheated; Secondly, the method shown of connecting the tubes F K and S, by means of the bottom plate A provided with the channels B C and D; Thirdly, the arrangement of the spiral tube F, the tubes K and L, and the bottom plate A, in combination with the heater E.

4723. Furnaces and Appliances for Burning Petroleum, &c., *J. Findlay, Glasgow.—4th October*, 1882.—(*Not proceeded with.*) 2*d.*

This consists in fitting in connection with furnaces, such as the furnaces of land, marine, and locomotive steam boilers, or with grates or stoves, a special arrangement of appliances in which a series of tubular burners fitted with asbestos wicks draw up and burn liquid fuel.

4724. Machinery for the Manufacture of Elastic Fabrics, *W. R. Lake, London.—4th October*, 1882.—(*A communication from T. H. Ball, Chicago.*) 6*d.*

This relates to machinery for crimping a fabric preparatory to introducing springs, being especially applicable for use in the manufacture of the elastic fabric described in patent No. 5685, A.D. 1881, and it consists in the use of clamps, by means of which the fabric is crimped on wires.

4726. Door Locks or Latch Checks, *W. A. Barlow, London.—4th October*, 1882.—(*A communication from F. W. Boldt and P. C. A. Vogel, Hamburg.*) 6*d.*

This relates to a door check which is automatically thrown in a position to operate by the act of closing the door. The locking plate is provided with a hinged check bar with which is a pear-shaped slot, and from its edge projects an incline. When the check bar is free it drops into a slot in the lock plate. The latch has a bolt acted upon by a spring, against which it can be drawn back. The head of the bolt is bevelled and when the door is closed it rides up an incline on the check bar and passes through the large end of the pear-shaped slot.

4727. Trapping Sewers and Drains, *W. A. Barlow London.—4th October*, 1882.—(*A communication from L. Henry, Brussels.*) 6*d.*

The apparatus is for use in branch sewers connecting houses to main sewers, the object being to allow the matter to enter the latter, but prevent it re-entering the branch sewers. A hinged lid or door works over one end of a box which is fitted on to the end of the branch sewer, such lid being balanced by a suitable weight.

4730. Chiming Clocks, *W. R. Lake, London.—4th October*, 1882.—(*A communication from J. Lindauer, New York.*) 6*d.*

This consists partly in combining the chimes and hour-striking mechanism with one and the same main spring and train of wheels, thereby constructing the clock movement with two instead of three main springs and attendant mechanism.

4733. Process for the Integral Extraction of the Constituent Principles of Fatty Bodies, *W. H. Beck, London.—4th October*, 1882.—(*A communication from C. Violette and A. Buisine, Lille.*) 6*d.*

The fatty bodies are placed in a digester with a suitable proportion of ammonia, and heated directly by a furnace flame so as to raise the temperature progressively and maintain the pressure during several hours between 5 and 7 atmospheres. The ammoniacal saponification being effected, the whole is forced into a boiler heated by a superheated steam coil and by the waste heat from the furnace, such boiler communicating by a neck with a coil of a condensing column. The dissociation of the ammoniacal soap commences as soon as it arrives in the boiler, and is completed by raising the temperature to 180 deg. C. The ammoniacal liquid from the condensing coil can be again used.

4734. Furnaces for Consuming Smoke, *F. Brown, Luton.—5th October*, 1882. 4*d.*

This relates to improvements on patent No. 2635, A.D. 1882, and consists in shaping the fire bars of the furnace so that they have an incline upwards at the back end, and are made unusually deep. The furnace is provided with a hanging bridge.

4736. Preventing the Radiation of Heat from Steam Boilers, &c., *J. Roberts, Oldham, and G. Travis, Failsworth, Lancs.—5th October*, 1882. 2*d.*

The boiler or pipe is first coated with any ordinary non-conducting compostion or material, then with a layer of ground or disintegrated cork, and finally a second coating of the ordinary composition or material is placed over the cork.

4737. Fountain Pen-holders, *F. F. Benvenuti, Swansea.—5th October*, 1882. 4*d.*

In order to admit air to the upper part of the inkholder of fountain pen-holders, a hole is formed near the end of the case, and over it fits a valve secured to one end of a lever pivotted near the middle of its length, and its other end terminating near the lower end of the case, so that when the pen is in use the fingers will rest on the lever, and so force the valve from its seat over the hole, and thereby allow air to enter. A spring tends to keep the valve to its seat.

4739. Ventilators, *A. Gendebien, Brussels.—5th October*, 1882.—(*Not proceeded with.*) 2*d.*

This relates, First, to the arrangement of outlets consisting in a receiving surface and an outlet; Secondly, to a particular form of the outlet or gills, which are tangential to the air inlet galleries; and Thirdly, to a special disposition of twin ventilators suppressing the axis, the arms, and the inside pallets.

4741. Bicycles and Tricycles, *H. Sutcliffe, Halifax. —5th October*, 1882.—(*Not proceeded with.*) 2*d.*

This relates to the construction of an automatic varying crank in which the treadle is connected to a clip acting on a spring on the crank arm, so as to compress the same when pressure is applied to the treadle, and thus lengthen the crank during the propelling part of its sweep.

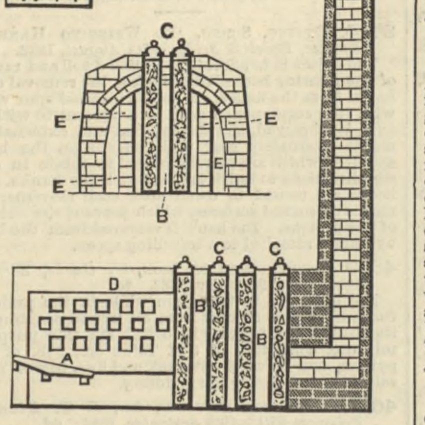
4742. Hoes, *W. Edwards, Wolverhampton.—5th October*, 1882. 6*d.*

The blade and eye are formed without any welding or rivetting from one piece of sheet metal, and there is a fluted or hollow rib running from the eye partly down the blade.

4744. Converting Cast Iron into Steel or Steely Iron, *J. Bond and H. J. Whiteley, near Darlington. —5th October*, 1882. 4*d.*

A is an oven or furnace which may be constructed in several forms for receiving a series of tubes or chambers B with covers C thereon. Openings D and flues E for distributing the flames and heated gases are arranged as most convenient. The castings to be con-

4744



verted into steel or steely iron are placed into the tubes, after which the upper ends are sealed by covers C. The fire is then ignited, the heat of which is regulated, so as to keep the tubes at a suitable temperature for a certain length of time, by which means the castings are converted into steel or steely iron.

4745. Grain Driers, *A. M. Clark, London.—5th October*, 1882.—(*A communication from H., G. E., and C. F. Cutler and B. T. Thompson, Mass., U.S.*) 6*d.*

This relates to grain drier in which the grain is passed through a revolving cylinder heated by steam pipes. The cylinder is of wood, and is inclined, its lower head being double and having a central partition and radial partition plates to form four chambers on each side of the plate. The partition plate receives the ends of pipes extending through the cylinder, and the back plate receives the ends of pipes surrounding the former and connected to the upper head. The steam enters by the first pipe, and returns with the water of condensation by the second pipe.

4747. Photographic Engraving, *F. J. Emery, Burslem.—5th October*, 1882.—(*Not proceeded with.*) 2*d.*

This refers to Niépce's process of engraving, in which a metallic plate is coated with a thin film of bitumen, and it consists in the use of a fatty or waxy image which is transferred to the surface of the bitumenised metal so as to protect the film of bitumen from light, and also soften such film, so that the unaltered parts can be removed with greater facility.

4748. Musical Tops, *F. Wirth, Germany.—5th October*, 1882.—(*A communication from M. Dannhorn, Germany.*)—(*Not proceeded with.*) 2*d.*

This consists in fitting tops with metal plates provided with reeds arranged so as to play a tune.

4750. Busts or Bodies for Supporting and Exhibiting Ladies' Costumes, *A. W. Child and G. B. Childs, Clerkenwell.—6th October*, 1882.—(*Not proceeded with.*) 2*d.*

This consists in making the busts and stands in two parts, so that when separated the body can be reversed and introduced into the stand, and thereby occupy less space.

4751. Obtaining Tanning Material from the Asphodel Plant, *W. R. Lake, London.—6th October*, 1882.—(*A communication from A. Badoil and H. Lienders, Paris.*)—(*Not proceeded with.*) 2*d.*

The asphodel is washed to free it from earth and then grated or crushed, and the pulp so obtained pressed. The juice is subjected to a complete fermentation to extract the alcohol, and the pressed pulp is dried and reduced to powder, when it can be used for leather-dressing purposes.

4757. Mixing Water with Gas or Steam, *E. de Pass, London.—6th October*, 1882.—(*A communication from E. Körting, Germany.*) 6*d.*

The object is to effect the utmost possible intimacy of the mixture of water with gas or steam, and it consists in imparting a revolving motion to the jet of water, causing the centrifugal force resulting therefrom to tear it into drops, and in using an almost cylindrical mixing nozzle, the sides of which are perforated with a number of holes drilled at an acute angle to the direction of the flow of the jet of water. The gas or steam enters the nozzle through these holes, and in the form of fine jets strikes the water jet. The revolving motion of the water jet is produced by slanting surfaces inserted in the water nozzle and in the water pipe.

4758. Obtaining Ammonia from Furnace Gases, *J. and J. Addie, Glasgow.—6th October*, 1882. 6*d.*

The object is to fix the ammonia in gases from blast furnaces, and other furnaces and gas-producers, by means of an acid in the form of a gas or vapour, and subsequently condensing and recovering the compound thus formed. It is preferred to use sulphuric acid for this purpose.

4759. Measuring Water, &c., *W. and C. W. B. Hamer, Northwich.—6th October*, 1882. 8*d.*

A cylinder with piston has inlet ports at each end, to which two pipes are connected, and communicate at top and bottom with the inlet and outlet pipe, and so arranged as to contain four seatings for two equilibrium valves, one such in each pipe. The valves move by a falling weight on an arm arranged to be tipped over at each in and out stroke.

4760. Hoists for Mills, Warehouses, &c., *S. Jones, Warrington.—6th October*, 1882. 6*d.*

This consists in the use (in a single hoist) of one rope for raising, lowering, and braking purposes, and for a double hoist two ropes only are required. The throwing of the winding mechanism into gear also tightens the driving belt, and thus enables it to have a firmer grip. The levers of the brake and hoisting gear are connected by pins and slots, so that the action of pulling the gear in motion also throws the brake out of gear. The gear is put into action by excentric or cam motion, whereby the driving wheel is thrown forward against the main driving wheel, and this throwing forward tightens the belt and ensures a firmer grip. The moment the actuating handle or rope is released, the gear automatically throws itself out of gear, and brings the brake into action. The fulcrum of the brake is adjustable so that the brake can be altered and wear taken up.

4766. Double-barrel Small-arms, *D. Bentley and W. Baker, jun., near Birmingham.—6th October*. 1882.—(*Not proceeded with.*) 2*d.*

The object is to discharge both barrels by one trigger, and it consists in giving motion to a slide by the tumbler of the lock, so that the trigger is put in connection with the sear of the right-hand lock when the right-hand lock is at full cock, and with the sear of the left-hand lock when the right-hand lock is not at full cock. The invention further relates to improvements in drop-down double-barrel guns having internal hammers, which are cocked by the raising of the breech ends of the barrels for loading, and it consists in suitable means whereby the shutting and locking down of the barrels after the gun has been cocked, communicates the required tension to the main spring for the discharge of the gun.

4769. Treatment of Carbonaceous Minerals for Oil, Gas, Ammonia, &c., *A. Neilson and A. Cunningham, Renfrew.—7th October*, 1882. 8*d.*

This consists in treating Renfrewshire shale and similar carbonaceous materials for obtaining oil, gas, ammonia, and other useful products by fusing the residues after the volatile matters have been gradually driven off. The apparatus employed consists of upper vertical retorts combined with lower chambers or cupolas, and with blast tuyeres and accessory parts for fusing and withdrawing the earthy metallic residues.

4770. Apparatus for Cooling and Refrigerating Liquids, *C. Pieper, Berlin.—7th October*, 1882.—(*A communication from H. Egells, Berlin.*) 8*d.*

This relates to improvements on patents No. 1678, A.D. 1878, and No. 2010, A.D. 1880, in which ice or cold is produced by evaporating water under pressure very greatly reduced by the use of a compound or duplicate exhausting pump in combination with appliances for absorbing the vapour by means of sulphuric acid, and for reconcentrating the acid after having become diluted. The apparatus for reconcentrating the acid consists of a cylindrical vessel with a conical cover all lined with lead having at the lower part concentric coils of pipe. The pressure in the vessel acts on both sides of the lead lining. Each coil is connected to a steam pipe, and to a condensed water pipe. From the top of the vessel a pipe leads to an annular casing, within which is a suction pump, such casing acting as a condenser, for which purpose a water jet is provided. Under the vessel is a receptacle to receive the concentrated acid.

4774. Boiler for Generating Steam, *H. C. Bull, Brooklyn, U.S.* 6*d.*

The boiler consists of three cylindrical vessels, the central one filled with a nest of tubes extending between a top and bottom plate, and being divided into two portions, the under one being water filled and a steam generator, and the upper one being steam filled and a superheater. This vessel is placed over a gas combustion chamber, and is surmounted by an uptake communicating with the chimney. The vessels on either side of the central one are similar, each having a dome top and an interior conical shell bottom extending upwards and opening out through the side, where a charging door is provided, branches also being provided leading to the gas combustion chamber of central vessel. Each conical shell is set over a closed furnace provided with fire bars and a cleaning door. The side vessels contain water, and are connected at bottom to a branch from top of central vessel.

4779. Obtaining Synchronous Movements, *F. Wolff, Copenhagen.—7th October*, 1882.—(*A communication from P. la Cour, Denmark.*) 6*d.*

This consists of a vibrating body such as a tuning fork permanently vibrating or oscillating by automatic electric intermittent action, and thereby transmitting an intermittent or undulating current, and of a wheel subject to oscillation or vibration under the influence of the said current.

4788. Machines for Treating Hides, Skins, or Leather, *W. R. Lake, London.—7th October*, 1882. —(*A communication from C. Holmes, Boston, U.S.*)—(*Complete.*) 6*d.*

A head is arranged to be reciprocated by a crank and connecting rod, which is extended and its motion utilised to alternately lift and depress the tools, the carriers of which are hinged to the head and connected to rods passing through the connecting rod, and provided with stops, against which the latter is alternately brought as it oscillates, thereby lifting the tools. Springs hold the tools for their work. The tools may also be lifted clear of the work when desired.

4908. Filling and Corking or Stoppering Bottles, *A. Macdonell, Ireland.—16th October*, 1882. 6*d.*

This relates to improvements on the "Macdonell bottling machine," in which a stationary and rotary portion are so arranged in relation to each other that as the latter revolves, cams are caused to actuate the various parts for effecting the filling and corking of the bottles automatically. The stationary part carries the movable stand for the bottles, a mouthpiece through which the liquid and cork are introduced, and which carries the valves to regulate the admission of liquid and egress of air, and a movable plunger to force the cork into the bottle, and also a "kick-off" or automatic device and shoot for discharging the bottles.

SELECTED AMERICAN PATENTS.

From the United States' Patent Office Official Gazette.

276,761. Incidence Window, *Friedrich Bredehorst, Bremen, Germany—Filed May 24th*, 1882.

Brief.—The window has horizontal lenses arranged

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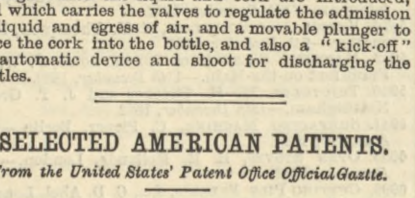

diagonally to each other, and having their deflecting faces upward.

276,781. Wind Gauge for Thrashing and Cleaning Machines, *Joseph R. Curry, Lawrence, Kans.—Filed December 21st*, 1882.

Claim.—The blast-regulating attachment for fan blowers or thrashers, which consists essentially of the governor *g h i k c l*, pivotted levers *e*, boards *b*, valves *d*, pivotted or hung to operate in the wind passages of the blower, said valves being connected directly to

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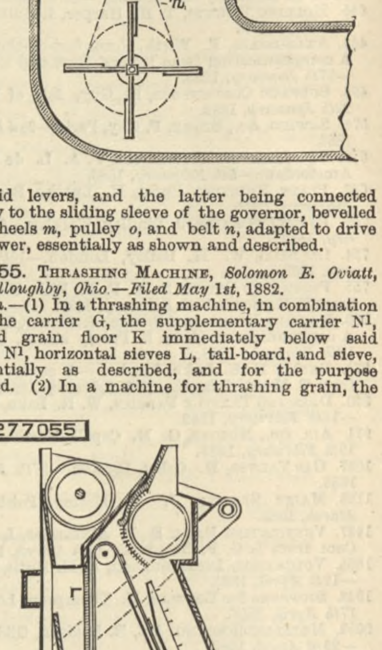

the said levers, and the latter being connected directly to the sliding sleeve of the governor, bevelled gear wheels *m*, pulley *o*, and belt *n*, adapted to drive the blower, essentially as shown and described.

277,055. Thrashing Machine, *Solomon E. Oviatt, Willoughby, Ohio.—Filed May 1st*, 1882.

Claim.—(1) In a thrashing machine, in combination with the carrier G, the supplementary carrier N^1, inclined grain floor K immediately below said carrier N^1, horizontal sieves L, tail-board, and sieve, substantially as described, and for the purpose specified. (2) In a machine for thrashing grain, the

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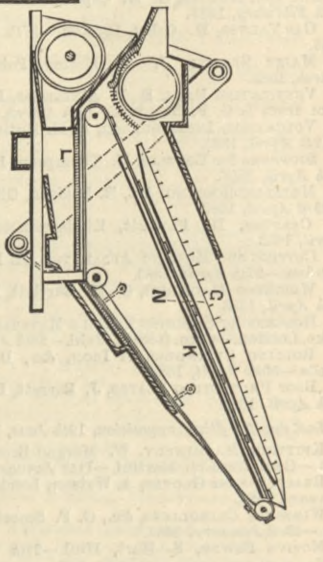

combination of the carrier G, supplementary carrier N^1, inclined grain floor and sieves swept by said supplementary carrier, and extension tail-board and sieve, constructed and arranged to operate in a manner as described, and for the purpose specified.

CONTENTS.

The Engineer, June 1st, 1883. PAGE

About one-third of the ozokerite that comes into the market is worked into paraffine, and two-thirds into ceresine.

South Kensington Museum.—Visitors during the week ending May 26th, 1883:—On Monday, Tuesday, and Saturday, free from 10 a.m. to 10 p.m., Museum, 13,861; mercantile marine, Indian section, and other collections, 4497. On Wednesday, Thursday, and Friday, admission 6d., from 10 a.m. to 6 p.m., Museum, 2030; mercantile marine, Indian section, and other collections, 1257. Total, 21,645. Average of corresponding week in former years, 16,633. Total from the opening of the Museum, 22,055,937.