INTERNATIONAL INVENTIONS EXHIBITION.

As our readers are aware, this Exhibition is to be opened to the public on the 4th inst. by H.R.H. the Prince of Wales. Considerable alterations and extensions have been made to the buildings since last year, many of the low and narrow erections which were generally very inconvenient and ill-lighted having been swept away and replaced by wider and loftier structures. Notably we may mention the addition of North and South Courts to the South Gallery, which has not only given much extra space, but has greatly improved the internal appearance of this portion of the Exhibition. What was known at the "Healtheries" as the Western Annexe has also been entirely rebuilt on a much larger scale, and opened on one side to the West Gallery.

The Inventions Exhibition consists of two divisions. The first comprises inventions, which include apparatus, appliances, processes, and products invented or brought into use since 1862, the general aim being to bring before the public the progress which has been made during the last quarter of a century in applying the discoveries of science to the purposes of daily life. The second is entirely devoted to musical instruments, and machinery, apparatus and appliances connected with their use, or bearing upon the science and art of music.

Division I., to which we shall confine ourselves, is subdivided into thirty-one groups, containing 165 classes, which are disposed throughout the buildings in the manner shown in the accompanying plan:—

Group I—Agriculture, Horticulture, and Arboriculture: comprising field implements; barn and farmyard implements; dairy and poultry farm appliances; agricultural construction; cattle food; horticultural apparatus; arboriculture.

Group II — Mining and Metallurgy: comprising machinery and appliances used in mines and quarries; production and manufacture of iron and steel; forging and foundry work, &c.

Group III—Engineering Construction and Architecture: comprising roads; railways and tramways; bridges and viaducts, &c.

Group IV—Prime Movers, and Means of Distributing their Power: comprising steam engines and boilers; gas and air engines, &c.; means of utilising natural forces; and means of transmitting power.

Group V—Railway Plant: comprising rolling stock (excepting locomotives); fixed and other appliances; brakes (hand and automatic); tramways; atmospheric railways; portable railways, &c.

Group VI—Common Road Carriages, &c.: comprising carriages for common roads; bicycles and tricycles; saddlery and harness; farriery.

Group VII—Naval Architecture: comprising ship and boat building; ships' fittings; marine propulsion (including steering).

Group VIII—Aeronautics: comprising balloons; aeronautic apparatus.

Group IX—Manufacture of Textile Fabrics.

Group X—Machine Tools and Machinery: comprising metal-working machines; wood-working machinery; stone-working machinery.

Group XI—Hydraulic Machines, Presses, Machines for Raising Heavy Weights, Weighing, &c.: comprising pumps; hand, steam, rotary, centrifugal; fire engines; cranes and other lifting apparatus; hydraulic and other presses; weighing machines.

Group XII—Elements of Machines: comprising mechanical movements; separate parts of machines.

Group XIII—Electricity: comprising generators, conductors; testing and measuring apparatus; telegraphic and telephonic apparatus; electric lighting apparatus; electrometallurgy and electro-chemistry; distribution and utilisation of power; electric signalling; lightning conductors; electro-medical apparatus; electrolytic methods for extracting and purifying metals; electro-thermic apparatus.

Group XIV—Apparatus, Processes, and Appliances connected with Applied Chemistry and Physics: comprising inorganic products, and means used in obtaining them; organic and synthetical products, and means used in obtaining them; apparatus and appliances for compressing and liquefying gases, and applications thereof.

Group XV—Gas and other Illuminants: comprising coal gas, water gas, oil gas, carburetting air, &c.; tests and photometrical apparatus; burners; and means of utilising and applying gas; mineral and other oils; candles, &c.; lamps for oil and spirits; holders for candles, &c.

Group XVI—Fuel, Furnaces, &c.: comprising manufacture of fuel; furnaces for manufacturing purposes; stoves for coal, for gas, for oil, &c.

Group XVII—Food, Cookery, and Stimulants: comprising machinery for treating grain and flour; manufacturing articles of food, &c.

Group XVIII—Clothing: comprising fabrics; articles of clothing; machinery and apparatus; cleaning clothing; dress fastenings, &c.

Group XIX—Jewellery: comprising jewellery and personal ornaments.

Group XX—Leather, &c.: comprising manufacture of leather; treatment and application of leather—exclusive of saddlery and of boots and shoes—artificial leather, &c.

Group XXI—India-rubber and Gutta-percha, &c.: comprising machinery for treating india-rubber and gutta-percha, &c.

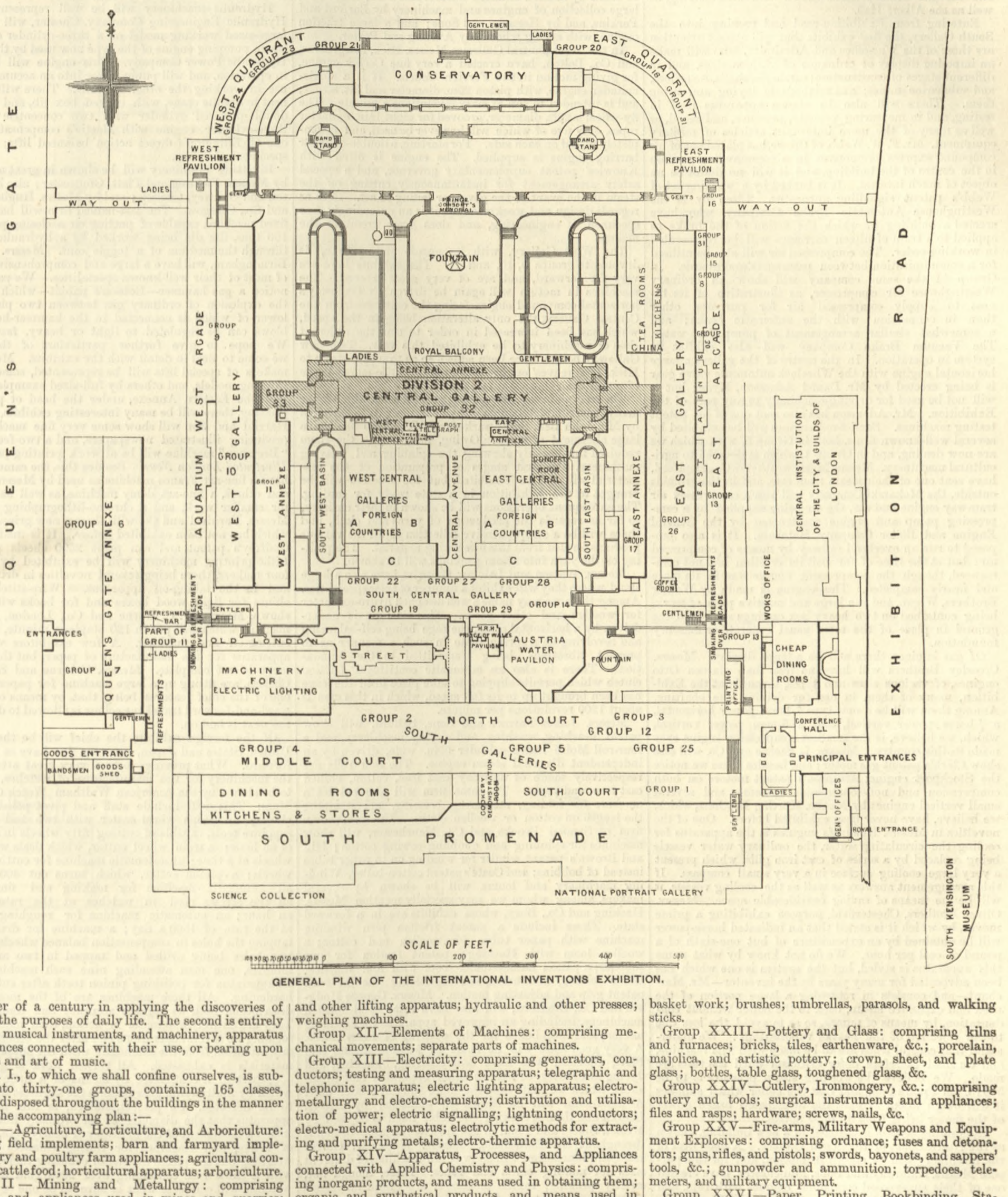
Group XXII—Furniture and Accessories—Fancy Goods: comprising furniture and upholstery; floor coverings and wall coverings (other than paperhangings); artistic and ornamental metal work; trunks; portmanteaus, &c.; basket work; brushes; umbrellas, parasols, and walking sticks.

Group XXIII—Pottery and Glass: comprising kilns and furnaces; bricks, tiles, earthenware, &c.; porcelain, majolica, and artistic pottery; crown, sheet, and plate glass; bottles, table glass, toughened glass, &c.

Group XXIV—Cutlery, Ironmongery, &c.: comprising cutlery and tools; surgical instruments and appliances; files and rasps; hardware; screws, nails, &c.

Group XXV—Fire-arms, Military Weapons and Equipment Explosives: comprising ordnance; fuses and detonators; guns, rifles, and pistols; swords, bayonets, and sappers' tools, &c.; gunpowder and ammunition; torpedoes, telemeters, and military equipment.

Group XXVI—Paper, Printing, Bookbinding, Stationery, &c.: comprising machines and processes for the manufacture of paper, paste-board, and papier-mâché; machines, &c., for cutting, folding, and ornamenting paper; paper hangings; letterpress and other printing; bookbinding, manufacture of portfolios, &c., applications of papier-mâché; artists' implements and materials; writing materials and appliances.



GENERAL PLAN OF THE INTERNATIONAL INVENTIONS EXHIBITION.

Group XXVII—Clocks, Watches, and other Time-keepers: comprising clocks; time signals, &c.; watches and chronometers; tools, &c.

Group XXVIII—Philosophical Instruments and Apparatus: comprising optical; astronomical; physical; electrical; chemical; mathematical; meteorological; geographical; nautical; weighing and measuring; biological.

Group XXIX—Photography: comprising processes and their results; apparatus (excluding lenses); application of photography to various purposes; typography, ceramics, relief-moulds, &c.

Group XXX—Educational Apparatus: comprising models and apparatus.

Group XXXI—Toys, Sports, &c.: comprising toys, games, and exercises; field sports; scenic and dramatic effects.

In addition to the foregoing, the plan also shows the space allotted to foreign exhibitors, the name of the country being given in each case.

Division II. comprises three groups of sixteen classes, and occupies those portions shown with dark shading, as well as the Albert Hall.

Entering from Exhibition-road and passing into the South Gallery, the first exhibits that will attract attention are those of the War-office and Admiralty, who will make an imposing display of ordnance of various sizes, and in different stages of construction; carriages, shells, torpedoes, and submarine mines; and methods of laying and firing them. There will also be shown apparatus used in testing, and in measuring velocity, pressure, and recoil, as well as many of the more important articles of military equipment. Mr. F. W. Webb, of Crewe, has placed one of his compound express locomotives in a commanding position in the centre of the building, and it will no doubt be an object of much interest. It is backed by a working set of Webb's patent signalling apparatus. Close by is the Westinghouse Automatic Brake Company, who have erected a building in which the action of the brake as applied to a train of fifteen carriages will be represented in working order. The compressed air will also be utilised for a communication between passengers and guards. In Group 11 the same company will show an ordinary Westinghouse air compressor, as illustrative of its fitness to supply compressed air for purposes other than in connection with the automatic brake; and a somewhat similar arrangement of pump for water. The Vacuum Brake Company will also exhibit its system in operation. In the centre of the gallery a large horizontal engine with the Wheelock automatic valve gear is being erected by Mr. Daniel Adamson, Hyde; but it will not be used for driving machinery in any part of the Exhibition. Mr. Adamson has also sent one of his patent testing machines. Semi-fixed engines will be exhibited by several well-known firms, both in Group 5, with which we are now dealing, and in Group 1, which is devoted to agricultural machinery. Messrs. Merryweather & Co., Deptford, have sent one of their steam tram-cars, and in the grounds outside, the Mekarski Company will run a compressed air tramway engine and car, the air being supplied by a compressing pump and engine constructed by the General Engine and Boiler Company, Hatcham. It is also proposed to run an overhead railway by means of compressed air; but at the time of our visit its erection had not commenced, though the compressing engine was in its place and nearly completed. This engine is made by Walker Brothers, Wigan, and is a large and massive piece of work, being contained on two heavy box castings sunk into the ground in place of the more usual concrete or masonry foundation.

Of gas engines there will be a large display. Messrs. Crossley Brothers will have no less than sixteen Otto engines, of various sizes and types, throughout the Exhibition, many of them in use for driving the shafting. Among them will be a new-type 7-horse power horizontal, a $\frac{3}{4}$-horse power vertical, and a 5-man power vertical, which, we believe, is the smallest compression engine ever made in this country. Messrs. L. Sterne and Co. will also show Clerk's patent gas motor; and besides these we notice the Stockport engine; Atkinson's patent motors on both compression and non-compression systems; and several small vertical engines by Messrs. Körting Brothers, which, we believe, have never been exhibited before. One of the novelties in Messrs. Körting's engines is the apparatus for cooling the circulating water, the ordinary water vessels being replaced by a series of cast iron gills, which present a very large cooling surface in a very small compass. If this arrangement answers as well as the cooling vessels, it will be the means of saving considerable space. Messrs. Oliver Brothers, Chesterfield, purpose exhibiting a prime mover, by which it is stated that an indicated horse-power will be obtained by an expenditure of but one-sixth of a pound of coal per hour. We do not know by what name this apparatus is styled, but the system is one which has been advocated for many years by the inventor—Mr. Marchant—and consists in returning a large portion of the used and expanded steam, back to the boiler without condensation, by means of pumps, so as to avoid the loss due to the rejection of the heat of vaporisation! We understand that careful trials are to be made with this machine, and we shall therefore defer criticism until the tests are made. We believe the working steam pressure is to be 500 lb. per square inch, and that the boiler which supplies it will weigh about 27 tons, the anticipated brake power of the motor being from 80 to 90 horses.

The mining section is situated in a new building, known as the North Court of the South Gallery. A good deal of the machinery will be shown in motion, and for this purpose Messrs. Galloway and Sons, Manchester, have erected one of their superposed compound engines with 14in. and 24in. cylinders by 3ft. stroke. This engine has a fly-wheel, 15ft. diameter, grooved for eight $1\frac{1}{4}$in. diameter ropes, with hand barring gear, and will run at seventy-two revolutions per minute. Three Galloway boilers, alongside, will supply steam for this engine, as well as for working such of the exhibits as have their own steam engines. Hauling engines will be exhibited by the Uskside Engine Company, Newport, Mon.; Messrs. Robey and Co., who will show Richardson's patent mining engine; and others. In addition to a horizontal engine with Parnell's valve gear, Messrs. Hathorn and Co., Charing-cross, will have a large air compressor, running at about 100 revolutions per minute, and supplying air compressed to 150 lb. per square inch for working a number of rock drills. Messrs. Joshua Buckton and Co. have sent a very fine testing machine, capable of exerting a pull of 50 tons. This is one of Wicksteed's patent machines, and it is provided with an indicator for registering the elongations. Messrs. Jordan, Son, and Commans have had a large space allotted, and will show a number of their specialities, such as stone crushers and disintegrators, jigging machinery for copper ore, concentrating apparatus for gold mining, and stamps.

Of agricultural machinery, which is to be found in the South Court of the South Gallery, we do not propose to say much at present, for the simple reason that most of it was so carefully covered up at the time of our visit that it was impossible to make more than a very partial examination. We noticed, however, a portable engine and some very fine specimens of work by Messrs. Richard Garrett and Sons, Leiston; a large collection of engines and machinery by Barford and Perkins, and by Hornsby and Sons; and a large traction engine, with spring wheels, by Aveling and Porter.

In the West Central Galleries Messrs. Hick, Hargreaves, and Co., Bolton, have erected a very fine Corliss engine, for giving motion in the Foreign Courts. It is a single-cylinder engine, with piston 20in. diameter and 3ft. stroke, and is intended to run at sixty revolutions a minute. The fly-wheel is 20ft. diameter, grooved for eight $1\frac{1}{2}$in. diameter ropes, only five of which will however be used, and is completely plated on each side. For starting, a double-cylinder barring engine is supplied. The engine is fitted with Knowles' patent supplementary governor, and a special safety arrangement for instantaneously cutting off the steam in the event of the governor failing to act. Both as regards design and workmanship, it is an exceedingly fine specimen of engineering, and does great credit to the makers.

The West Gallery, with its arcade and annexe, is devoted to groups 9, 10, and 11. The exhibits here are very far forward, and are of very great interest. The machines in motion will again be driven by Galloway's horizontal compound engine facing the entrance from the Central Gallery, the only alteration being in the speed, which has been increased in order to suit the different class of machinery to be exhibited this year. Two new Galloway boilers have been added, so as to supply steam to Hick, Hargreaves' engine, and to give a little more reserve of power than there was last year.

The art of spinning and weaving pure asbestos, which for so many years completely puzzled manufacturers, is to be shown by Mr. John Bell, Southwark-street, S.E., who has had a large allotment of space. Owing, however, to the room required for properly showing the spinning and weaving machinery, the first stages of preparation of the raw material will not be exhibited, but the asbestos will be brought to the Exhibition in a state ready for carding. The subsequent operations will be shown in their entirety, so far as regards the production of yarns and cloth, and there will be a comprehensive collection of all the various products formed from this interesting material. The plaiting of the yarn into steam packings will be shown.

Messrs. Watson and Laidlaw, Glasgow, have also a large stand where they will exhibit a number of their specialities. Among them we may name a well designed hydro-extractor for woollen and other goods. This machine is underdriven by a horizontal strap, the cage being self-balancing and revolving on a spring plate in such a manner as to prevent vibrations being transmitted to the foundations. There is also an automatic centrifugal friction clutch which permits slipping to take place until the cage has been brought up to its full speed, which in this case is about 1200 revolutions per minute.

Messrs. James Farmer and Sons, Salford, will show patent bleaching, washing, and drying machinery, and a four-roll Moiré lustre calender 50in. wide, driven by an independent diagonal steam engine. The four rolls are respectively made of ordinary cast iron, cotton, chilled cast iron, and paper. The same firm will also exhibit a machine for folding, measuring, creasing, and stamping the length on cotton or woollen cloths. The well-known firm of Samuel Brooks and Co., Manchester, will show machines for spinning and doubling sewing cotton; Hill and Brown's patent winder for winding on to paper tubes instead of bobbins; and Coate's patent cotton-baller. Winding machinery and looms, will be shown by several makers, among whom we may specially mention Messrs. Hacking and Co., Bury, whose exhibits are in a forward state. These include a patent friction pirn winding machine with paper tubes for woollen and cotton; a woollen loom with Hacking's patent motion for four shuttles; a patent handkerchief loom with four shuttles; and a folding, measuring, and registering machine with patent grip and adjusting motion. Messrs. George Hodgson and Co., Bradford, will also have some well-finished machinery, including an improved apparatus for shedding motion, and drop boxes for the weaving of fancy cloths. A very good show will be made by Messrs. Mather and Platt, Oldham, who have sent scouring, bleaching, and dyeing machinery, as well as other apparatus and appliances, which we shall describe more fully at a later date. A hand-loom will be shown in operation by Messrs. Howell and James, making the table linen to be used by Messrs. Spiers and Pond in the various refreshment rooms throughout the Exhibition. Messrs. Walter T. Glover and Co., Manchester, will show seven machines of different sizes for making cords and ropes. These, though not, strictly speaking, textile machines, are of an analogous nature, seeing that the object is the production of cord or spindle banding as well as some kinds of thread.

Passing on to the section devoted to machine tools, there will be noticed a novel appliance by Messrs. Harpers and Co., Aberdeen, for cutting key seats on pulleys. This is an exceedingly simple and, we believe, efficient machine, capable of cutting as many as sixty keyseats of small size in an hour, while the seat in an 8ft. diameter pulley can be completely finished off in about twenty-five minutes. Another advantage is that there is no frame to limit the size of the wheel that can be dealt with.

Several excellent specimens of wood-working machinery will be shown by Messrs. S. Worssam and Co., Chelsea, and Messrs. John Watts and Co., Bristol. The former will have a new general joiner; a self-acting saw with both roller and rope feed; and a band saw for cutting ships' timbers to any angle; while the latter will exhibit a powerful double band saw with self-acting roller feed.

Messrs. Hulse and Co., Manchester, promise a large collection of engineers' tools, including a box radial drilling machine; a planer with broad traverse; a profiling machine for vertical and horizontal milling; and a horizontal double-headed slot drill. Several ingenious and novel machines will be shown by Messrs. Sales, Pollard, and Co., Farringdon-road, for making cigars and cigarettes, and for folding tobacco up into packages, at the rate of twenty-two per minute. This latter machine is the invention of Mr. Lloyd, a member of the firm, and has taken much time and money to perfect.

Hydraulic machinery will be well represented. The Hydraulic Engineering Company, Chester, will exhibit a large-sized working model of a three-cylinder compound steam pumping engine of the type now used by the London Hydraulic Power Company. This engine will be shown in operation, and will pump water into an accumulator for use in working the other exhibits. There will also be a neat hydraulic crane, with curved box jib, and having a double-powered cylinder with two concentric rams; a three-cylinder engine with Hastie's compensating gear; one of Ellington's direct action balanced lifts; and some specimens of valves.

Rivetting machinery will be shown in great abundance by Messrs. Fielding and Platt, Gloucester; also by Anderson and Gallwey, Chelsea; and by Messrs. Hughes, Smith, and Co., Glasgow. The last-named firm will have a large fixed machine, capable of putting on a closing pressure of 100 tons, the die being worked by a hydraulic plunger through the medium of a toggle joint. Messrs. Tangyes, Birmingham, will have a large and comprehensive exhibit of most of their well-known specialities. We particularly notice a gas hammer—Robson's patent—which works by the explosion of ordinary gas between two pistons, the lower of which is connected to the hammer-head. The blows can be regulated to light or heavy, fast or slow. We hope to give further particulars of this when we come to deal in detail with the exhibits. Most of the makers of special lifts will be represented, some by large working models, and others by full-sized examples.

In the Eastern Annexe, under the head of paper and printing, there will be many interesting exhibits. Messrs. Harrild and Son will show some very fine machinery for producing illustrated newspapers, and a two-feed fine-art "Bremner" machine will be at work printing part of the *Illustrated London News*. Besides this, the same firm will have a fine-art Franco machine as used by Messrs. Cassells and others, a fine-art demy machine, as well as a platen for smaller work, and a chromo-lithographing machine. Messrs. Furnival and Co. will show a new gripper platen which has not been exhibited before. It is made on Mr. Godfrey's patent, and can print 2500 sheets per hour. Litho-printing machinery will be exhibited by three or four makers, there being several novelties in driving gear and in the taking-off apparatus. Wire-stitching machines for light wood boxes and for books will also be shown, Messrs. W. C. Horne and Co., London, having a machine which will put in 120 staples a minute, including cutting-off and finishing. A few exhibitors will show apparatus for the manufacture of paper, but this department is not complete. Messrs. Osborne and Shearman, Chelsea, are fitting up a large machine for paper-staining, one of the chief features being that by means of a backward-and-forward travel one colour is allowed to dry before the next is laid on.

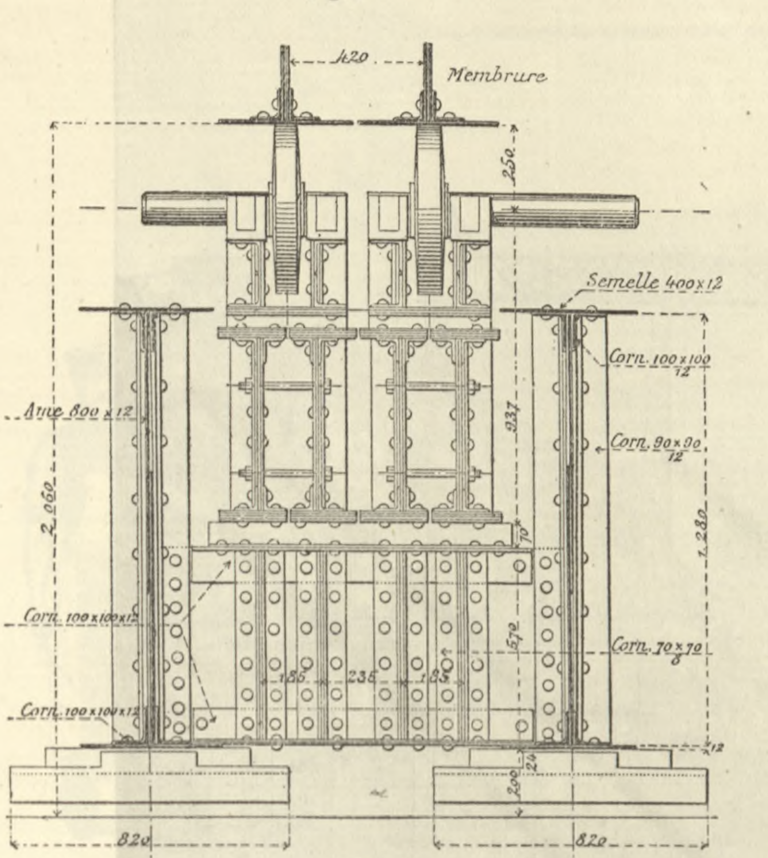
Of the foreign exhibits, the chief will be those of the United States and Japan, but very few have as yet come forward. What promises to be a very great attraction is the machinery for the manufacture of watches, which is to be shown by the American Waltham Watch Company, Mass: This will include staff and pivot polishing machinery; an escape wheel cutter with two steel and four sapphire tools, capable of cutting fifty wheels in a quarter of an hour; a train wheel cutter, which deals with forty wheels at a time; an automatic machine for cutting crown wheels; a pinion cutter, which turns out 400 a day; an automatic machine for making and finishing-off all the screws used in watches at the rate of 400 an hour; an automatic machine for roughing pinions at the rate of 1500 a day; a machine for drilling and tapping the holes in compensation balance wheels, twenty-two holes being drilled and tapped in two and a-half minutes, one man attending nine such machines; and an apparatus for polishing pinion teeth after cutting and hardening. All these machines are of the most perfect description, both as regards accuracy and completeness. They are entirely automatic in action, each machine performing its several operations one after the other, without any attention from the attendant until the supply of raw materials is exhausted. All turned work is gauged to $\frac{1}{1000}$-part of a centimetre by means of a little machine which by multiplying gear enables the slightest inaccuracy to be detected. So perfect, indeed, is this measuring apparatus that the diameter of an ordinary human hair causes a movement of the indicator of nearly $\frac{5}{16}$in. Models of works, and machines for testing balances and for weighing out the pieces instead of counting them, together with a show case containing over 2000 gold and silver watches, will complete what is sure to be one of the most sought after stands in the Exhibition.

Owing to the state of chaos which necessarily prevails throughout an exhibition during the eight or ten days preceding the opening, the foregoing can only be taken as an imperfect outline of what is to be seen at the Inventories. As in former years, we purpose publishing a series of descriptive articles embracing the principal novelties and features of interest.

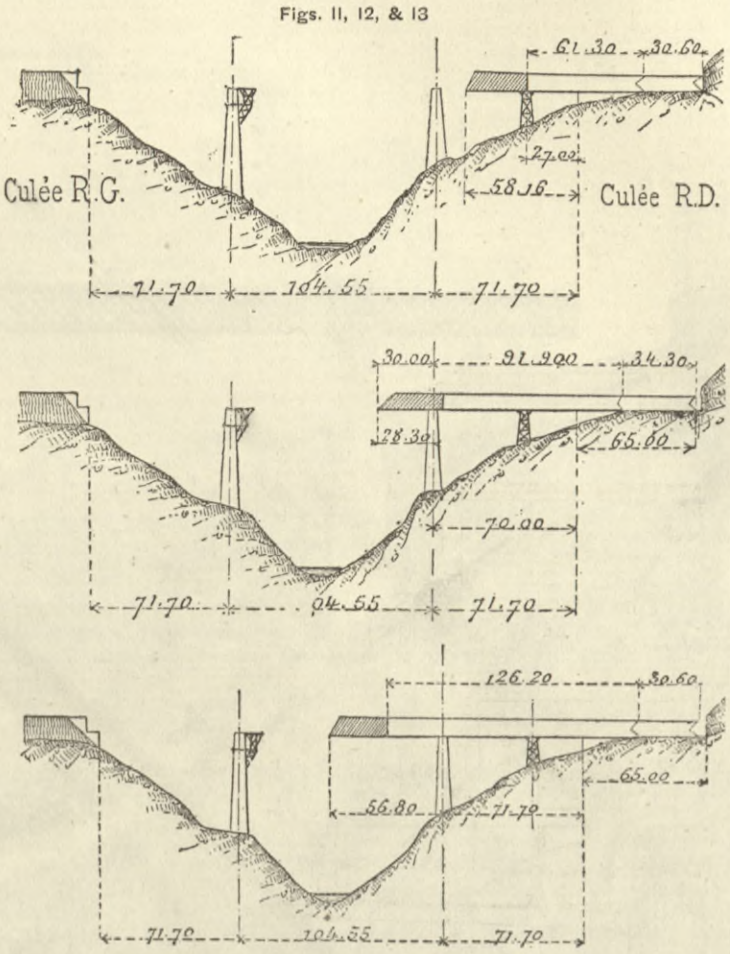
THE LA TARDES VIADUCT, MONTLUCON AND EYGURANDE RAILWAY.

(For description see page 332.)

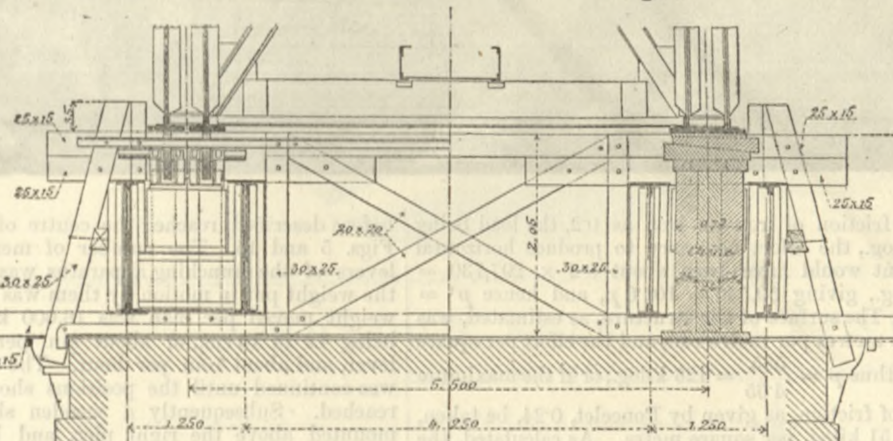
Fig. 7

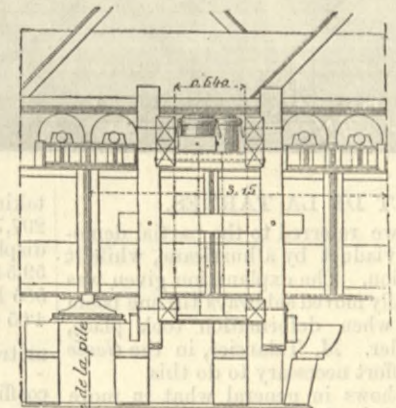


Figs. 11, 12, & 13



Figs. 8





Figs. 9 & 10

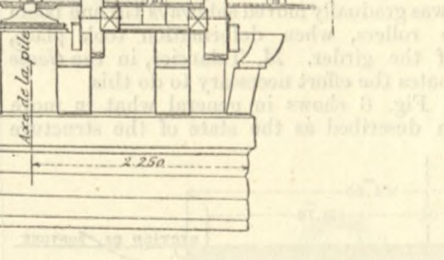
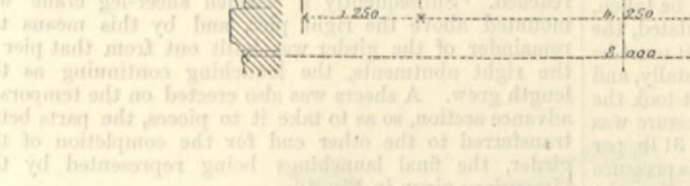
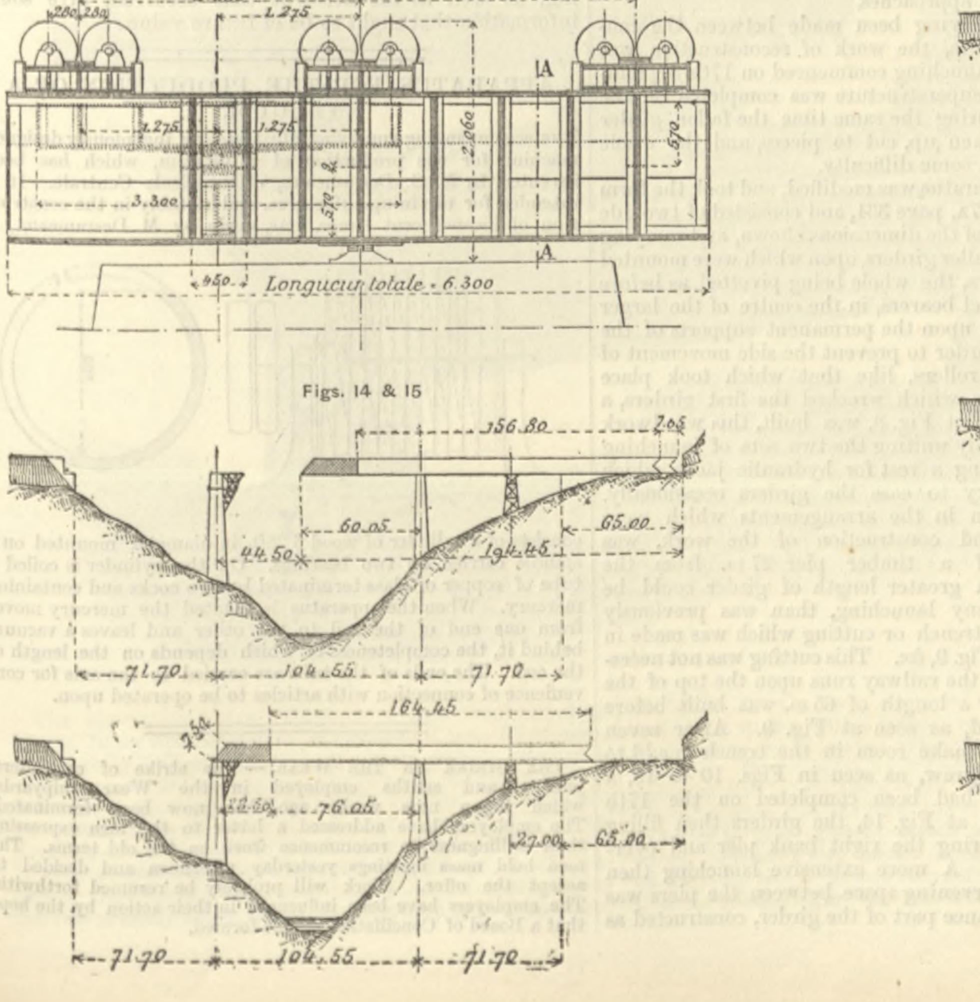


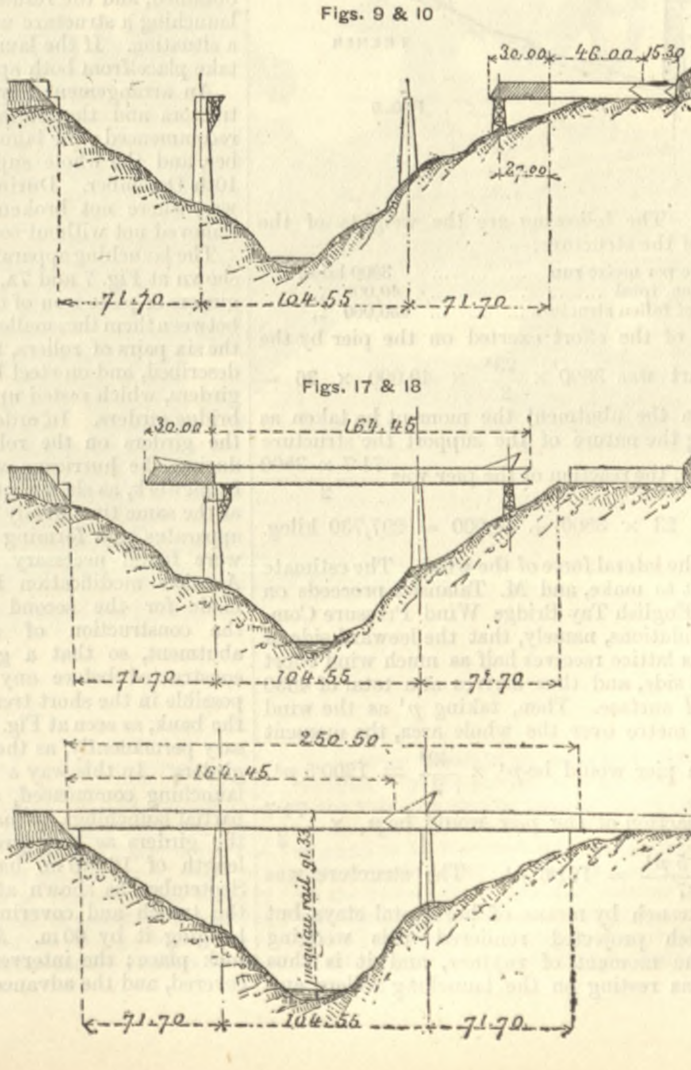
Fig. 7a



Figs. 14 & 15



Figs. 17 & 18



THE LA TARDES VIADUCT, MONTLUCON AND EYGURANDE RAILWAY.

THE VIADUCT DE LA TARDES.

In our last impression we referred to the partial demolition of a portion of this viaduct by a hurricane, while it was in course of construction. The explanation given was that the girder was gradually moved sideways till one boom slipped off the rollers, when deformation took place, and the fall of the girder. M. Talansier, in the *Genie Civil*, thus estimates the effort necessary to do this.

The diagram Fig. 6 shows in general what in more detail has been described as the state of the structure

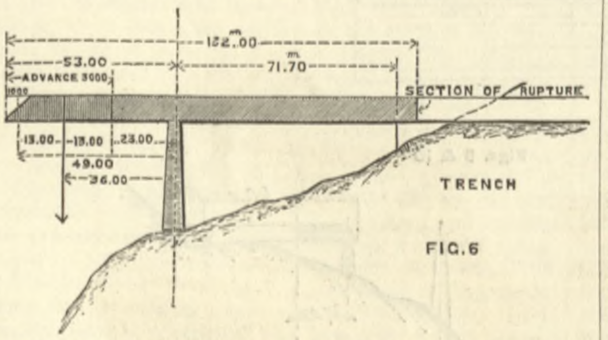


FIG. 6

before the fall. The following are the weights of the different parts of the structure:—

Superstructure per metre run	3800 kilos.
Advance section, total	40,000 „
Total weight of fallen structure	430,000 „

The moment of the effort exerted on the pier by the overhanging part was $3800 \times \frac{\overline{23}^2}{2} \times 40{,}000 \times 36 =$ 2,445,100. If on the abutment the moment be taken as *nil*, not knowing the nature of the support the structure had in the trench, the reaction of the pier was $\frac{71\cdot7 \times 3800}{2} + \frac{2{,}445{,}100}{71\cdot7} + 23 \times 3800 + 40{,}000 = 297{,}730$ kilog. Beside this was the lateral force of the wind. The estimate of this is difficult to make, and M. Talansier proceeds on the basis of the English Tay Bridge Wind Pressure Committee recommendations, namely, that the leeward side of the bridge of this lattice receives half as much wind effort as the windward side, and thus arrives at a total of 4650 square metres of surface. Then, taking p^1 as the wind effort per square metre over the whole area, the moment produced on the pier would be $p^1 \times \frac{\overline{49}^2}{2} = 1200\cdot5\, p^1$. The horizontal reaction of the pier would be $p_1 \times \frac{71\cdot7}{2} + p^1\, 49 + \frac{1200\cdot5\, p^1}{71\cdot7} = 101\cdot6\, p^1$. The structure was wedged in the trench by means of horizontal stays, but the length which projected rendered this wedging ineffective on the moment of rupture, and it is thus neglected. It was resting on the launching rollers, and taking the friction of iron on iron as 0·2, the load being 297,730 kilog., the effort necessary to produce horizontal displacement would have been about $0\cdot2 \times 297{,}730 =$ 59,546 kilog., giving $59{,}546 = 101\cdot6\, p$, and hence $p^1 =$ 585 kilog. The surface of the structure, as estimated, was 4·65 square metres per metre run, and the effort per square metre was thus $p = \frac{585}{4\cdot65} = 126$ kilog., or if the maximum coefficient of friction, as given by Poncelet, 0·24, be taken, then $p = 151$ kilog. per square metre. As calculated, the surface offered to the wind is the minimum, and it must be supposed that the wind did not act wholly horizontally, and the effect would be thus reduced; but however it took the structure, it would appear that its effective pressure was from 126 to 151 kilog. per square metre—25·8 to 31 lb. per square foot. It may be easily conceived that this pressure obtained, and the result shows the dangers attending the launching a structure with so much overhang in so exposed a situation. If the launching method be adopted, it should take place from both approaches.

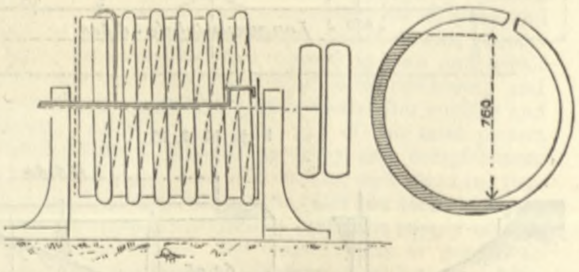
An arrangement having been made between the contractors and the State, the work of reconstruction was recommenced; the launching commenced on 17th September, and the whole superstructure was completed on the 10th December. During the same time the fallen girder was, where not broken up, cut to pieces, and the whole removed not without some difficulty.

The launching apparatus was modified, and took the form shown at Fig. 7 and 7A, page 331, and consisted of two side girders of plate iron of the dimensions shown, and carrying between them the smaller girders, upon which were mounted the six pairs of rollers, the whole being pivotted, as before described, and on steel bearers, in the centre of the larger girders, which rested upon the permanent supports of the bridge girders. In order to prevent the side movement of the girders on the rollers, like that which took place during the hurricane which wrecked the first girders, a framework, as shown at Fig. 8, was built, this woodwork at the same time firmly uniting the two sets of launching apparatus, and forming a rest for hydraulic jacks, which were found necessary to ease the girders occasionally. Another modification in the arrangements which were made for the second construction of the work, was the construction of a timber pier 27 m. from the abutment, so that a greater length of girder could be constructed before any launching, than was previously possible in the short trench or cutting which was made in the bank, as seen at Fig. 9, &c. This cutting was not necessary permanently, as the railway runs upon the top of the girders. In this way a length of 65 m. was built before launching commenced, as seen at Fig. 9. After seven partial launchings, to make room in the trench to add to the girders as they grew, as seen in Figs. 10 to 15, a length of 164·45 m. had been completed on the 17th September, as shown at Fig. 14, the girders then filling the trench and covering the right bank pier and overhanging it by 60 m. A more extensive launching then took place; the intervening space between the piers was covered, and the advance part of the girder, constructed as before described, reached the centre of the left pier—see Figs. 5 and 15. The number of men employed at the levers of the launching apparatus was forty-nine, and as the weight put in motion by them was 800,000 kilogs., the weight moved per man was 16,000 kilogs., the advance being 12 to 13 cm., or about ½in. per movement of the lever, and about 10in. per hour. The work of launching was continued until the positions shown at Fig. 17 was reached. Subsequently a wooden sheer-leg crane was mounted above the right pier, and by this means the remainder of the girder was built out from that pier to the right abutments, the launching continuing as the length grew. A sheers was also erected on the temporary advance section, so as to take it to pieces, the parts being transferred to the other end for the completion of the girder, the final launchings being represented by the dimensions given in Fig. 18.

This large piece of viaduct construction and launching was thus completed, and the difficulties of the undertaking, as well as the accident that occurred, give some information that ought to be of future value.

APPARATUS FOR THE PRODUCTION OF A VACUUM.

THE accompanying engraving illustrates an ingeniously designed machine for the production of a vacuum, which has been invented by M. G. Desrameaux, of the Ecole Centrale. It is intended for use in manufactures, and notably in the construction of incandescent lamps. As made by M. Desrameaux, it



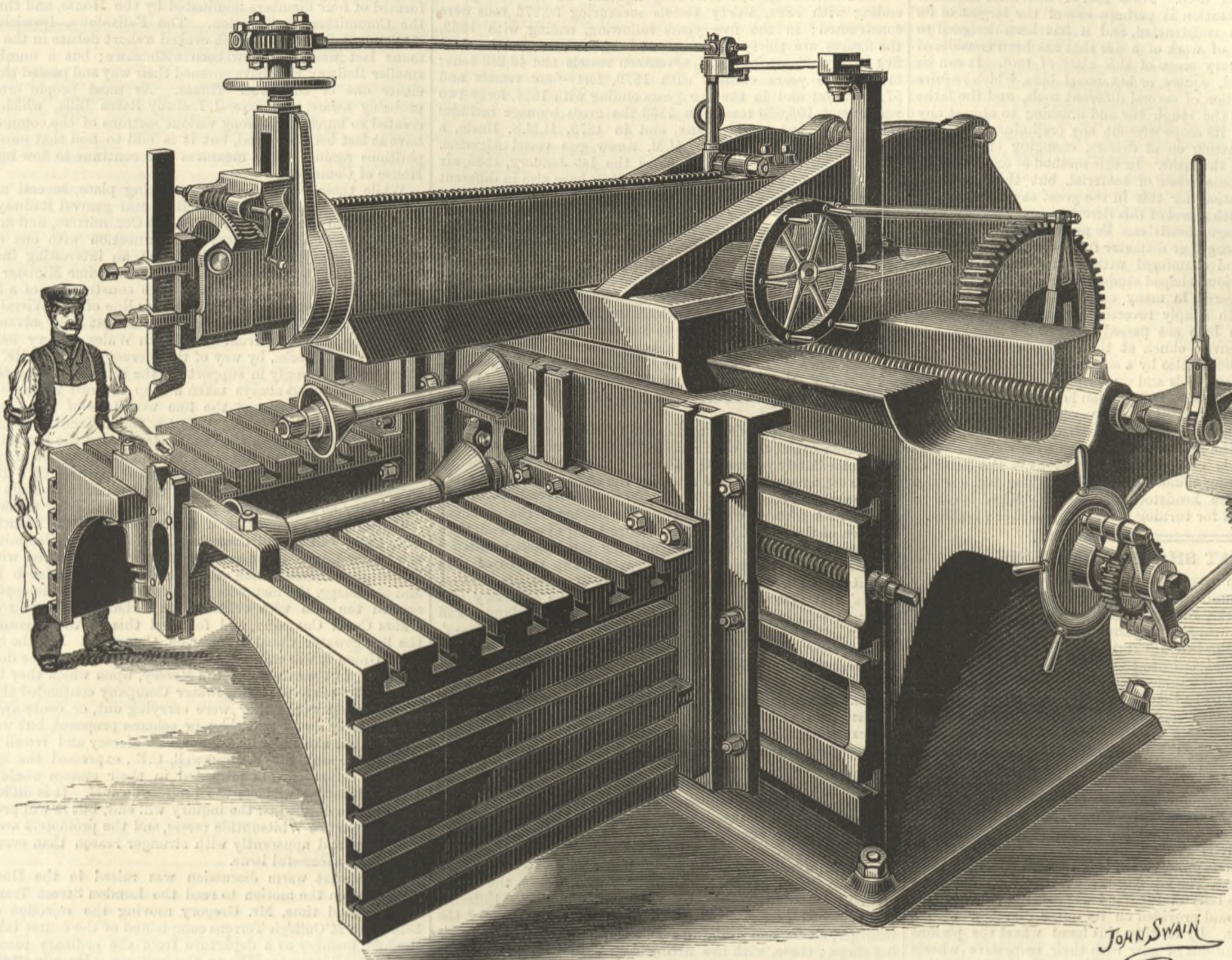
consists of a cylinder of wood 3·28ft. in diameter mounted on a spindle carried on two bearings. On the cylinder is coiled a tube of copper or glass terminated by two cocks and containing mercury. When the apparatus is rotated the mercury moves from one end of the coil to the other and leaves a vacuum behind it, the completeness of which depends on the length of the coil. The ends of the tube are carried to the axis for convenience of connection with articles to be operated upon.

THE STRIKE ON THE WEAR. — The strike of carpenters, joiners, and smiths employed in the Wear shipyards, which began nine weeks ago, has now been terminated. The employers have addressed a letter to the men expressing their willingness to recommence work on the old terms. The men held mass meetings yesterday afternoon and decided to accept the offer. Work will probably be resumed forthwith. The employers have been influenced in their action by the hope that a Board of Conciliation will be formed.

HEAVY SHAPING MACHINE.

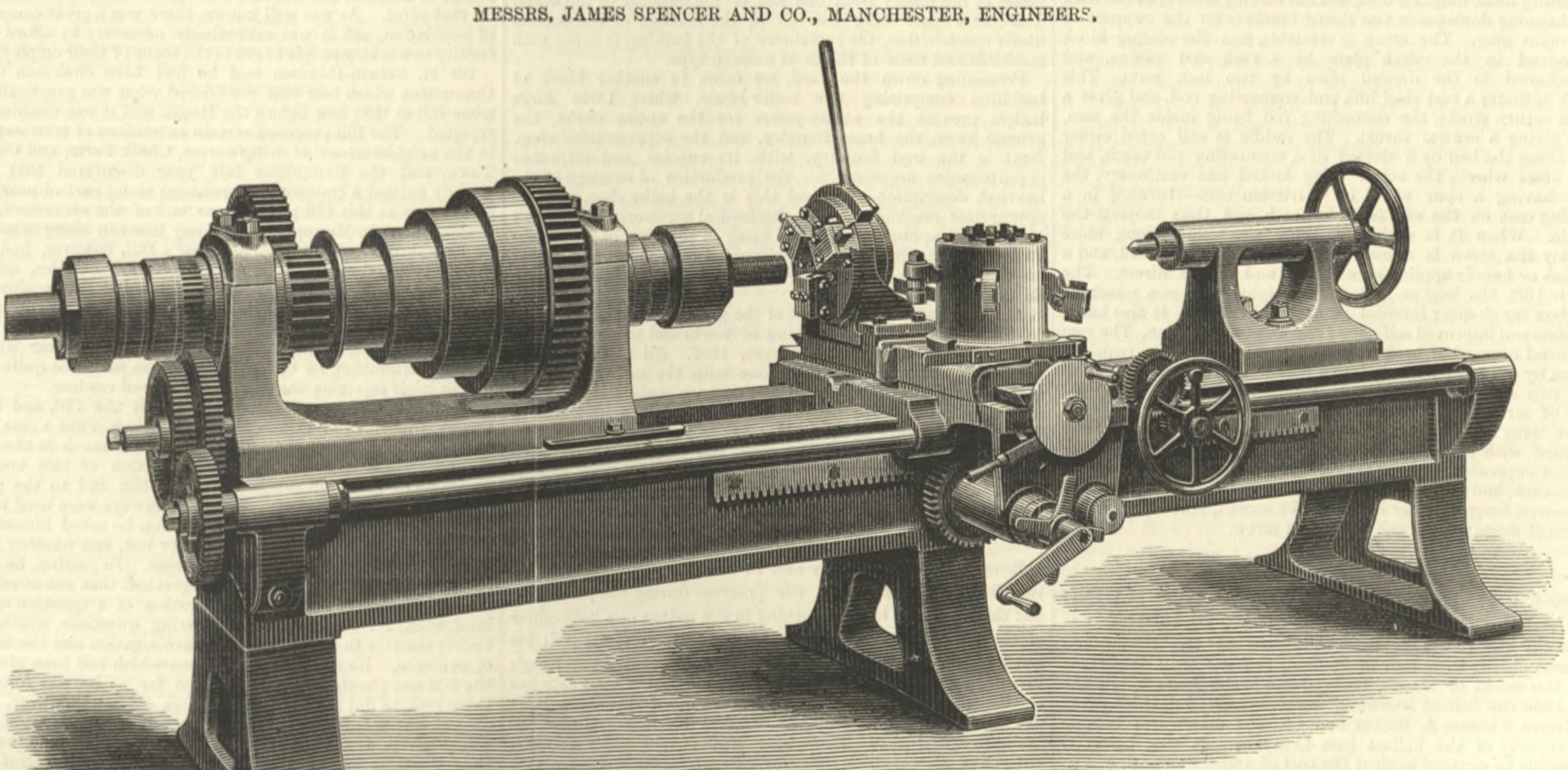
MESSRS. ARCHDALE AND CO., BIRMINGHAM, ENGINEERS.

(*For description see page 334.*)



HOLLOW SPINDLE CAPSTAN LATHE.

MESSRS. JAMES SPENCER AND CO., MANCHESTER, ENGINEERS.



THE illustration above represents a lathe constructed by Messrs. James Spencer and Co., of Hollinwood, near Manchester, and specially designed for turning all kinds of studs, crank pins, and screws out of the solid bar. In its main features it is what is familiarly known as a hollow spindle capstan rest lathe, and has a 12in. centre, is double geared, and is provided with a large-sized spindle of compressed steel, having a hole right through it, 4½in. diameter, to admit bars of iron or steel up to 4in. diameter. The spindle has a cone chuck at each end for gripping the bars securely whilst under operation with the various tools. The bed is 10ft. 6in. long, supported by three standards, and is made extra strong, with a bottom so cast as to form a trough for collecting the oil or soap water which is used for keeping the tools cool. On the bed is an ordinary carriage which has a self-acting motion worked by a shaft, along the front of the bed, driven by gearing at the back end of the headstock, which can be varied to give different speeds of traverse as in ordinary lathes. The self-acting motion is put in operation by screwing up the cross handle nut in front of the carriage, which acts on a pair of friction cones, and this cross handle obviates the use of a spanner, which is an important item where quick work is required. On the carriage is a specially constructed slide rest in the form of a circular head having square holes in its circumference to hold five tools of various shapes suited for the work required to be done, and this circular disc can be revolved on a central pin to bring the various tools in position for cutting. On the lower part of the head notches are cut corresponding with the proper positions of the various tools, and a hand lever, with a suitable catch to drop in the notches, is arranged so as to be readily put in or out as may be desired. On the carriage is also an additional slide, independent of the capstan rest slide, which carries a screwing head with three concentric dies opened and closed by a lever, which are arranged to screw from $1\frac{1}{8}$in. up to $2\frac{1}{8}$in. diameter, and the nut for the screwing slide can be disengaged by a lever in front of the carriage, so that the screwing head can be left at the back part of the carriage when the capstan rest is being used. For a tool of this kind the lathe shown in our illustration is perhaps one of the largest of its kind that has been constructed, and it has been designed to accomplish a variety of work of a size that has been considered as beyond the ordinary scope of this class of tool. It can be used on either round, square, or hexagonal bars, which require the successive operation of several different tools, and the lathe is capable of taking the rough bar and finishing to almost any size or shape within its scope without any preliminary forging, or the centering, putting on of drivers, changing of tools, or putting in and out of the lathe. In this method of manipulation there is no doubt some waste of material, but there is much more than compensation for this in the great saving of labour that is effected. With a tool of this description set screws with either square or hexagon heads can be prepared, the shafts cut off to any required length or diameter from $1\frac{1}{2}$in. to 4in., rough nuts can be faced and chamfered with suitable mandrils to fix the nuts on, and various shaped studs, bolts, motion crank and set pins can be prepared, in many cases with only one setting, and in any case with simply reversing the article after one setting. The rough bars are passed through the spindle, and gripped by the concentric chuck at the front of the spindle, or in the case of long pieces also by a second chuck at the back of the spindle; the various tools and screwing head as required are then brought into operation, and the job is finished before the lathe is required to be stopped or the workman leaves his position. In comparison with what may be termed the ordinary method of working, the great saving of time with such a tool as we have described is obvious, the operations in the place of constant changes being almost continuous. The lathe is also provided with a loose headstock, so that if desired it can be used as a general tool for turning shafts, &c., between centres.

A GREAT SHAPING MACHINE.

THE engraving on page 333 illustrates an unusually large shaping machine manufactured by Messrs. James Archdale and Co., Manchester Works, Birmingham. The length of stroke of this fine machine is 3ft., the longitudinal traverse of the saddle 9ft., the length of the bed 12ft.; the total length of the bed over the bracket at end is 18ft., the tables project 4ft. 3in., the vertical movement of the tables is 18in., the power of the gearing is 12 to 1 and 20 to 1; there is a quick return stroke. There are cast steel link connecting-rods and feed wheels. The tables are constructed to sustain a weight of 12 tons to 15 tons. The machine is self-acting in all cuts, and has two circular motions for large and small work. The total weight is 24 tons, the ground space taken up is 20ft. by 18ft. The main frame of the machine is cast in one piece and strongly ribbed inside to give necessary strength. The foot of the frame is extended to the left to support the driving gear. The weight of this frame or body is 11 tons. The driving gear, &c., consists of a five speed cone pulley, 20in. to 36in. in diameter and two changes of spur gear. The changes are effected by a screw on the pulley shaft, the boss of the hand wheel being cut as a nut internally and split and provided on its outer diameter with a split grip for locking. By moving this hand wheel the pinions can be brought in and out of gear with their respective wheels and locked in position on the shaft. These wheels give motion to a strong back shaft having a key bed and sliding pinion carried in a bracket at the back of the travelling head or saddle. This bracket and saddle are all one casting. This pinion works into a powerful spur wheel keyed fast on the main crank shaft also carried in a bearing at back of saddle. The saddle or travelling head weighs 3 tons, and has carried from it at the back and hanging downwards two strong brackets for the support of the main gear. The crank is variable, and the sliding block is moved in the crank plate by a rack and pinion, and is fastened in the desired place by two lock nuts. This crank actuates a cast steel link and connecting rod, and gives a quick return stroke, the connecting rod being inside the ram, thus giving a central thrust. The saddle is self acted either way along the bed by a slotted disc, connecting rod catch, and cast steel wheels, the screw being locked and stationary, the nut—having a spur wheel on a friction cone—turning in a bearing cast on the saddle underneath, and thus moving the saddle. When it is desired to move the saddle along more quickly the screw is unlocked at each end of the bed, and a ratchet or handle applied at one end and moved direct. The ram is 13ft. 6in. long and two tons weight, and has a quadrant tool-box for shaping internal or external curves. It also has a noiseless and improved self-acting down-cutting motion. The ram is moved forward or back when being adjusted to the requisite stroke by a pinion working into a rack. There are, as we have said, two circular motions, with minimum feeds of $\frac{1}{1020}$ and $\frac{1}{2400}$ of a revolution respectively. The smaller one will take about 24in. diameter, and the larger one about 48in. It is supplied with suitable mandrils and cones, and also a steady bracket supported on both tables. The two tables weigh about 3 tons each, and project 4ft. 3in. from the bed of the machine, and are moved longitudinally by means of screws, and vertically by powerful worm wheels and worm and screw.

MESSRS. HARLAND & WOLFF'S SHIPBUILDING AND ENGINEERING WORKS, BELFAST.

AMONG the places of interest visited by the Prince and Princess during their tour in Ireland, not the least important were the works of Messrs. Harland and Wolff, Belfast. In the year 1850 the Belfast Ironworks were commenced in Eliza-street by Messrs. Thomas A. Barnes and Co., and afterwards became the property of the Belfast Iron Company. It was, however, impossible to contend against the cost of importing coal, and in a few years the iron manufacture was given up, but the attempt had one result of importance, and that was the introduction of iron shipbuilding in Belfast; the yard on the Queen's Island having been, in fact, projected to use the product of the ironworks; and although the last-named enterprise unfortunately failed, the shipbuilding business did not. In 1853 ground was taken on the island by Messrs. Robert Hickson and Co., and operations commenced by laying down the Mary Stenhouse, a sailing ship of 1289 tons register, which was launched in 1854. Messrs. Robert Hickson and Co. continued the business until the end of 1858, and during their career built four sailing ships, two screw steamers, and a tug, of the aggregate measurement of 6707 tons. In 1859 both the iron shipbuilding yard and the wood shipbuilding establishments of the Belfast Shipbuilding Company, who occupied premises also on the island, and had constructed three wooden ships of considerable tonnage, were acquired by Mr. E. J. Harland, who had been Messrs. Hickson's manager, and from that time progress and development were rapid. In 1866 Mr. Wolff became a partner, and the firm has since been known as that of Harland and Wolff, but the number of partners was in 1874 increased by the accession of Mr. W. H. Wilson and Mr. W. J. Pirrie, both of whom had been pupils of the original firm. The progress will best be shown by the following figures:—In the five years ending with 1864, thirty vessels measuring 30,276 tons were constructed; in the five years following, ending with 1869, the figures are thirty-six vessels and 28,023 tons; in the next five years ending with 1874, seventeen vessels and 46,283 tons; in the five years ending with 1879, forty-four vessels and 57,068 tons; and in the five years ending with 1884, forty-two vessels and 105,626 tons. In 1868 the gross tonnage includes H.M. screw gun vessel Lynx, and in 1878, H.M.S. Hecla, a torpedo ship; and in 1880, H.M. screw gun vessel Algerine. The firm have also launched since the 1st January, 1885, six vessels with a tonnage of 14,134, and they have also in different stages at the present time twelve vessels, equalling about 28,000 tons, all to be constructed of steel. In 1870 was launched the Oceanic, the first of the famous White Star fleet, which may be said to have marked a new era in the history of Atlantic steam navigation. Since that date the firm have constructed for Messrs. Ismay, Imrie, and Co., no less than twenty vessels, with a tonnage of 75,000, including the famous Britannic and Germanic, and also the Ionic, which the Prince of Wales visited some twelve months ago, prior to her leaving for New Zealand. Their Royal Highnesses had also an opportunity while going through the works of seeing the Belgic and Gaelic, and meeting with Mr. T. H. Ismay, one of the managing owners of this magnificent fleet, whose flag now flies on all the waters of the world.

The royal party arrived at the main entrance of the works on the Queen's-road and were received by the members of the firm, and immediately proceeded to inspect the shipbuilding portion of the concern, which now occupies the entire peninsula known as the Queen's Island.

The first feature which strikes the visitor is the excellent location of the works, the building slips being at each end, with a depth of water sufficient for launching the largest vessels for mercantile or war purposes. Between the two ranges of slips are situated the workshops, which consist of extensive smiths', fitters', and platers' shops, fitted up with the necessary machinery; painting shops, sail lofts, riggers, mast-building, and boat-building shops; joiners', cabinet makers', upholsterers', and carvers' shops; the whole being arranged with a view to the greatest economy of labour. A narrow gauge tramway intersects the entire works, and connects the various departments. In addition to these will be observed enormous piles of timber, iron and steel, and other materials, and locomotive cranes for handling them. Passing through the ship-yard, and crossing the patent slip and part of the graving dock, their Royal Highnesses proceeded to the fitting up jetty, and there inspected three or four large transatlantic steamers lying in the basin receiving their equipments, and thence crossing the caisson, proceeded to visit the engineering portion of the establishment. These works are equally well appointed, and as convenient as the ship-yard. Alongside of them is Abercorn Basin, where the largest ships constructed by the firm are easily accommodated to receive their machinery. Lines of rails intersect the shops, and lead below the 80-ton steam sheers on the quay. Entering the principal gateway, there is on the right the office of the manager, clerks, and draughtsmen. Opposite we have the erecting shops; these, with the fitting shop and turnery, form the centre and two aisles of the principal building, the size, loftiness, and lightness of which are very striking. A close examination of the building shows that it also possesses solidity, being reared on massive iron columns, which support girders of the same material, and these in their turn carry the powerful steam travelling cranes in each bay for transporting castings and heavy pieces of machinery from one end of the building to the other. The centre space being reserved for the erection of the engines under construction, the remainder of the building is fitted with machines and tools of the most modern type.

Proceeding down the yard, we come to another block of buildings comprising the boiler-house, where three large boilers provide the steam-power for the entire works, the general store, the brass foundry, and the coppersmiths' shop. Next is the iron foundry, with its cupolas and all other appurtenances necessary for the production of castings of the heaviest description. Beyond this is the boiler shop, with its appropriate machinery. The mechanical appliances here are all of the most approved kind, and many of them are of novel construction. The firm are thereby enabled to turn out the largest engines that the steamship requirements of the present day demand.

The firm have not lost sight of the great benefit to be derived from electric light—see drawing of works and account of same in THE ENGINEER of 23rd January, 1885. All of the departments are connected by telephone with the main office and each other. The progress of the concern is also evident from the fact that in 1858 the business commenced with a staff of 100 men and a yard of about $1\frac{3}{4}$ acres in extent. The concern now covers upwards of forty acres, and employs nearly 5000 hands, and expends in wages alone a quarter of a million pounds annually.

PRIVATE BILL LEGISLATION.

BOTH in the two Houses and in the Committee-rooms, Private Bills have again made fair progress during the past week, but there has also been something in the nature of a "slaughter of the innocents." For example, the Central Subway Bill for constructing a subway or underground tramway from King's Cross to Charing Cross has been abandoned; the same fate has befallen the Charing Cross and Waterloo Electric Railway Bill; and in like manner the King's Cross and Waterloo Subway Bill has been withdrawn. There thus appears now to be only one of the five Metropolitan Subway Bills proposed this year, viz., the Clapham and City Bill, left. On the other hand, the London and Blackwall Railway Bill, for enabling the company to widen and improve the line from near Fenchurch-street to Stepney Junction, and to enter into traffic arrangements with the London, Tilbury, and Southend Company, has been passed by a Commons Committee; the Bill authorising the Great Eastern Railway Company to widen their system at a number of different points, the Metropolitan Company's Bill for constructing a branch from Aylesbury to Chesham, and other purposes, and the Bill for developing the work at the Columbia Fish-market, by laying down tramways round the market and connecting it with the North London Railway, have also successfully faced the ordeal of a Select Committee. The same result has been achieved by a Bill promoted by the Manchester, Sheffield, and Lincolnshire Company, for making various extensions of their system in Lancashire and Cheshire, but in this case there was no opposition. As we have previously stated, two of the Bills intended to establish across-river communication below London Bridge have collapsed, but the Corporation Tower Bridge Bill remains, and a Select Committee has been appointed to consider it, composed of Mr. Rogers, Mr. Ritchie, Mr. Bryce, Sir H. Holland, and Mr. Herbert Gladstone. The Lower Thames Valley Main Sewerage Bill having been read a second time in the Commons, has been referred to a hybrid committee, formed of four members nominated by the House, and three by the Committee of Selection. The Felixstowe, Ipswich, and Midlands Railway Bill, which evoked a short debate in the Commons last week, has now been withdrawn; but a number of smaller Railway Bills have pursued their way and passed through either one or the other House. As most people are now probably aware, the several Railway Rates Bills, which have created so much stir among various sections of the community, have at last been dropped, but it is odd to find that numerous petitions against these measures still continue to flow into the House of Commons.

While these results have been taking place, several miscellaneous Borough Improvement Bills and general Railway Bills have engaged the attention of Select Committees, and are still the objects of investigation. In connection with one of the railway schemes, happily approved of, an interesting incident a few days ago was the examination of the Prime Minister in its favour. It was a Bill to authorise the construction of a line in Cheshire, between Neston and the new line of the Wirral Railway Company at Birkenhead, giving, amongst other advantages, direct communication from the North Wales colliery fields to the Liverpool Docks, by way of the Mersey Tunnel. Mr. Gladstone spoke strongly in support of the scheme, stating that he and his family had always taken a deep interest in the district affected, and he believed the line would be of great benefit, especially to North Wales. Whether this influential testimony decided the case or not, the Committee passed the preamble.

While referring to this part of the country, we may also mention that the same Committee also approved of a Bill for extending the time for completing the tunnel to be made under the Mersey at Liverpool for passenger and vehicular traffic.

Contrary to expectation a few weeks ago, the Manchester Ship Canal Bill is still occupying Lord Cowper's Committee of the Upper House. The case for the promoters closed with the examination (among some other witnesses) of Mr. Jacob Bright and Mr. Slagg, the members for Manchester, and the opponents opened the case with evidence on behalf of the Shropshire Union Canal Company, and followed this by the opposition of the Bridgewater Canal Navigation Company. For the Shropshire Union it was urged that great damage would be done by the canal to the estuary of the Mersey, upon which they largely depended; while the Bridgewater Company contended that the improvement works they were carrying out, or contemplating, would amply do all that the new scheme proposed, but without working the same mischief. For the Mersey and Irwell Navigation Company, Sir F. Bramwell, C.E., expressed the opinion that the improvements projected in their system would be of great advantage without the proposed canal. It is difficult to forecast the date when the inquiry will end, but it will probably close before the Whitsuntide recess, and the promoters are more than ever, and apparently with stronger reason than ever, confident of a successful issue.

A somewhat warm discussion was raised in the House of Commons on the motion to read the London Street Tramways Bill a second time, Mr. Gregory moving the rejection of the Bill. Mr. M'Cullagh Torrens complained of the course taken by the hon. member as a departure from the ordinary practice of referring all private Bills to Committees. He admitted that similar Bills had been rejected last year by a Committee, but that, he thought, did not bind the House in regard to a new Bill. It would be very unfair to prevent the promoters of this Bill going before a Committee again. The hon. member for Sussex stated that he did not want to see tramways in the centre of London, but he could not agree with the hon. member on that point. As was well known, there was a great congestion of population, and it was exceedingly necessary to afford every facility to working people to get to the scene of their employment.

Sir H. Selwin-Ibbetson said he had been chairman of the Committee which last year considered what was practically the same Bill as that now before the House, and it was unanimously rejected. The Bill proposed certain extensions of tramway lines in the neighbourhood of King's-cross, Chalk Farm, and Camden Town, and the Committee last year discovered that there already existed a tramway line running along part of nearly the same route as this Bill proposed as one of the extensions, and, besides this, the Metropolitan Railway line ran along what was to be another extension. Last year's Bill, however, had been mainly rejected owing to the engineering difficulties, and the dangers that would arise from the crowded traffic along the proposed lines. He quite admitted the right of the promoters of a Bill to go before a Committee and lay evidence as to their scheme, but where a Bill came forward year after year with no material alteration, he thought the House would be quite justified in itself rejecting the Bill on the second reading.

Mr. Gorst and Mr. Puleston supported the Bill, and Sir A. Otway, Chairman of Committees, said this was not a case of an encroaching railway sending out its feeders much to the detriment of other persons. The construction of this tramway would be of great advantage to the public and to the poorer classes of the community. Those tramways were used mainly by the working classes; and the question he asked himself was whether this extension was desirable or not, and whether it was likely to confer benefit on those classes. In passing, he might say that it was very much to be regretted that other subjects had been imported into the consideration of a question of this kind, such, for instance, as engineering questions, which were clearly matters to be decided after investigation and the hearing of evidence. He accepted the reasons which had been given for the Bill not passing last year, but, so far as he was informed, those reasons did not exist to the same extent this year. This project was that of the tramway company in possession of tramway lines in that part of London crowded by the working classes, and it led from their tenements to the nearest place where they could really obtain fresh air—Hampstead. So far as he was able to judge, the journey to Hampstead was shortened by about ten minutes. The objections which had been raised to the Bill were questions essentially for the consideration of a Committee, because such details could never be discussed in the House. In his judgment, the principle of this Bill was one of public advantage. Its object was to afford the general public greater facilities for cheap and desirable locomotion. For these reasons he advised the House to pass the second reading of the Bill.

Eventually the Bill was read a second time, and will in due course come before a Select Committee upstairs.

It is estimated that the carrying out of Mr. Pearson's plan for restoring Westminster Hall, for which the Select Committee pronounced last week, will cost something over £20,000, towards which £10,000 will be voted this session, if the House confirms the Committee's decision.

FOREIGN AGENTS FOR THE SALE OF THE ENGINEER.

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*** *We cannot undertake to return drawings or manuscripts; we must therefore request correspondents to keep copies.*

*** *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.*

L. H. (Glasgow).—*Send a copy of your specification.*

G E. (Dublin).—*In practice rather more heat will be required to raise the temperature of a house* 20 *deg. when the air outside is* 32 *deg. than when the air outside is* 52 *deg.*

REX.—*You can obtain india-rubber cement for the purpose at any shop dealing in india-rubber goods. It is made by dissolving india-rubber in bisulphide of carbon.*

H. B. J.—*We do not know whether the system of manufacture is or is not an infringement of Admiralty rules. Stamped hooks, if properly made of good iron, are stronger and more trustworthy than welded hooks.*

R. E.—*We have never heard of such a device, and we doubt whether it would be useful. To begin with, it does not follow that the sights would come on if the ship were on an even keel, because the object is not necessarily at rest; and, secondly, a pendulum at sea is never a reliable instrument. It gradually acquires momentum, and for your purpose would therefore be useless. Moreover, if you had to wait until the vessel came on an even keel you might have to re-train the gun for direction.*

PATTERN PLATES.

(*To the Editor of The Engineer.*)

SIR,—We should be much obliged if any of your readers could give us the names of firms who undertake to make really good pattern plates for machine moulding. ENGINEERS.

April 27th.

BROCHURE ON GAS ENGINES.

(*To the Editor of The Engineer.*)

SIR,—If "G. O." will send his address to me, I shall be pleased to send him a copy of the brochure in French. Unfortunately, I have no copies in English near me. B. H. THWAITE.

37, Victoria-street, Liverpool, April 25th.

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MEETINGS NEXT WEEK.

SOCIETY OF ENGINEERS.—Monday, May 4th, at 7.30 p.m.: Paper to be read, "On Cable Tramways," by Mr. W. Newby Colam, the leading features of which are as follows:—(1) Description of lines in America, Australia, and New Zealand. (2) A detailed description of the construction of the Highgate Cable Tramway.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The next meeting will take place at the Cannon-street Hotel on Saturday evening, May 2nd, at 8 p.m., when a paper will be read by Mr. Henry Stokoe "On Beetroot Sugar, and Machinery for Manufacturing it."

ENGINEERING SOCIETY, KING'S COLLEGE, LONDON.—Thursday, May 7th, at 4 p.m.: Discussion "On Electrical *v.* Mechanical Signalling for Railways."

CHEMICAL SOCIETY.—Thursday, May 7th, at 8 p.m.: Ballot for the election of Fellows (important). "On the Action of the Copper Zinc Couple on Organic Bodies—Part X.—Benzine Bromide," by Dr. J. H. Gladstone and Mr. Tribe. "Researches on the Relation between the Molecular Structure of Carbon Compounds and their Absorption Spectra," by Professor W. N. Hartley. "On Some Points in the Composition of Soils, with Results, illustrating the Sources of Fertility of Manitoba Prairie Soils," by Sir J. B. Lawes and Professor Gilbert.

SOCIETY OF ARTS.—Monday, May 4th, at 8 p.m.: Cantor Lectures. "The Manufacture of Toilet Soaps," by Mr. C. R. Alder Wright. Lecture I.—Distinctions between toilet and ordinary household and scouring soaps. Early historical references to soapmaking. Chemical characters and nature of soapmaking processes in general. Raw materials—alkalies and acids, fats and oils, glycerides, &c. Hard and soft soaps; ammonia soaps. Classification of manufacturing processes, and subsidiary operations. Watering of soaps. Some novel points in connection with the chemistry of soaps. Wednesday, May 6th, at 8 p.m.: Twentieth ordinary meeting. "Nobert's Ruling Machine," by Mr. J. Mayall, jun. Friday, May 8th, at 8 p.m.: Indian Section. "The Ancient and Modern Methods of Treating Epidemics of Small-pox in India," by Mr. Robert Pringle, late Sanitary Department H M. Bengal Army. Sir Philip Cunliffe-Owen, K.C.M.G., C.B., C.I.E., will preside.

THE ENGINEER.

MAY 1, 1885.

THE PROTECTION OF OUR COMMERCE.

BEFORE these lines are in the hands of our readers England may be engaged in a great war; a war unparalleled by any British military enterprise since we fought Russia thirty years ago. The dominant question is, of course, its influence on our trade and our food supplies; the latter being the more important of the two. Various writers and speakers have attempted to show that the conditions which will prevail must be very much like those operating during the great continental wars culminating in 1815 with Waterloo. This is a completely erroneous view. In Napoleon's time large fleets of merchantmen, many of them carrying guns, sailed in company under the protection of one or more frigates, of which class of ship we possessed 258. As all were sailing vessels, it was quite impossible to keep closely to any definite route; and for this reason the frigates had to accompany the flotillas of merchantmen. Again, privateering was permitted, and this introduced an element of risk which had to be provided against. Furthermore, it was very difficult to keep an enemy's fleet blockaded in harbour, because a change in the wind might at any moment blow the blockading fleet out to sea. For these reasons the risks incurred by Britain were, in one sense, much more numerous, though not more serious, than they can be now. The change in conditions has rendered it essential that the risk which will exist shall be combatted in a different fashion. What that is we propose to indicate here.

No one assumes that Russia can assail England, or that she will send ironclads to London or Liverpool. Russia's naval operations must be confined to harassing our commerce; unless indeed she should attempt to break out of the Baltic or the Black Sea, and her chances of success are in either case extremely small. A powerful English fleet will be sent to watch the mouth of the Baltic, while a squadron of observation will probably suffice to guard the Dardanelles. What we have to dread, as we have already pointed out, is an attack on our commerce by cruisers. Our trade extends to all parts of the world; but very large sections of it are carried on over well defined routes. Thus, for example, steamers running between Liverpool and New York follow what is practically a narrow path across the Atlantic; a track, in short, perhaps not 100 miles wide, and which with due caution might be made still narrower. Our policy should consist in patrolling such routes with swift, well-armed cruisers, in sufficient numbers to afford complete protection to the ships using them. In this there ought to be no difficulty. Such ships would burn but little coal while patrolling, and they would have a base of operations on each side of the Atlantic. It would even be possible in moderate weather to coal them at sea. This, however, ought not, under any circumstances, to be necessary. It would be necessary to keep a considerable number of cruisers continually running slowly backwards and forwards between this country and America, coaling at the end of each voyage, and then making a return trip. As regards the various ports in which Russian cruisers might find shelter on the American coasts, a properly organised intelligence service ought to keep us so fully informed of all that takes place, that it should be impossible for such foes to get out without a couple of British cruisers being ready for them. So much for the American traffic. As for our communications with India, it will be our own fault if they are to be in any way hindered. The Suez Canal is beyond the reach of Russia, and it is difficult to see how any Russian man-of-war could exist in the Indian Ocean or the Red Sea, because she could have no readily accessible base of operations, and no place to get coal—provided, of course, that our own coaling stations are safe. Thus, then, the guarding of our most important commercial routes presents no very great difficulty. It is, in other words, quite practicable to provide for the safety of our merchant ships with an ease and to an extent undreamt of in former wars. But it will be readily seen that this protection cannot be given unless those in authority manifest foresight; spend money freely; and fling red-tape traditions to the winds. The question is, can or will the Admiralty do what is right in this matter? On this point we have very grave doubts.

The first essential is plenty of cruisers, and it is because we have not plenty of craft of this kind that we regard the future with foreboding. It is not sufficient that we should have more cruisers than the enemy. We shall want a very great many more to impart commercial confidence. Taking the route to America as 3000 miles, and assuming that cruisers, to be efficient, should not be more than fifty miles apart, we should require about sixty vessels. In the Indian Ocean, and on the Australian route, we ought to have at least as many more—to begin with, at all events. This means 120 cruisers; as a matter of fact, we have twenty-four. In the year 1800 we possessed 258 frigates, and no fewer than 557 smaller vessels of war. The frigates and a very large proportion of the smaller vessels were employed solely in protecting our commerce, blockading, and acting as vessels of observation. Nelson used to call frigates the eyes of the fleet. It is true, on the one hand, that for the reasons we have already stated—namely, that it is possible in the present day for ships to follow fixed routes—it is much more easy to protect our commerce than it was in the Trafalgar epoch. But, on the other hand, we have ten-fold the number of ships to protect; and if less than we possessed in Nelson's time would not have sufficed, we must be fearfully badly off now. No attempt, indeed, at patrolling, properly so-called, can be made with a couple of dozen ships; and we presume that the Admiralty pins its faith on the possibility of snapping up Russian cruisers the moment they leave certain ports. This is, however, leaning on a broken reed. The scheme has been tried over and over again. If even one ship eluded her watchers, she might do incalculable mischief before she was caught. The Alabama must not be forgotten. We see with pleasure that the Admiralty are taking up such ships as the Arizona and the Oregon; but this will not suffice. A dozen splendid and extremely costly steamers may be chartered or bought, but it is not by any means certain that these are really the best craft for the intended purpose. They are excessively fast, but only because they can burn a tremendous quantity of coals. The Oregon, for example, needs about 300 tons a day at full speed. At slow speeds such ships must be very wasteful of fuel. Their size will not be an element of strength, but of weakness. Two 14 knot ships would probably prove much more effective than one Oregon. We do not say that the Oregon, America, Arizona, &c., should not be taken up; but if our commerce is to be efficiently protected, at least fifty vessels of smaller size and less speed should be obtained and fitted up with all possible despatch. It will, perhaps, be said that such ships cannot carry heavy guns. Now it may be quite true that it would be difficult to obtain fifty merchant steamers that could mount, say, a 40-pounder Armstrong in the best possible way, but to assert that their decks could not be strengthened, if need be with timbers between decks, is simply nonsense. Once we are at war we must be satisfied with things short of perfection. It is by no means likely that any enemy can let perfect cruisers in numbers loose upon us. We shall have to guard, no doubt, against badly-armed and comparatively slow craft, which will be, however, quite competent to destroy British cargo steamers. It is strange if England cannot send to sea such a cloud of armed steamers as will suffice to afford complete protection to our trade; but will this be done? We have the ships, we have the money. Have we got the guns and the men? We think so. Have we got the will at the Admiralty; the skill, the power of organisation, that full comprehension of the nature of the difficulties with which we have to grapple, without which no successful grappling can take place? We are not sure. We have, however, no doubt that there are plenty of guns available to make fast merchant steamers efficient cruisers, always provided that the War-office and the Admiralty will bear in mind that for the purpose required any gun is better than none. The Russian cruisers are not likely to be very formidable. The authorities must not be too particular how they propose to prevent their depredations, so long as they are prevented.

THE INVENTIONS EXHIBITION.

THE International Inventions Exhibition, which will be opened by the Prince of Wales on Monday next, is intended "to bring vividly before the public the progress which has been made during the last quarter of a century in applying the discoveries of science to the purposes of daily life." It will be devoted to apparatus, appliances, processes, and products invented or brought into use since 1862, the date of the last great International Exhibition. Excluding music, which forms a separate division, there are thirty-one groups, many of which are subdivided into sections. The range of subjects is so vast that anything like a formal retrospect would be entirely out of the question, but we cannot let the occasion pass without a few words to emphasise the importance of the Exhibition, and to suggest briefly some lines of thought which may be profitably pursued by those who visit South Kensington with an eye to something more than mere pleasure.

It is in some respects a fortunate circumstance that the Exhibition is held at such a time as to include what may be called the first fruits of Mr. Chamberlain's Patent Act, and we believe that a very large proportion of the exhibits will be found to consist of inventions protected under that Act. We were always of opinion that a less ambitious measure would have satisfied every reasonable requirement, but politicians of a certain school have sedulously propagated the notion that Invention was held in bondage by Capital, and that the time had arrived when her chains must be struck off. The Bill was accordingly brought in, and the passing of it was hailed as the commencement of a new era. It was said that there was a large number of inventors whose ingenuity was kept down by an oppressive law. True, invention was not altogether dead, just as some plants manage to struggle to the light even when crushed by the weight of a heavy paving stone. It was hoped that a new stratum of Arkwrights, Watts, and Stephensons would be reached, and that a perennial flow of great inventions might be expected. The proposition was put forward as requiring no proof that the greater the facilities for taking out patents the greater would be the number of useful inventions. The example of America was continually held up for imitation, and affecting pictures were drawn, according to which there was a continual drain of inventive talent to the land of freedom. But an examination of the official returns showed that the number of American inventors who took out patents here was very much larger than the number of English inventors who sought the protection of the American laws. That inventive talent is capable of being discouraged we do not for a moment deny; but it is a hardy plant, and it will grow, and in profusion too, even under very unfavourable conditions. Every reasonable encouragement should be offered to inventors, and the path should be made smooth for them; but the lives of those who have benefitted mankind by their ingenuity indisputably prove that the mere difficulties of obtaining a patent are very small indeed when compared with the troubles which await an inventor when he begins to put his invention into practice.

The number of applications received at the Patent-office last year, when the new Act came into force, was nearly three times as large as that recorded in any previous year. In numerous instances inventors, when preparing their papers for obtaining a patent, filled up at the same time a form of application for space at the Inventions Exhibition. The world will have an opportunity of judging to what extent Mr. Chamberlain's Act has stimulated invention, in the highest sense of the word. Some thousands of specifications of patents under the recent Act have now been printed, and without professing to have read them all, the impression we have formed is that the quantity of "fruit," to use the Baconian expression, is just about what it was. It would be obviously unjust to draw attention to particular patents, but we may say generally that a very large number of persons have with their own hands erected monuments commemorating their own ignorance and inexperience. A large body of inventors are not only woefully, and, it is to be feared, in many cases wilfully, ignorant of the labours of their predecessors, but also of ordinary physical laws and mechanical principles. The celebrated Dr. Cartwright, the inventor of the power loom, tells in an amusing way that when he had, as he thought, made very considerable progress, he condescended to inquire what others had been doing. He found that he had spent an infinite amount of trouble in inventing over again some things which had been in use for a long time, and other things which had been tried and found useless. Hundreds of inventors still continue to follow in Dr. Cartwright's steps. The race of perpetual motionists still flourishes vigorously, notwithstanding the spread of technical education; but this is not to be wondered at, since there will always be a very large number of half-educated persons who know just enough to go wrong. Some of the patents for elements of machines would seem to have been taken from some of the "tables of mechanical motions" which have been published from time to time. Many a man has gone wrong on the subject of ventilation, but perhaps more have come to grief about preventing collisions at sea and raising sunken ships. Not a few of these contrivances undoubtedly display ingenuity, and have probably cost their authors considerable pains, labour, and expense. In many cases, however, they are neither new nor useful, and are unfitted to meet the conditions of practical work. If it were possible to obtain from inventors a candid account of their experiences, we fear that the record would be largely filled with regrets that they had failed to benefit themselves or anybody else.

It cannot be too often insisted upon that many highly ingenious and meritorious inventions fail because they are ill-timed. In some cases the world is not ready for them, whilst in others the mechanical difficulties which stand in the way are too great to be overcome, except at such cost as to render their successful commercial working impossible. An invention may be completely successful when carried out with all the care demanded by an experiment in the physical laboratory, but may fail in practice. In the next generation some commonplace inventor may devise a simple mechanical method of facilitating the production of a detail, and success follows. These considerations may sometimes assist in weakening the cry of want of novelty so often brought against a successful invention. Several instances of this will doubtless suggest themselves to visitors who have some knowledge of the history of invention. The comparative ease with which rigid accuracy of workmanship is now secured makes all the difference between failure and success.

Although the period embraced by the Exhibition is not sufficiently wide to include the rise of what may be called the self-acting system, it will, nevertheless, contain many important developments. The machine for making wire cards furnishes a very well-known instance of this class of machine, in which a number of distinct operations follow each other at certain fixed times determined by a series of cams, or their equivalents, on a main driving shaft. Such is the general principle, but the details are varied. It is, perhaps, not generally known that the first machine of this kind was constructed nearly a century ago by Ralph Heaton, of Birmingham, for making button shanks from wire. Another tendency may also be noted here—that is, the gradual substitution of a continuous rotary motion for an alternating motion, thus avoiding the loss of time in the back-stroke. The introduction of circular saw in the early part of this century was a great step in this direction. The same object is also secured, though in a somewhat different manner, by the band saw, which was patented by William Newberry as far back as 1808. We may also instance the very large use which is now made of milling cutters as a substitute for the file. Notwithstanding the number of efforts which have been made during the last seventy years, the rotary steam engine has not superseded the reciprocating form of machine.

Such are a few of the thoughts which will no doubt occur to many of those who visit the Exhibition, and there will be found depicted on the walls of the entrance hall a series of contrasts, showing the state of the arts at various periods. For instance, the Rocket locomotive is contrasted with an engine of the most approved modern type, the spinning wheel is shown side by side with the self-acting mule, and so on.

COAL AND COKE EXPORTS.

It can scarcely have escaped notice that there has been of late a continuance of an old change in the source of the bulk of our coal exports. That change is in the more rapid growth of the exports of coals from Cardiff than from Newcastle. Taking last month, for example, Newcastle-on-Tyne exported 318,475 tons of coals—a decrease of about 26,000 tons from the quantity for the corresponding month of the past year. In the same month the exports of Cardiff were 675,239 tons—an increase of about 50,000 tons on the quantity for the corresponding month. This is an example that is frequent, if the returns of the two ports be compared. If the coastwise shipments of the two places be added to the exports proper above given, the position is rather altered, for the coastwise shipments from Newcastle are often three times those of Cardiff; but, as a whole, the Welsh port is gaining on the Tyne port, and it is curious to notice the reason. Moreover, if we speak of the coastwise shipments being larger from the Tyne, we must remember that that is in part because the supplies for London sent thence are sent by sea, whilst from Wales there is a larger quantity sent by rail than by sea. On the whole the Welsh port's shipments are advancing so rapidly on those of the Tyne port that it is probable that this year they will exceed them. In a measure this is due to the fact that a larger part of the coal exported is sent to ports to which Wales is nearer than the north country, but it is also in part due to the fact that an increased preference has of late shown itself for Welsh coal. That demand is partly new, but it is also in a degree due to substitution of Welsh for Newcastle coal. The fact is one that is very noticeable, though there have been other explanations and reasons assigned that have had some weight. But to the general public the neck-and-neck race that has of late been run by the two greatest coal shipping ports being likely to terminate in early victory for Cardiff, is a fact that will come as a surprise, for these trade statistics are not very generally followed up. It may be added, also, that in some other of the ports—Newport and Sunderland, for instance—there is also a trial of trade speed that has its interest, and that may be glanced at when the year is a little more advanced, but the general tendency is in favour of Wales, and to the disadvantage of the northern ports.

BRITISH AND FOREIGN VESSELS.

Returning to a subject we discussed a short time ago in The Engineer, the question of the relative proportion of British and foreign vessels employed in the export coal trade, we find figures of interest in recent statistics. Thus for Newcastle during the month of March there were 249 cargoes in British vessels and 135 in foreign vessels, numbers which show an increase in the proportion of the home vessels as compared with those of a year ago. From Sunderland 83 British and 41 foreign vessels took export cargoes of coal; from Blyth, 14 British and 21 foreign vessels; from West Hartlepool, 23 British and 35 foreign vessels; from Cardiff 273 British and 143 foreign vessels; and from Borrowstoness and its dependent ports, 7 British and 39 foreign vessels took coal cargoes for foreign ports. On the whole these figures show that there was a larger number of the cargoes out of the total carried in our own vessels. It may be that this is due to the difference in the season, for a large portion of the foreign vessels seem those taking back coal cargoes to their own countries, whence they have brought timber, &c. Possibly, however, the preponderance of the steamships in our mercantile navy, and the fact that that type of vessel is now entering largely into the timber trade, may also be amongst the causes of the change, as far as it is evident. With the vast mercantile fleet that we have, we should be able to carry the coal cargoes hence in a greater degree than even the improved figures we give above show to be the case. But there is one point about the large carriage of coal by foreign vessels which is well worth notice, and that is the fact that much of the coal is sent in vessels of comparatively small capacity. For instance, from the Tyne to Drontheim there were ten cargoes of coal and coke sent in the month under review, eight in foreign vessels, and the remaining two in British. The average cargo was about 400 tons. To Nykjobing the average cargo was less, as well as to Randers and other places, and to these foreign vessels were chiefly sent, in some cases exclusively. It is, therefore, probable that it best suits the merchants, and possibly the ports, in some countries to have their cargoes small. As our sailing vessels are dying out, and as we build few small steamers, it is possible that this is one of the chief reasons for what seems the preference for foreign vessels, and it would be overcome by the building of cheaply-working small-tonnage steamers fit for the requirements of the coal trade.

"COCOA" GUNPOWDER.

A Gainsborough man has managed to elicit from the War Department an explicit statement in regard to the "German contracts for gunpowder," about which so much was heard a month or two ago. Mr. Rowland Winn, M.P., made a speech on this subject which displeased the Gainsborough gentleman, who was so exercised in his mind about it that he wrote to the Marquis of Hartington. His lordship states the facts succinctly thus:—"It happens that the German gunpowder makers have discovered a process of making a powder which gives high velocities in heavy guns with low pressures. Nearly every European Power—the Russians, the Spanish, the Dutch, the Italians—have ordered this powder, known as 'Cocoa,' from the Germans, who are fully employed upon it." The Marquis adds that the Germans have comparatively trifling orders from the English Government, "as we are making it at our own works in Waltham Abbey in large quantities, and have acquired the right to manufacture it by our contractors in England." "Moreover," he says, "a factory is now being fitted with the most approved machinery to produce it, and it is not anticipated that more orders need be given to Germany." Lord Hartington adds that this gunpowder, "though it is the best for the biggest guns, is not the only one suitable, whilst it is the only one the Germans are now making for us." This is a satisfactory statement and explodes the powder bogey pretty effectually. Pity the India-office could not make a similar explanation of its alleged rushing about the Continent to place orders for rails with foreign firms. That charge has been frequently urged against them, and it has not yet been officially cleared off, so far as we have seen.

TORQUAY WATERWORKS.

Torquay may now boast of one of the finest water supplies possessed by any town in England—or perhaps in the world—when referred for comparison to the storage capacity per head of population. The construction of a large new reservoir, filter beds, and connected works, has been carried out to meet the increasing requirements of the town. They are situate at Kenwick, near Christow, Devon, and are in close proximity to their existing reservoir at Tottiford. The first sod was cut some two years since, but upon account of the fissures met with in the rock, the works have been carried out under very great engineering difficulties. The whole are now completed, and Torquay will have a most plentiful supply of water for the future, the two reservoirs having a superficial area of no less than a hundred acres, and are capable of containing 300,000,000 gallons of water when full, or a supply for 300 days for the whole of the district supplied. The engineer is Mr. H. M. Brunel, of Delahay-street, Westminster, and the works have been carried out by Mr. A. Krauss, of Bristol.

DEATH OF MR. SAMUDA.

We announce with much regret the comparatively sudden death of Mr. Joseph D'Aguilar Samuda, formerly M.P. for the Tower Hamlets, whose name is well known, especially at the East-end of London, as a large employer of labour, and which took place on Monday last, at his residence in Gloucester-square, Hyde Park. He was the second, but only surviving, son of the late Mr. A. Samuda, an East and West India merchant, of South-street, Finsbury, by his marriage with Joy, daughter of the late Mr. H. D'Aguilar, of Enfield-chase, Middlesex. Mr. Samuda was born in 1813—and was therefore seventy-one at the time of his death—and was a Commissioner of Lieutenancy for London, a Deputy-Lieutenant for the Tower Hamlets, and a magistrate for Middlesex and Westminster. He became a civil engineer in 1832, was for many years a member of the Institute of Civil Engineers, and was for some time a vice-president of the Institute of Naval Architects, and was formerly Lieutenant-Colonel of the 1st Tower Hamlets Rifle Volunteers. Mr. Samuda was a member of the Metropolitan Board of Works from 1860 till 1865, in which year he entered Parliament in the Liberal interest as a colleague of Mr. Arthur Russell in the representation of Tavistock. He sat for that constituency down to the general election in 1868, when he was returned as one of the members for the Tower Hamlets, his name standing second on the poll, the defeated candidates being Mr. E. H. Currie, Mr. Ayrton, and Captain Maxse. He sat for the Tower Hamlets down to the last general election, when he was defeated by Mr. Ritchie. Mr. Samuda married, in 1837, Louisa, daughter of the late Mr. Samuel Ballin, of Holloway, Middlesex. The news of Mr. Samuda's death will be received with great regret, not only by his old constituents, but by a large circle of friends, and by the commercial world generally. Mr. Samuda is best known for his work as a shipbuilder; with the introduction of steam navigation he had a great deal to do; of warships he has built several; his last and most remarkable work being, perhaps, the Riachuelo.

ELECTRICAL ENGINEERING AT THE INVENTIONS EXHIBITION.

No. II.

The modern dynamo machine must be considered as the foundation on which heavy electrical engineering is based. Formerly, when the only sources of electricity were the frictional machine, the thermo-pile or the galvanic battery, this agent could be used for light work only, as, for instance, in telegraphy, in the firing of mines, in recording and measuring velocities or intervals of time, and in various laboratory experiments. But the transmission of any considerable energy or the production of light on a commercial scale was necessarily excluded on account of the high price which had to be paid for electrical energy when generated by any of these methods. With the invention of the dynamo machine all this has been changed. We can now obtain electrical energy at a cost only slightly in excess of that entailed by the production of an equivalent amount of mechanical energy, and thus it has become commercially possible and profitable to deal with electricity on a large scale.

Before entering on a detailed description of some of the more important dynamos which will be on view at the forthcoming Exhibition, we propose to say a few words on the general principles on which these machines are founded. Our object in doing this is two-fold. In the first place, it seems desirable to lay, so to speak, a scientific foundation on which our future description of particular machines may be placed, and to obtain thus a standard for comparison between different machines; and in the second place, we think that a simple and practical explanation of the principles involved in the construction and working of dynamos will be acceptable to a large number of our readers who are interested in the subject without being professional electricians. A great deal has already been written on the subject of dynamos in books and journals specially devoted to electrical matters, and we have ourselves from time to time given articles referring to some particular point in the theory of the dynamo; but still the subject is comparatively new, and those readers who for lack of time or inclination avoid the mathematical intricacies of a special article may often obtain all they require from a simple practical description.

All dynamos are based upon Faraday's fundamental discovery that if a wire be moved in the neighbourhood of a magnet, or if a magnet be moved in the neighbourhood of a wire, a force is created which tends to make an electric current flow along that wire. Whether a current actually flows in the wire depends on the continuity of the circuit. If the ends of the moving wire are not otherwise connected, the tendency, or as it is technically termed, the electro-motive force, exists all the same, but no current can flow and no mechanical energy is required to move the wire. But if the ends of the wire be closed by an outer circuit a current will flow, and mechanical energy will be absorbed in moving the wire. This energy reappears in the shape of electrical energy, and is computed by multiplying the electro-motive force by the strength of the current. The commercial units for electrical measurements are the volt for electro-motive force, and the ampère for current, and their relation to the mechanical unit of energy is a fixed one, like that of the mechanical equivalent of a unit of heat. A current of one ampère flowing for one minute under an electro-motive force of one volt represents about 45 foot-pounds mechanical energy, and one-horse power is equivalent to 735 volt-amperes or watts, as units of electrical energy are now called. In giving these figures we neglect fractions, which is the more permissible as there still exists some uncertainty as to the exact value of the electro-mechanical equivalent, but for practical purposes we may take the figures 735 as sufficiently correct. It should be mentioned that up to a short time ago electricians used to consider 746 watts equal to one-horse power, but since Lord Rayleigh's recent determination of the ohm and the volt in absolute measure have shown that the old standard ohm was too small by about one and a-third per cent., and that the old standard volt computed from it was similarly wrong, a correction of the electro-mechanical equivalent has become necessary wherever the measurements are taken in legal volts, ampères, and ohms. This question of exact measurements is one of great importance to the practical engineer, as the correct estimation of the commercial efficiency of dynamo machines depends on it. Let us for a moment consider how a mechanical engineer, if called upon to determine the efficiency of various dynamos, would proceed. He would insert between the engine and the dynamo some kind of mechanical dynamometer, or, if such an appliance be not at hand, he would indicate the engine and determine as nearly as possible the actual mechanical horse-power put into the dynamo. Simultaneously with these observations he would measure the strength of the current sent by the dynamos into the outer circuit and the electro-motive force maintained between the terminals of the dynamo—that is, between the two ends of the outer circuit. To do this our engineer need not be an electrician, for instruments are now obtainable which indicate the number of ampères or volts just as a steam gauge indicates the pressure in a boiler. Our experimenter may be profoundly ignorant of the internal construction of the dynamos or of electrical science altogether, and yet he will be perfectly able to determine the commercial efficiency of the dynamos submitted to him if he only knows this one fact, that 735 volt-ampères represent one-horse power.

Returning now to our general problem, it will be clear that the stronger the magnet, the longer the wire actually under the influence of the magnet, and the quicker the speed of movement the greater will be the electro-motive force created. In practice the movement is always a rotary one, and the wire is arranged on a disc, or on a drum, or on a cylindrical ring. The magnets, technically termed field magnets, are placed in such position that their poles partly surround the revolving body of wire—the armature—with just sufficient clearance to allow of its free rotation. As far as these general principles are concerned all dynamos are alike; but a great difference exists in matters

LOST ENERGY.

By Professor R. H. Smith.

No. II.

I will in conclusion consider the question of bearings, frames, and foundations. This is really the most important part of the whole subject, and, unfortunately, it is so complex that mathematical treatment, even with a much rougher approximation to accuracy than the preceding calcuations pretend to, is impossible. Under this heading come all the vibrational losses that occur through wall brackets, countershaft hangers, &c. &c. During each revolution of an engine the cover at each end of the cylinder springing back a certain distance, dependent on its own rigidity as a plate and on that of its mode of connection to the bed-plate. The work done thus is probably nearly all lost; because, although the covers spring back with nearly perfect elasticity, they do not do so at a time when such recovery can help usefully in driving the engine. The same may be said of the springing of the guide bar, which is bent twice per revolution. The brasses in the crank shaft pedestal are subjected to a bearing pressure which not only varies in amount, but which—so far, at any rate, as concerns that component of it produced by the working of the engine exclusive of the constant weight of shaft, fly-wheel, &c.—changes in direction so far as to be absolutely reversed twice per revolution. The work lost in stressing and straining the brasses, pedestal, and its supports in each periodic variation of pressure equals the average force multiplied by the displacement of the surface of the brass. Now this displacement does not only, or chiefly, depend on the size and elasticity of the brasses. It depends much more on the design of the pedestal that supports them, and again, on what comes behind the pedestal to support it. The strain energy created is not put into the brasses only, but all their supports also have strain energy periodically stored up in them. For example, the opposing thrusts of the steam on the cylinder cover, and of the crank shaft on the pedestal, rack the whole base-plate, bending it convex upwards on, say, the outstroke, and downwards on the instroke, and the strain energy produced during each stroke is distributed really through almost the whole volume of metal in the whole frame. If the engine and the machine it drives be all "self-contained" in one frame, then if the whole be skilfully arranged, it is possible to prevent this conversion of energy, that might otherwise do useful work, into waste strain energy from spreading beyond the frame on which the whole is mounted. But the connection between the frame of the driving engine and of the machinery it drives is in the vast majority of cases only established through the surface of the earth and the walls of the building. In this ordinary case the waste strain energy caused by the pulsation of the effort spreads far beyond the limits of the frame proper of the machinery. In other words, the periodic displacement or "give" of the surface of the bearing depends, not only on the build of the machine, but on the manner of its setting, the character of the foundation on which it is set, and even on the nature of the surrounding portions of the ground and buildings. A wall bracket vibrates with the varying effort of the shaft it carries through an amplitude dependent in large measure upon the rigidity of the wall carrying the bracket, and the rigidity and stability of this wall depends upon its connections with the rest of the building and with the earth. A striking illustration of the truth of the far-reaching range of the strain waves of energy lost from an engine must be within the observation of many engineers; namely, the case of an engine, which appears to be more noisy in a distant overhead part of the building than in the engine-room itself. The walls in the engine-room, where they are close to their foundations, vibrate through very small amplitudes, and create little noise, but the vibratory energy being transmitted upwards to where the walls are free to sway through greater amplitudes, creates at these higher parts a louder noise. Now, all this sound represents so much waste energy lost from the engine, and it is evident that if these upper more freely vibrating parts of the walls were not there, there would be less passage, so to speak, less facility for the discharge of waste energy, and therefore less energy wasted. All these surroundings form so many conductors of waste energy away from the machinery, and the waste flow of energy will be greater or less according as the sum of conductivities or resistances offered by these various passages of escape be great or small.

It is to be observed that by far the greater portion of the energy so driven in at the bearing surfaces is lost—is hopelessly irrecoverable. It is transmitted away in slow or rapid waves. No doubt these waves are partly reflected at many different surfaces, but it is a hundred to one that they will be reflected in the wrong direction to be capable of being restored to the working energy of the engine, and even if by any remote chance a portion were reflected in a favourable direction, it is almost certain that it will not be reflected at such an exact time as to reach again the bearing surface at such a period that it will help, and not hinder, the useful work of the engine.

If F be the whole maximum force applied to a bearing so as to compress the material of the bearing and supports, and if this be applied through a normal section S, the stress is $\frac{F}{S}$ and the ratio of compression is $\frac{F}{E\,S}$ where E is a modulus of elasticity. If L be the length of material compressed, the whole shortening is $\frac{F}{E}\frac{L}{S}$, and since the average force during the compression is $\frac{1}{2}$ F, if the load increase from O to F, the work spent in producing it is $\frac{F^2}{2E}\frac{L}{S}$. If the load on the bearing vary from F_2 to F_1, the work so spent is $\frac{F_1^2 - F_2^2}{2E}\frac{L}{S}$. Now what we may term the driving effort is in every machine proportional to $F_1 - F_2$, the ratio depending on the shape of the machine and the special position of the bearing referred to. Let the ratio be q, so that the average driving effort during the time in which the bearing pressure increases from F_2 to F_1 equals $q\,(F_1 - F_2)$, and let the "stroke" or distance worked through by the driving effort, in the same time be l. The whole work done during this time is $q\,(F_1 - F_2)\,l$, and the ratio of that part of it spent in compression of the material under this bearing to the whole is, therefore, $\frac{1}{Eq} \cdot \frac{F_1 + F_2}{2S} \cdot \frac{L}{l}$. This ratio increases in proportion to the average bearing pressure, and inversely as S, which may be taken to represent the average value of the section through which that bearing pressure is transmitted. It is also greater in proportion to L, the length affected by the increase of pressure. How is this length to be determined? It must be confessed that it is impossible in any practical case to calculate the exact value of the above ratio, but by considering purely hypothetical and simple conditions, we will be able to recognise the general circumstances on which it depends in actual practice and the way in which it varies. There is a limit to L dependent on the periodic speed of revolution or reciprocating motion of the machine. Suppose the plummer block mounted on the end of a very long pillar laid in the direction of the pressure. If the period during which the pressure be increased be short enough and the pillar be long enough, there will not be time to send the extra compression along the whole length of the pillar before the succeeding diminution of pressure begins. The gradually increasing compression travels along the pillar as a wave does, the speed being in wrought iron between 16,000ft. and 17,000ft. per second, and between 12,000ft. and 13,000ft. per second in cast iron. This speed is proportional to the square root of the modulus of elasticity. In my last formula the ratio $\frac{L}{l}$ will be the ratio of this speed to the linear velocity at which the driving effort works, because l is the distance through which it works in the same time that the wave advances the distance L. Thus we find $\frac{L}{l}$ proportional to $\frac{\sqrt{E}}{v}$, where v is the velocity at which the driving effort $q\,(F_1 - F_2)$ works. Making the necessary reductions, we find the ratio of lost to whole work done may be written $\frac{1}{q\sqrt{E\,m}} \cdot \frac{F_1 + F_2}{2S} \cdot \frac{1}{v}$, where m is the mass per unit volume of the material of the pillar. For wrought iron we would have $\frac{\cdot0064}{q} \cdot \frac{F_1 + F_2}{2S} \cdot \frac{1}{v}$, where the factor may vary from ·006 to ·007 using inches, pounds, and seconds as units. For cast iron we find $\frac{\cdot0072}{q} \cdot \frac{F_1 + F_2}{2S} \cdot \frac{1}{v}$ using the same units, and the factor varying from ·007 to ·008, according to quality of iron. It is hardly needful to say that these factors are of no use for the purpose of making absolute calculations in actual work, because, among other things, there is the fact that the wave of compression passes for the most part of its length through a heterogeneous mass of iron, brick, mortar, stone, and one or other kind of soil. But it is most instructive to observe that, other things being equal, the percentage of power lost in this way decreases as the velocity (v) at which the useful effort works increases, and also increases as the average stress $\left(\frac{F_1 + F_2}{2S}\right)$ on the bearing pedestal, bracket, frame, or base-plate increases.

In conclusion, let us revert for a moment to the problem of the marine engine, and consider it in the light of the explanations I have given. Here opposite racking moments are produced by the engine twice per revolution. The useful work done is the pushing of the ship through the water, the ship and the water forming together the "driven machine." The whole machinery is not "self-contained," unless we include in it the limitless ocean that surrounds the ship. The above moments tend to make the ship roll. What prevents it rolling in obedience to these moments? We cannot say that the inertia of the huge mass of the ship prevents rolling. The great mass to be moved prevents the angular velocity generated being large (and, therefore, also the amplitude of the roll being large, unless the effects of successive periodic moments be superadded, which is unlikely, as it would require a very special relation between the natural period of roll of the ship and that of revolution of the engine); but the angular momentum generated is unaffected by the mass. The greater the mass the less the angular velocity, but the product of the two remains the same, *i.e.*, is simply proportional to the moment. Part of the effect of these varying moments is spent, no doubt, in sending transverse vibrations through the ship, which run to and fro until they are lost in heat. But there are two other chief elements of loss to consider, due to two chief resistances to the production of such rolling in the ship moving as a whole. The skin friction of the water resists rolling, and whatever roll may take place involves a waste of work done on this skin friction. Again, no roll, however small, can take place without transverse displacement of the water masses lying at both sides of the ship. These displacements are the origins of lateral waves which run outwards from the ship. Of course the water resists the displacement, and the work done in overcoming this resistance is spent in producing wave energy, which, of course, is wholly lost. I myself cannot even guess what might be the possible relative waste of power lost in these two ways; I can only throw out the suggestion that there may be found here an explanation of at least part of the great loss, as yet unaccounted for, that is proved by experiment actually to occur.

SUAKIM-BERBER MILITARY TELEGRAPH.

Usually in opening up a country, the telegraph precedes the railway, but for obvious military necessities the line of telegraph from Suakim to Berber can only proceed concurrently with the railway, which latter has had to wait upon the military advance. The most rapid system of constructing and maintaining such a telegraph line is the first necessity, and for this purpose the War-office has adopted Messrs. Siemens Bros.' latest form of patent telegraph pole, which is erected upon the dwarf pile system patented by Messrs. LeGrand and Sutcliff, of London, to which we have drawn attention on a former occasion. This patent dwarf pile is designed for the erection of many kinds of structures, among which railway signal posts may be mentioned, for which it is remarkably well adapted, but it seems to lend itself most peculiarly to the erection of telegraph poles, for which purpose nothing hitherto introduced appears in any way to approach it; and recognising its importance, Messrs. Siemens Bros. and Co. have within the last few years taken up the exclusive licence in connection with telegraphs, and have furnished them for the erection of many thousands of telegraph poles in different parts of the world. Fig. 1 of the accompanying illustration shows one form of LeGrand and Sutcliff's patent pile, together with the rammer by which it is driven into the ground. The pile is of cast iron, and is slightly taper. The rammer is of wrought iron, and forces the pile into the ground by delivering its blow just over the point. Fig. 2 shows the pile driven into the ground with Messrs. Siemens Bros.' patent taper iron tubular pole attached to it. This is effected in a most ingeniously simple manner. The pole is slit up for a few inches from the bottom, which enables it to readily fit itself on to the taper

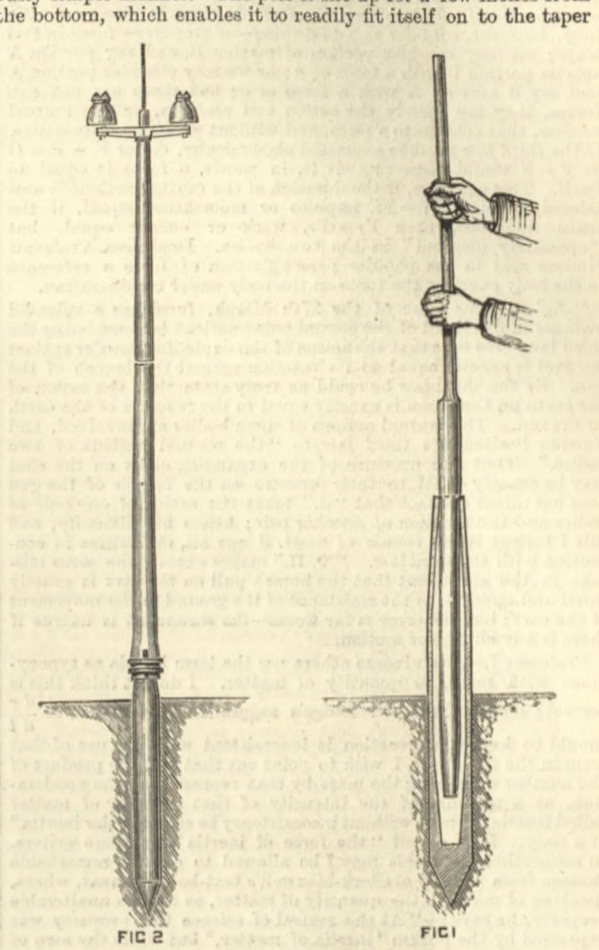


FIG 2 FIG 1

top of the dwarf pile, and a wrought iron ring driven over securely fastens the pole to the pile. The whole operation of erecting a pole in ordinary ground is but the work of a few minutes for two men, the time occupied in driving the pile being from two to three minutes. Thus it is found in actual practice that two men can erect more poles in a day's work than formerly occupied ten men on the old plan of digging holes and ramming in the ground; whilst it is also found that the full complement of wires can immediately be attached, as the pole is at once as firm as under the excavation system it would be after the ground has had a twelvemonth to consolidate. In addition to the very great saving in time, labour, and plant, the facility of transport is equally marked, for one camel can walk away with four 16ft. poles and piles complete, and thirty camels can thus take six miles of line. The Imperial Brazilian Telegraph lines are nearly exclusively carried on these poles, which will stand comparison with the best lines in existence. As a proof of this, on December 14th, 1884, the director of the Imperial Telegraphs carried on direct communication between South Luiz, *viâ* Rio de Janeiro, Montevideo, and back to Rio de Janeiro—a distance of 6045 miles. A message of thirty-three words took $5\frac{3}{4}$ minutes in transmission, and during this time a severe thunderstorm was raging in the Province of Espirito Santo, and rainy weather in the south of Brazil.

Naval Engineer Appointments.—The following appointments have been made at the Admiralty:—Edward Swinney and R. E. Smith, assistant engineer, to the Conquest; W. W. Hardwick, assistant engineer, to the Alexandra, additional, for the Orion; and Richard Phillips, ssistant engineer, to the Tamar.

Engineering Society, King's College, London.—At a general meeting held on Thursday, April 23rd, Mr. R. B. Anderson, Stud. Inst. C.E., read a paper on "Heat in its Relation to Combustion," in which he dealt with the terms used in connection with combustion, and described the instruments used in making experiments with fuel. Referring to heat units, of which several were enumerated, he advocated the use of the "gram-degree," under that name, as it involved no confusion as to the thermometric scale employed, and explained itself. At the same time he deprecated the use of the word "caloric, on account of the loose manner in which it was employed to represent the "gram-degree" and the "kilo-gram-degree." He referred to the convenience of using, as a measure of heat, the amount necessary to convert water, at normal temperature, into steam at any boiling-point, which Watt had discovered to be very nearly a constant quantity. The author next dealt with the experimental determination of calorific values, explaining by the aid of diagrams the ealorimeters of Rennford, Lavoisier, Dulong, Fabre and Silberman, Andrews, and Thomsen. From this he passed to the various modes of calculating these values from the chemical composition of the body, advocating the use of M. Cornut's formula—

$$Q = 8080\,C' + 11214\,C'' + 34462\,H,$$

where Q is the desired result, C′ the amount of solid carbon, C″ that of the volatile carbon, and H the hydrogen contained in the fuel under examination, a formula generally giving very roughly approximate results. At the same time he recommended that where possible a direct calorimetrical determination should be made. The author then described the methods of calculating calorific intensities, showing what an important part dissociation played respecting the temperature attainable. Tables of various data were appended, and the method of obtaining the calorific value of carbon burnt to carbonic oxide explained, as also the way in which the amount of heat necessary to gassify carbon was estimated.

LETTERS TO THE EDITOR.

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

NEWTON'S LAWS OF MOTION.

SIR,—The third law runs: "Reaction is always equal and opposite to action. That is, the mutual actions of two bodies on each other are always equal and oppositely directed." Yet most people direct all their attention to the first part, practically ignoring the second. Indeed, in some text-books the first part is given without the second. If we consider the first part by the aid of its restatement in different words in the second, we shall notice, firstly, that action and reaction are the mutual actions of two bodies—either being the action, the other is the reaction; secondly, that they are the mutual actions of the same two bodies; lastly, that nothing is stated respecting force or its equivalent resistance.

Force is not mentioned, because it is neither more nor less than the mutual actions of two bodies. No portion of matter can exert force on itself, two portions, A and B, must be concerned. We may, however, consider this dual thing—or property—force in two ways; we may consider portion of matter B, and say portion A acts on portion B with a force of a; or we may consider portion A and say B acts on A with a force of a; but these are not two forces, they are merely the action and reaction, or the mutual actions, that constitute a force, and without which no force exists. If the third law must be expressed algebraically, either $F - F = O$ or $F = F$ would answer; that is, in words, a force is equal to itself. This equation, if the duration of the mutual actions is considered, becomes $Ft = Ft$, impulse or momentum equal, if the space described, then $Fs = Fs$, work or energy equal, but "oppositely directed" in the two bodies. Doubtless Professor Hudson sees in the popular personification of force a reference to the body exerting the force on the body under consideration.

"J.," in your issue of the 27th March, furnishes a splendid instance of disregard of the second point noticed in considering the third law. He says that the action of the exploding powder against the shot is exactly equal to its reaction against the breech of the gun. By the third law he could as truly state that the action of the earth on the moon is exactly equal to the reaction of the earth on the sun. The mutual actions of three bodies are involved, and Newton limited his third law to "the mutual actions of two bodies." That the pressure of the expanding gases on the shot may be exactly equal to their pressure on the breech of the gun does not affect the fact that "J." takes the action of one pair of bodies and the reaction of another pair; hence his difficulty, and this I believe is the source of most, if not all, difficulties in connection with the third law. "Φ. Π." makes exactly the same mistake in the statement that the horse's pull on the cart is exactly equal and opposite to the resistance of the ground to the movement of the cart; but the error is far worse—the statement is untrue if there is any change of motion.

Professor Lodge and some others use the term inertia as synonymous with mass, or quantity of matter. I do not think this is correct; and as Professor Lodge's suggestion that mf, or $m\frac{dv}{dt}$ should be known as reaction is inconsistent with the use of that term in the third law, I wish to point out that mf, the product of the number expressing the mass by that representing the acceleration, as a measure of the intensity of that property of matter called inertia, so may without inconsistency be called "the inertia" of a body. It is called "the force of inertia" by some writers. In connection with this may I be allowed to quote a remarkable passage from page 86 of Clerk-Maxwell's text-book on heat, where, speaking of mass, or the quantity of matter, as its sole unalterable property, he says:—"At the revival of science this property was expressed by the phrase 'inertia of matter,' but while the men of science understood by this term the tendency of the body to persevere in its state of motion—or rest—and considered it a measurable quantity, those philosophers who were unacquainted with science understood inertia in its literal sense as a quality—mere want of activity or laziness. I therefore recommend to the student that he should impress his mind with the idea of mass [*i.e.*, "*quantity of matter*"] by a few experiments, such as setting in motion a grindstone or a well-balanced wheel, and then endeavouring to stop it, twirling a long pole, &c."

With all due deference to so great an authority, I must say that this would more strongly impress on the mind of the student the existence of that property whereby matter opposes resistance during change of motion, than that matter is not destroyable, as, for instance, when a piece of coal is burned; and I should suppose this property of "persevering" resistance during change of motion was intended to be expressed by the phrase "inertia of matter." Whether this be so or not as regards the ancients, it is this meaning that underlies the present ordinary use of the term. It is this meaning from its equivalence to force that renders the phrase "centre of inertia" preferable to "centre of gravity," the forces due to gravity being convergent. This equivalence to force also makes "moment of inertia" more than a compound word; but as the proportionality of "the inertia" of a body to its acceleration is almost invariably overlooked, so also the proportionality of the "moment of inertia" to the angular acceleration is never stated. If, then, mf is the inertia of a particle, f being the circumferential acceleration about an axis, $f = \psi r$, where ψ is the angular acceleration and r the distance of the particle from the axis, and then the moment of inertia becomes $mf \times r = m\psi r \times r = mr^2 \times \psi$.

If Mr. J. Lyon still thinks the word inertia is not needed, he must prefer some phrase, such as "moving force," or Professor Lodge's or Clifford's mass-acceleration, for the quantity represented by mf.

Taking, then, "the inertia" or resistance due to change of motion or acceleration into account, we might extend the third law to: The resultant of all the forces acting on a body is always equal and opposite to the resultant of all the resistances. But as the resistances are simply forces due to the surroundings of a body, which tend to prevent change of motion in certain directions, we really have made the statement: The resultant of all the forces acting on a body is always equal and opposite to "the inertia." But this is the second law, without implied reference to duration.

Newton subsequently extends his third law, and mentions, amongst other resistances, that due to acceleration. Some neglect this, amongst whom are "Φ. Π.," and the writer of your leader of February 13th. They believe that force cannot by any possibility produce motion, quoting in support "that every force is balanced by a resistance," not being aware that when there is acceleration, part of that balancing resistance is due to the change of motion produced by the force—that is, to "the inertia."

E. LONSLEY.

Royal College of Science, Dublin, April 28th.

SIR,—I agree so perfectly on most subjects with Dr. Lodge, that I take up my pen now with some hesitation. His influence is, however, so great that I cannot, in the interests of students and of that truth for which I have fought for years, let his last paper, published in your last impression, pass wholly unchallenged.

Dr. Lodge, as it seems to me, has not even yet grasped Newton's meaning. What Newton stated in the clearest possible language is that when any force operates on a body or between two bodies, a stress is set up, and it is a fundamental principle of stress that its two components must be equal and opposite. Dr. Lodge has previously admitted this. I quote the following passage from a paper "On Action at a Distance and the Conservation of Energy," from his pen, which appeared in the *Philosophical Magazine* of June, 1881:—"It is impossible to have a force without a body which is exerting that force, and also without another body on which the force is exerted, and which is exerting an equal counter force." This is, in other words, and very well chosen words too, Newton's third law.

Now if we assume that force is the cause of motion it follows that the passage which I have quoted cannot be true. The only escape is found in the hypotheses—(1) that a balanced force can produce motion, which is absurd; or (2), that Dr. Lodge's words are not intended to convey the normal meaning.

If Dr. Lodge is right, force cannot be the cause of motion, and no doubt he is right. I have already stated that force is not the cause of motion, but that motion is the cause of force, using the word force to express either or both of the components of a stress; and this is Dr. Lodge's view; for, to quote from the same paper in the *Philosophical Magazine*, "It is not the force which does work, but the body which is exerting the force that does it." This is a legitimate deduction from what went before. All forces, says Dr. Lodge, are balanced forces, and consequently are incapable of producing motion, or, in other words, incapable of doing work. This is a perfectly clear, consistent statement of what appears to me to be a fact. I fully believe in its accuracy.

So far I am at one with Dr. Lodge. I regret to see that in his last contribution to THE ENGINEER he has ignored his own statements. Dr. Lodge in 1885 holds views different from that which he held in 1881. If he did not, he could not possibly have written the following passage: "'An Old Student,'" he writes, "further wants to know whether, when he pulls a stone by a rope, his pull is the cause of the stone's motion? He must go to the metaphysicians if he wants a long, circumspect, and elaborate answer to any question about 'causes,' from me he will only get the common-place one, Yes." I am not aware what was passing through the mind of "An Old Student" when he was writing his letter, save from his words, but I understand him to use the word "pull" in the sense of the positive side of a stress, the resistance of the stone being the negative side—the "equal and opposite" of the third law. The "pull" here is the precise equivalent of the "force" of Dr. Lodge in the *Philosophical Magazine;* and when Dr. Lodge tells "An Old Student" that his—the "Old Student's"—pull makes the stone move, he flatly contradicts his previous statement, that "it is not force that does the work"—viz., moves the stone—"but the body which is exerting the force"—namely, the "Old Student." I do not myself see what the metaphysician has to do with all this. It seems to me that Dr. Lodge, had he held to his old profession of faith, would have told "Old Student" that his pull could not possibly move the stone, seeing that, by Newton's third law, the resistance of the stone was exactly equal to the pull; he would have referred him to the passage in the *Philosophical Magazine* which I have quoted above, and he would then have gone on to explain in the terse, solid, admirable English which he writes, why the stone did move. This last is the information that students, both old and young, really must have before they will believe that Newton's third law is true.

It may be, of course, that Dr. Lodge attaches some occult meaning to the word "pull," but this I do not for a moment hold to be probable. Indeed, he says, "I can assure him that I have set no traps for him by juggling with words." This I fully believe. The statement is, therefore, a bald contradiction of that in the *Philosophical Magazine*.

Dr. Lodge talks about "waddling back out of swampy ground;" he seems to me to have failed in the attempt to escape without leaving his boots behind him. For example, let me cull the following passage from THE ENGINEER, page 311. He is dealing with the "Tug of War" question, and makes the following astonishing statement:—"We see, then, that to gain the victory one side must exert, $R + R^1$, more horizontal force against the ground than the other, although the pull of both sides on the rope is the same." Permit me to ask Dr. Lodge how it happens that the horizontal force of either body against the ground can be greater than the resistance offered by the tension of the rope? Here is the crucial point of the whole problem. By Newton's third law the pull on the rope is the exact measure of the thrust on the ground at each end; and this can be proved by the fact that if there were no thrust on the ground there would be no pull on the rope. If, for example, the men at one side stood on a wheeled vehicle or on roller skates which moved without friction, they could exert no pull. It seems, indeed, to me to be waste of time to prove what is a self-evident proposition. By no possibility can the thrust on the ground be greater than the pull on the rope. But the pull on the rope is, by the nature of the case, the same for both sets of men, and as the thrust of the ground is measured by the pull of the rope—by Newton's third law—it also must be the same for both sets of men.

I have in what I have now written left out the word reaction, because it only tends to complicate a very simple question. Reaction introduces a time element, which has nothing whatever to do with Newton's third law, which is simply that force, and the resistance to that force, are always equal and opposite. I use the words force and resistance in their popular sense.

In a former letter I have stated that transfers of motion are always accompanied by stresses. It may, perhaps, be worth while to add here that the amount of the stress depends on the quantity of motion transferred, and on the time occupied in the transfer.

Might I venture to ask Dr. Lodge, as an experiment, to try writing "motion" instead of "energy" in all his formulæ bearing on energy in future, and see what comes of it?

It may not be out of place if I say here a few words concerning inertia, a word concerning the true import of which, as well as concerning the nature of the thing itself, some confusion of mind undoubtedly exists. Turning to Williamson and Tarleton, I find that Newton's first law is regarded by these gentlemen as enunciating the theorem of inertia. "This law," they say, "asserts that a body has no power or tendency in itself to alter either its velocity or the direction of its motion. This is usually called the Law of Inertia of Matter." Wiesbach defines inertia as "That property of matter in virtue of which matter cannot move of itself, nor change the motion that has been imparted to it." Now this simply asserts a truism, and gives us no idea at all of the reason why. Nothing can, I think, be more unsatisfactory, and if we read a little further in almost any text-book, we shall find that inertia is spoken of as a form of resistance—the inertia of a body resists the force applied to it. That is the common belief shared in by men who ought to know better.

Now this and many other erroneous notions spring up because little or no consideration is given to the important part played by time in all that concerns dynamical questions and problems. It is quite true that a body will not move or change its motion of itself, and this simply because there is no earthly reason why it should. It is not an active principle, but a passive principle, and Newton's first law does not really refer to inertia, properly so called, at all. It simply enunciates what may be termed an axiom, namely, that a mass of matter does not possess volition. When we come to deal with this principle mathematically, it is found that the incapacity of a body to move has to be expressed in numerical terms; and the passive attribute of matter is regarded and treated as though it were active; and to get over this incongruity we are supplied with the phrase, "moment of inertia," which, done into English, means moment of incapacity-of-a-body-to-move-of-itself. This is an excessively roundabout way of stating a very simple truth. The fact is that *inertia is neither more nor less than the capacity of a body for motion.* To revert to an illustration I have used before, we may regard two masses of matter, say two lumps of lead, one weighing 1 lb. the other weighing 10 lb., as two jugs, one capable of holding one pint and the other ten pints of water, and the inertia of the larger lump is just ten times as great as the inertia of the smaller lump. The lumps of lead in no sense or way resist the motion imparted to them, say, by gravity; but matter can only absorb motion at a definite rate. It is impossible to impart in an infinitely small space of time any motion to a body previously at rest. In a way I have already called attention to, whenever a transfer of motion takes place a stress is set up; and those who speak of inertia as a mode of resistance have in their minds one side—that which I have called for convenience the negative side—of the stress. But the stress element is not inertia. That, as I have explained, is the capacity of the body for receiving motion.

It will be readily understood that there is no real limit to the capacity of any quantity of matter, however small, for receiving any quantity of motion, however large. Consequently the inertia of any mass of matter is infinite, and in this sense matter and motion find no analogue in jug and water. But the fact remains that time being given and stress being given, the capacities of bodies for receiving motion will be as the quantity of matter which they contain, while the stresses which occur when they are receiving or imparting motion will vary as the time. Thus, while a stress of, say, 10 lb. exerted for one second suffices when a velocity of 32ft. per second to be imparted to a body weighing 10 lb., a stress of 20 lb. will accompany the transfer of motion at such a rate that a similar velocity will be attained in half a second. The result in both cases is the same; that is to say, the same quantity of motion is stored up in both bodies, but the storing up took twice as long to effect in one case as the other.

Here I may point out that the stress which a body already in motion is capable of exerting is purely a function of the time during which the stress is exerted. In other words, a mass of matter almost inconceivably small can set up an almost inconceivably great stress, if the time during which the transfer of motion takes place is also almost inconceivably small.

It is worth notice that the stress set up by gravity bears a constant relation to the quantity of matter, and is apparently entirely independent of time—a statement which can only be true of matter when its mass and velocity are constant. Important deductions may be drawn from this, but it would occupy far too much of your space to proceed further in this direction now.

Perhaps you will permit me to return for one moment to the horse and cart problem. To cite an amusing example of the way in which the teachers of youth try to get out of the difficulty raised by Newton's third law, I quote from a little text-book, published in 1875, and written by Mr. Philip Magnus, of University College, London, "Lessons in Elementary Mechanics." Mr. Magnus has been telling his readers about the laws of motion, and gives the third law as follows:—"Action and reaction are equal and opposite; that is, to every action there is a corresponding reaction equal in magnitude and opposite in direction." He then goes on to insist on the truth of this law as regards statics; he has no doubt or hesitation about it. "Statical reaction," he tells us, "is always perpendicular to the surface, and exactly equal to the pressure which the body causes in that direction." Next, he proceeds to deal with the dynamical aspect of the law. "If a horse draws a tramcar by means of a rope, the horse is drawn in the opposite direction by a pull equal to that which he exerts through the rope. The rope is, in fact, stretched by two equal forces in opposite directions." This is all quite true, and so far Mr. Magnus gets on swimmingly, but it suddenly dawns on him that if all that he has written be true, he cannot explain why the car moves. "Tension," he says, "is a force that acts equally toward both ends of a stretched string, and at any point in it." Fairly put into a corner by this last statement, he jumps over the fence by saying, "The force necessary to move a body when transmitted through a string must be just greater than the force of tension, which acts equally toward the pulling body and the body pulled." That is to say, Newton's third law is quite true for statics, but it is not quite true for dynamics. Nothing, I think, is more remarkable in the range of science than the tenacity with which men cling to the notion that it is a pull or a push which causes motion.

This idea that pull and resistance nearly but not quite balance each other seems to be in favour. Professor Hudson holds to it, so does Dr. Lodge. Now there is a fatal objection to it, namely, that a little additional force on the pull side will not suffice to produce motion. A little will not suffice, unless all that we have been hitherto taught is wrong. Thus, for example, a force, pull, push, or effort of 1 lb. is required to impart a velocity of 32ft. per second in one second to a mass of matter weighing 1 lb. But according to Newton the pound weight moved reacts against the force moving it with an effort of one pound. But Mr. Magnus, and Professor Hudson, and Dr. Lodge all tell us that the impulsive effort is just a little more than the resisting effort. Let us admit this to be true for the sake of argument. Then (1) Newton's third law is not true. (2) Let the impelling force be x and the resistance be x_1. Next, let us assume that $x_1 = x \times \cdot 9$. Then the work of acceleration is done by nine-tenths of the effort which according to all previous teaching is necessary for its performance. The smaller the difference between x and x_1, the greater is the contradiction between fact and what I cannot help calling fancy. The continuous acceleration of a body is absolute proof that force cannot be the cause of the motion of the body accelerated, or that Newton's third law is wrong. Here is the cleft stick in which the modern philosopher finds himself. I assert, of course, that Newton is right, and I shall look with some interest for an explanation of how pull, force, or impulse can produce acceleration, and Newton's third law remain true at one and the same time.

London, April 27th. Φ. Π.

SIR,—Whilst I agree with Professor Oliver Lodge as to the importance of having a definite term to designate what he proposes to call reaction, I am afraid it will be exceedingly difficult, if not impossible, to find any one single known word to satisfactorily express what is wanted. I think the want of some suitable term was partly responsible for Professor Tait's extraordinary paper "On Force," to which Professor Lodge refers. He may keep his mind perfectly at ease as to whether he was criticising Professor Tait's paper, or only a parody of it, for almost any parody of it must have improved it. His thesis was that force could not exist without producing motion, that there was no such thing as balanced forces, and that Newton, properly understood, taught the same. One can easily guess what strange contortions Newton's language had to undergo to bring out this remarkable doctrine. For want of a word to represent the rate of change of momentum, he adopted the word force as being not only proportional to, but identical with, the acceleration of momentum it was producing.

The word reaction is used to express such an innumerable number of processes or effects that I don't think it can come to be adopted generally for $M\frac{dv}{dt}$. Inertial reaction or inertial resistance would not be readily misunderstood, and would do if two words are required—I prefer the latter term—but it would be much better if a new word could be coined. I would define inertial resistance as a force arising from change of velocity of a body, and which comes into existence whenever the statical forces affecting a body are unbalanced, and is equal to the complement required to balance the statical forces, so that the forces affecting any body are always balanced.

About seven or eight years ago, in controverting the view that there is no such force as centrifugal force, which was adopted by Professor Tait, Mr. R. A. Proctor, and others, I went at considerable length into the proof of the last proposition; I will, therefore, not repeat any of it here. I believe my argument was unanswerable, and I am not aware that any attempt has ever been made to disprove it. ROBT. D. NAPIER.

Windlass Engine Works, 100, Hyde Park-street,
Glasgow, April 27th.

SIR,—In my former letter I wrote $b = st$, it should be $b = \frac{s}{t}$, in which s is a line in space I should li e to see the mathematical proof that the equation $m\,d\,v = f\,d\,t$, given by Professor Lodge, is perfectly true as an expression of a general law. If perfectly true, it could not give the absurd result of mass being a consequent of the accelerating force. From the above equation,

$$m = f\frac{d\,t}{d\,v}.$$

When f becomes infinitely great, m, or mass, becomes infinitely great; that is very clear. Now the terms of an equation being inter-dependent, must be co-related to give a true result. But mass is recognised as distinct from a force, which may or may not act upon it, and is independent of it.

Professor Lodge, armed with the elementary rules of algebra, can doubtless annihilate mass and gravity in his equation, when $f = o$. The objection is that this is done, giving a result the mind cannot accept. The conflict between results of dead rules and perceptions of the mind will cease with a true apprehension and definition of force and inertia, and only then. But of this there seems very little prospect at present. The position of absolute truth taken up by Professor Lodge he must know to be untenable, and that equating a static with a dynamic is not correct procedure. The original question of the horse drawing the cart appears to have been lost sight of. If the tractive force = reaction, why does the cart move at all? To this there has been no satisfactory reply, and we may safely conclude that the answer is beyond the grasp of present mathematics. W. H. Longmore.

Leominster, April 27th.

Sir,—Perhaps some of your readers will enlighten me on the following point:—A body A in motion at the rate of 3ft. per second comes into contact with a similar body B at rest. The result is that they move on together at the new rate, 1·5ft. per second. The speed falls gradually from 3ft. to 1·5ft.; but inasmuch as B is at rest when struck, am I to assume that it starts off at once with a velocity of 1·5ft. per second? or is there a period when both bodies must move at the same rate, 3ft. per second, subsequently reduced? I am assuming that A and B are perfectly inelastic; two lumps of putty, in fact. X.

London, April 28th.

THE COST OF WORKING HYDRAULIC LIFTS.

Sir,—The letter from the American Elevator Company in your last issue is an abstract of the reply which I received from the company in February last after the discussion at Liverpool on the "Recent Progress in the Public Supply of Hydraulic Power" was closed. I now send you an abstract of the answer which I forwarded shortly after to Mr. Gibson of the American Elevator Company. The concluding paragraph of the American Company's letter is rather surprising. The company issues privately a statement—since made public by me with their consent—of the lifting machinery they would recommend to do a certain work and the cost of working by various means, including in their statements an incorrect estimate of the cost of working other types of lifting machinery. Their figures were extremely adverse to the use of the hydraulic power.

As the result of my criticism they withdraw their figures, but conclude by saying it is not a question of cost, but that their argument is that, all points being considered, they maintain the use of the public power is inadvisable for working passenger lifts, and in many cases for goods lifts. On the general question I would remark:—

(1) There is only one argument, as it appears to me, which, if substantiated, would justify the use of the low-pressure tank system which, I understand, the American company recommends, viz., that the supply given by the Power Company cannot be depended on. This argument is easily disposed of. I have now had eight years' experience in the supply of hydraulic power to the public, and during that period no one having once adopted it, has abandoned its use. On the contrary, numerous consumers have from time to time added machinery to be worked from the mains. Every system of power has been superseded by the public supply. By this I mean not only that the new system is taken in preference in new buildings, but that existing plant, consisting of steam engines, boilers, gas engines, pumps, tanks, and low-pressure lifts, have in numerous cases been abandoned and new machinery put down in order to secure the advantages of the public supply. Two hundred machines are already at work from the power mains in London. Making reasonable allowances for the necessary imperfections of any and every form of machinery, the system is at present brought to a high pitch of perfection, and its extending use will lead to still further development.

(2) In view of the facts I have adduced, no other conclusion can, I think, be arrived at but that it is the soundest policy to have all lifting machinery in those districts where the hydraulic power is, or may be, available, constructed so that this power can be used either at once or whenever such a course may seem desirable, without alteration to the machinery. The American Company acknowledges that if the Power Company reduces rates sufficiently, the system they recommend must fall. It is overlooked that the main element in regard to rates is the extent of the use of the power by the public. For instance, the small undertaking in Hull cannot afford to deliver power at present under a minimum of 4s. per thousand gallons, the average rate being 5s. per 1000 gallons of 700 lb. power water. The average rate so far obtained in London is about 3s. 6d. The cordial and increasing support afforded to the company by the public leads to the conclusion that the power may be profitably supplied at still lower rates in the future.

(3) There may be cases where at existing rates the economy may not justify the immediate abandonment of existing pumping or other machinery; but it is obviously an unwise expenditure to lay down new and costly plant of a type which is being rapidly displaced by the new and improved system of public power supply. The following is an abstract of our reply to the American Elevator Company's rejoinder:—

"I anticipate that no one who reads the first report and my criticisms thereon will follow the American Company in considering this matter as one between their lifts and hydraulic balance lifts.

"There are only two broad distinctions in lifts; in the one the load is forced up by rams; in the other it is pulled up by ropes or chains.

"Personally I am of opinion that the ram lift is essentially of a safer construction than the suspended lift.

"The hydraulic balance lift is a particular form of ram lift, which can be worked in all cases with the same economy of power as suspended lifts, and without chains or ropes being used at all. The American lift, on the other hand, is a particular type of suspended lift.

"I stated in my criticism of the American Company's first report that whatever description of lift were adopted—*i.e.*, whether ram or suspended—in any particular case the cost of power would be the same.

"We are not discussing the relative advantages of ram lifts and suspended lifts.

"The question is the cost of doing a certain amount of work by different sources of power; and if this is to be discussed with due regard to accuracy, it must be on the assumption—which is also the fact—that in different kinds of lifts, equally well designed and constructed, the power required to work them is practically the same.

"Having thus cleared the ground, a few words in reply are sufficient to deal with the new points brought forward: (1) The American company's first statement was founded on a hypothetical case. They answer my criticisms by dealing with a particular case, again shifting the ground of discussion. The circumstances in every case vary, and the precise figures will vary with the circumstances; but I maintain that the figures which I gave are reasonable and normal figures, and I am pleased to find that substantially the American company agree with them. (2) The following table gives the figures as contained in the American company's original report and those attained in their reply to my criticisms:—

	American Company's original figures. £ s. d.	American Company's amended figures without duplicate plant. £ s. d.
Gas	0 6 11	0 15 10
Steam	0 4 8	0 15 0
Hydraulic pump	1 4 5*	1 0 6†
Balance lift	1 4 6*	0 17 0†
Standard lift (direct)	1 0 7*	0 17 0†

* At 2s. 6d. per 1000. † At 2s. per 1000.

(3) On looking closely at the way in which these have been calculated, I find that there are again several discrepancies and omissions; for instance, 80 per cent. is now taken as the efficiency of the American lifts, instead of 70 per cent as previously. On referring to my paper on hydraulic lifts for passengers and goods in the 'Proceedings' of the Institution of Mechanical Engineers, a number of details will be found giving the performances of various descriptions of lifts in which the ultimate efficiency is as high as 85 per cent., this being the case of a high-pressure hydraulic balance lift, and yet when the American Company make the calculation of working from the hydraulic power mains direct, instead of by pumping, they reduce the efficiency from 80 per cent. to 70 per cent. There is thus a reduction of 10 per cent. to be made in the last two items, which brings these figures in accordance with my own, so far as working from the hydraulic power main is concerned. With regard to the other items for gas and steam pumping plant, by the American company's own statements, they have left out of consideration the interest upon capital expended, and they have also entirely left out of consideration the necessity that exists with private pumping plant for having duplicate machinery if an efficient service is to be maintained without interruption. When these corrections have been made I can claim to have proved my case by the American company's own admissions. (4) Hydraulic ram lifts for great heights are more expensive, for medium lifts there is hardly any difference in cost, for short lifts they are less expensive than suspended lifts. Where ram lifts are adopted it is generally because they are considered to be of safer and simpler construction, and the amount of money that may be spent on such lifts, as compared with suspended lifts, has no more to do with the cost of working than the amount that may be expended in ornamenting the lift cages. (5) Even if I allow to the American company some reduction in the item of cost to which they object, by no reasonable estimate in the case under discussion can the cost of low-pressure pumping plant be reduced below £1 per working day as against 15s. for the direct hydraulic power. But I have stated in my paper, from which the American company quote, that I place little reliance on these assumed daily averages. I consider the relative cost can only be properly compared on an annual basis. The actual annual cost in the particular case assumed would be somewhat as follows, according to the amount of work and basis of estimate: Low-pressure pumping plant, gas, steam, or hydraulic, £260 to £320 per annum; direct hydraulic pressure from the supply mains, either for ram or suspended lifts of good construction, £150 to £220; and the direct pressure would be, at least, equally reliable and more convenient in every way. (6) I have throughout eliminated all expenditure on the lift itself, treating this as a constant quantity whatever the system of power adopted. On the question as to which is the best type of lift, I am afraid the American company and myself are not likely to come to an agreement. On the question of cost of power we are, I believe, already nearly at one.

April 27th. E. H. Ellington.

THE AUSTRALIAN SHIPPERS' RING.

Sir,—There is a slight mistake in your remarks of April 3rd *re* Smith, Morrison, and Co.'s Australian "shippers'" ring, which we shall be obliged by you correcting in your next issue. In your columns you state:—"This was written in the end of 1883, and the whole of the controversy is now reproduced by a London firm of shipping and insurance agents, who have taken the bold course of organising an entirely new and independent line of first-class steamers, which are dispatched once every seven days from London, Liverpool, or Glasgow to Australasia." At the moment this is not the case, and we have merely to refer you to the enclosed circular, dated 3rd January, 1885, for full particulars as to the exact position of the matter on that date. The importance of our scheme to the working classes and export manufacturers of this country, as well as to all importers and consumers thoughout the Australasian Colonies, cannot be over estimated. We purpose holding a public meeting very shortly. Smith, Morrison, and Co.

14, St. Mary Axe, London, April 20th.

[From the circular referred to by our correspondents, we learn that the particular feature of Smith, Morrison and Co.'s Australian "shippers'" ring is that the vessels will be run at no profit whatever to the managers, beyond their remuneration for management.]—Ed. E.

Sir,—Referring to the enclosed circular, we shall esteem it a favour if you will kindly announce that our "public" meeting of those interested in the development of British trade with Australasia, and in the consequent welfare of our working classes, will be held at the Cannon-street Hotel on Wednesday, the 6th of May, at two p.m. Smith, Morrison, and Co.,

14, St. Mary Axe, London, E.C., April 27th. Shipping and Insurance Agents.

PROOF TESTS OF IRON AND STEEL.

Sir,—I read with interest your leader of yesterday, although, however, I do not consider it goes far to meet the points raised in my letter which appeared in your issue of the 10th inst. I should be unwilling to be construed into asserting that proof tests were "altogether valueless," and, further, it must be plain that my conclusions as to their restricted value were based not so much upon "stray instances" of subsequent failure as upon natural conditions incapable of elimination.

I dissent from the middle half of your leader, inasmuch as it has little reference to the subject under consideration, and it is not to "proof tests" but to "ultimate tests" that it more properly applies. I hardly go too far in saying that in general "proof tests"—which are the tests applied to subjects intended to be subsequently put into use—have contributed nothing towards "the investigation of the chemistry, the molecular formation, and the effects of working upon iron and steel;" neither are "proof tests" adopted in the two-fold sense stated, either as the standard introduced by engineers into their specifications, or "to enable business to be done at all" as between maker and buyer; but "ultimate tests" are commonly employed for all these purposes.

Few would rate higher than I the value of carefully conducted ultimate tests, and it is upon these, in conjunction with the principle of the uniformity of manufacture, that I mainly rely for security; nor should it be overlooked that in the ultimate test all the stages equivalent to the proof test are successively passed through, and the relative behaviours of the subject under the working. Proof and ultimate strains can thus be studied, affording useful data for such analogous reasonings as you refer to.

It may be argued that the behaviour under the proof test is alone of importance, as a well-designed structure would in practice never be strained beyond this limit, and hence the behaviour under any higher test must be chiefly of theoretical interest. It is unnecessary now to pursue this line of thought further than, whilst in theory largely admitting its principle, to reply that in practice, except in the case of direct transverse strain, any measurements and observations under proof tests have to be of so minute and delicate a character as in general to render useful deductions unobtainable, whilst with the aid of analogous reasoning information of more service can be gained from ultimate tests.

At present the value of proof tests appears to me to have chief reference to the quality of the workmanship in putting together the various parts of combined structures. Thus, in the case of a chain, the proof test may give evidence as to the welding being defective or otherwise; and with this knowledge, combined with the information afforded as to the ultimate quality of the material by bending and forge tests applied to a few of the links cut out for the purpose, a fair idea may be obtained as to the capabilities of the chain as a whole. Similarly in the case of a new boiler, unless the design or materials be grossly defective, the hydraulic and steam tests have no reference except to the workmanship in the rivetting—although, indeed, they are too often supposed to be indicative of the quality of all three, viz., design, materials, and workmanship. In reality these boiler tests should be merely regarded as ultimate tests of the chief portion of the workmanship, since if the seams do not leak under them, the rivetting in this respect may be considered perfect, especially if the tests are carried out previous to any caulking or fullering, as is the practice with some first-class firms. But it is perhaps in the case of girder bridges that proof tests are capable of affording the largest amount of useful information. The proof load should be applied immediately after erection and before any heavy traffic passes. The permanent set then noted gives evidence as to the quality of the workmanship, and from the net deflection the average strains developed in the flanges can be approximately calculated; also in railway bridges the effects of high speed in increasing the deflections and corresponding strains can be duly observed; and further, if careful records are kept, a fair idea of the deterioration due to rust, &c., could be obtained from repetitions of the proof test; and thus information of value would be handed down to posterity, the future custodians of the structures bequeathed by us.

Geo. P. Culverwell, B.A., Assoc. M.I.C.E.

3, Victoria-street, Westminster, April 25th.

BALANCED SLIDE VALVES.

Sir,—Few of your correspondents in the discussion on Peek's slide valve seem to be aware that the idea is an old one. The latest modern application of the idea that I can call to mind being the Halpin compound engine, illustrated in most engineering journals about three years ago. Mr. Halpin, I believe, has since abandoned this form of valve, chiefly on account of the difficulty in keeping it owing to the very unequal wear on the faces. This defect, conjointly with the difficulty usually found in providing any reliable means of lubrication for the fulcrum, seems fatal to the extended use of all such valves rotating partly or wholly round a fixed centre. The modified form of valve connected by a link or fulcrum pin, and moved crosswise by the action of the governor would be a little more successful if the bearing surfaces were kept at as great a distance from the centre as possible, *i.e.*, ports made short and wide. I recollect some experiments being made with the most rudimentary form of this valve, viz., a flat circular valve with radial ports, revolving round a fixed pin, strongly resembling a fire-door air grid beloved of æsthetic boiler builders. This valve was a total failure for the special purpose intended, and incidentally the difference in the wear on faces at fulcrum and centre was found very marked. Had this valve been allowed to wear away, it would in course of time have attained a conical form like the taper plug valve hitched to the end of the crank shaft in some three and four cylinder single-acting engines, and which is found to work fairly well for a few years with small powers.

This slide valve question will stand a deal of talking over. When will some of our "Whitworth scholars," who have had perhaps greater advantages for independent research than any others of the rising generation, rise above the dead level of mediocrity and settle this vexed subject. When will some favoured one of that favoured few evolve from his inner consciousness a simple, frictionless, slide valve. I sometimes wonder how our fathers tolerated the slide valve so long. Perhaps the co-efficient of friction for ungreased metal surfaces was less in those days. I saw an old slide valve lately which had been steadily grinding away sixty hours a week for the last fifteen years, a plain, simple chunk of good cast iron, innocent of relief rings and all such vanities, with a surface like a mirror, and good for many years grinding yet.

Slide valve disease is chronic with some of our modern engineers. I remember a certain manager who had it, and had it bad. He wrestled with the subject for some weeks, and then broke into open violence. He tackled the shop engine, an innocent, harmless piece of mechanism fitted with a link motion for varying the cut-off, and showing to heathen sugar estate agents from distant lands, but troubled with an annoying clatter in the valve gear. He removed the existing slide valve with its relief ring, and substituted an improved valve of his own design, fitted with a relief plunger working through a gland in the valve chest cover and connected to the slide valve by a link and pin joint. The whole contrivance worked splendidly. Directly in line with the axis of the plunger was one of these machines called steam rivetters, attended by a big Irishman, who distributed the steam and bossed a few satellites who swung the 7 lb. hammers used in drifting the rivet holes approximately concentric. They had a good time round that machine, when the plunger link wore out, and that particular engine has now a plain slide valve. Janus.

April 27th.

MISS TEMPLETON.

Sir,—To-day Miss Templeton was elected to a £12 pension in the Royal Scottish Corporation, and, as doubtless some of her success is to be attributed to the votes of some of your readers whose attention was called to the case by the notice you were kind enough to give, they will no doubt be pleased to learn the result.

2, Chiswick-square, Chiswick, W., April 29th. Henry C. Waters.

The *American Manufacturer* states that the so-called Kleinbessemerei, carried on at Avesta, in Sweden, for several years past, produces exclusively soft, fibrous iron by the simple device of pouring slag and iron together into the ingot mould. This requires, however, a very small charge—usually not more than half a ton—and a direct pouring from the converter, without the intervention of a ladle, which would chill the slag.

Liverpool Engineering Society.—The usual fortnightly meeting of this Society was held at the Royal Institution, Colquitt-street, on Wednesday, the president, Mr. W. E. Mills, in the chair. A paper by Mr. W. Goldstraw, entitled "The Relation between Engineering and Architecture," was read by the author. The relations between engineering and architecture are, on a reduced scale, the relations between science and art. Engineering may be said to be that entire system of knowledge and skill which comprises all mechanical pursuits, so far as they supply the material wants of men. Architecture, or the art of ornamental and ornamented construction, as applied to buildings, is the development and refinement of an important branch of engineering. They were both formerly practised by the same persons, but have become separate pursuits on the modern principle of the division of labour; and the requirements of science have made it difficult to follow both professions at once with success. It is desirable that the engineer should be more of an architect, and the architect more of an engineer. At the same time the two pursuits should be kept even more distinctively separate than at present. But whilst the engineer or the architect practises his special calling only, he should have a considerable knowledge of the other profession. Indeed, as both avocations are concerned with building, it would probably be a successful arrangement sometimes for an engineer and an architect to join in partnership. By this means, if the work done were of good quality, they might get many commissions which either of them by himself would fail to secure, or would imperfectly carry out. In such cases the competing professions and the public would be mutually benefitted.

AMERICAN NOTES.

(*From our own Correspondent.*)

NEW YORK, April 18th.

THE increased substitution of steel plate for iron threatens to revolutionise the iron trade throughout the States. The Bessemer rail mills, since the great falling-off in railway construction, have fortunately found a growing demand for steel nail plates and slabs for various purposes, to the extent of between 30 and 40 per cent. of their present output. Slabs are selling at from 30 dols. to 37 dols. per ton, according to quality and use intended. Manufacturers throughout Pennsylvania, Ohio, West Virginia, Indiana, and Illinois, and some other States, are finding it preferable to purchase slabs instead of relying so extensively as heretofore upon open-hearth and other steel-making processes. The slab steel is found to answer all requirements, to be homogeneous, and the production regular from week to week. Some damage has been done to the mills using these slabs, heretofore rolling iron plate, because of the fact that their machinery and motive power were not made for rolling steel plate. A large number of mills are now strengthening their rolls, increasing their motive power, and putting their mills into shape for rolling steel slabs. In fact, it is regarded throughout the State that puddled iron and open-hearth steel will be crowded aside in a comparatively short time. The latest improvement is the Clapp-Griffiths process, introduced from England by the Olivers of Pittsburgh, and one or two others, whose successful plant is attracting general attention. Steel of excellent quality is now being made at a cost ranging from 4 dols. to 6 dols. per ton more than that of crude iron, and it is estimated by the manufacturers that, running iron direct from the blast furnace, the cost of making slabs can be reduced 1.50 dols. or 2 dols. per ton. The Pennsylvania Steel Works near Harrisburg, and the Carnegies, of Pittsburgh, are now devoting more attention than any other firms to supplying the market with slabs, and they are finding the demand growing rapidly. The estimated cost of this new process is from 22 dols. to 23 dols. per ton. The Olivers have not as yet sold any rights to manufacture, but intend to do so, the manufacturers generally inquiring into the details, and a large amount of capital will no doubt be invested during the coming months in alteration of mills, and in the erection of small converters of two or three tons capacity.

The iron trade itself is not in a good condition. The heavy consumptive demand which was so confidently looked for is not at hand, and railroad, shipyard, car works, and other heavy requirements are not being presented. Small orders for rails are filled at 27.50 dols. The Pennsylvania steel mills are exceptionally favoured with orders; all others are short. The Albany and Rensselaer Ironworks, of Troy, New York, are to be reorganised, with a capital of 2,500,000 dols. Three large furnaces will be erected, with a daily capacity of 110 tons. The cost of ore at furnaces will be 6.27 dols. The cost of iron made under the contemplated improvements will be 14 dols. per ton. Iron-making is certainly on an eve of a revolution throughout the States. The Bessemer Steel Company has for fifteen years exercised an almost monopoly control over production and prices, but the Thomas-Gilchrist process and the Clapp-Griffiths process promise to radically modify the relations of manufacturers and consumers. The demand for bridge iron is light, but in spite of that fact several manufacturers are preparing to establish facilities for turning out shapes. Among them are the Cambria, the North Chicago Rolling Mill Company, the Bethlehem Iron Company, and the Allentown Rolling Mill Company. At present a combination exists, composed of seven of the largest firms. Very little iron is arriving from the South, but Northern makers are purchasing property and preparing to erect furnaces there, and will convert their crude iron into finished products. A great deal of railroad building will soon be developed in the South, and it is with a view of meeting this coming demand that so much enterprise is awakened in Southern iron-making.

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

(*From our own Correspondent.*)

ON 'Change in Wolverhampton yesterday, and in Birmingham this—Thursday—afternoon, it did not appear that business had improved. Merchants and actual consumers are buying less, and the new lines that have been placed on colonial and American account are very small. None of the ironworks have any accumulation of orders, and it is a matter of some anxiety to provide the hands with employment.

The steady but quiet improvement in the United States is, however, regarded as not without future promise for this district if it should develope, and war is avoided.

The demand for sheets shows more movement than for any other iron. Merchant singles are quoted at from £6 7s. 6d. to £6 10s.; galvanising doubles, £7 2s. 6d. to £7 5s.; and trebles, £1 additional. Steel sheets and strips are selling in increased quantities to the cut nail makers at from £6 15s. to £7 per ton. Some Staffordshire brokers are buying North of England iron sheets—singles—at £6 15s. delivered in the Thames.

Boiler plates are not reviving, and makers quote £8 to £8 10s., though steel plates are coming into this district from the North of England at £7 15s. delivered.

The two or three leading bar houses still assert their determination to maintain the list quotation of £7 10s. In second and third-class bars a great deal of underselling continues. Ordinary bars are £6, and common are quoted £5 10s., though in a few instances they can be obtained at even £5 2s. 6d.

The consumption of over 1000 tons of small bars will be occasioned by the execution of orders for manufactured goods received on account of the Russian Government. Angles are in better request, and makers quote £5 17s. 6d. to £6. Plating bars are £6 5s. North Staffordshire common bars are £5 15s., delivered in London.

The celebrated Lilleshall Iron Company, Shropshire, of which Lord Granville is an important proprietor, is actively endeavouring to establish its new steel trade.

Consumers of forge pigs are just now very slow in accepting deliveries, and makers' stores show augmentation, while new contracts are few. Cinder iron sells at 33s. onwards to 36s. 3d.; part-mines are 42s. to 45s., and all-mines are quoted 57s. 6d. to 60s. Hematites are quoted 54s. to 55s.

The coal trade upon Cannock Chase has become tame again. The prices which are being realised for house coal from the deep seams are about 9s. to 10s. best deep, 8s. deep one way, and 7s. kibbles. Shallow seam prices are 1s. per ton less. Forge coal is 5s. 6d. to 6s.; steam, 5s.; and slack, 2s. 6d. up to 5s.

Much activity continues at the electrical engineering works of Messrs. Elwell and Parker, Wolverhampton. The size of the accumulators is being constantly enlarged, and now a single accumulator is made which weighs 50 tons, and stores 500-horse power for lighting. Among the orders in hand is a battery which will supply 3000 incandescent lamps for one hour, and it is intended for the new Central station at Manchester. Another battery is being made for Hatherop Castle, the seat of Sir Thomas Bazley, and it will light 750 lamps an hour. The dynamo will be worked by a water-wheel.

An order has come into the district for wheels and axles on account of the Indian State Railway. The new St. George's Bridge and Roofing Works, which have been erected by Messrs. Rubery Brothers, Darlaston, have now begun operations, and Messrs. Simpson and Wood, of the Grand Junction Works there, are about to enter into the manufacture of bridges, girders, and roofing.

Indian railway work continues to come into the market, and the competition for the orders is keen. Manufacturers in Lancashire are running local makers very hard. Iron wagon underframes, flexible buffers, and screw couplings are inquired for on account of the Indian States Railway; cast iron plate sleepers and fish bolts and nuts by the East Indian Railway Company; cast iron columns, girders, and other ironwork for engine sheds, three 5-ton permanent way cranes, and 300 covered goods wagons, by the Oude and Rohilkund Railway Company; and switches and reversible cast steel crossings by the Southern Mahratta Railway Company.

The galvanised iron roofing manufacturers are regularly engaged, though the prices in many cases are the cheapest on record. Export contracts are the best.

Interest has been aroused among the chain and cable makers by the attention which has been called in the North of England to the circumstance that shipbuilders there are placing orders for chains and cables with Staffordshire makers, rather than with firms upon Tyneside. The explanation assigned by shipbuilders is understood to be the lower prices at which makers here will fill contracts; and the Tyneside makers urge that the difference is accounted for by the higher wages which they are compelled to pay. Local makers, however, tell me that their success is chiefly due to the superior quality of Staffordshire cable iron, and further, that if the Admiralty test for cable and rigging chains is raised, Staffordshire will, to say the least, maintain her advantage.

The chain-makers on strike in the Cradley Heath district state that several of the large employers will be willing to concede an advance so soon as present heavy stocks are reduced. The statement must, however, be taken only for what it is worth. Meanwhile, the operatives are resolved to "play on."

The death is announced, at the age of sixty-nine, of Mr. Edward Davies, one of the firm of Davies, Brothers, and Co., Crown Galvanised Ironworks, Wolverhampton. The deceased gentleman was one of the inventors of galvanised iron, and introduced the manufacture into Wolverhampton.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The continued uncertainty with regard to the future is still paralysing all branches of the iron trade in this district, and a stagnation of business is the prevailing feature of the market. In the pig iron trade the depression is extreme, and a disposition which has recently been shown in one or two instances to bid for long forward orders at even lower prices than were being asked a week or two back, is an indication that in some quarters a continuance of low prices is anticipated for some time to come. That certainly no early improvement is looked forward to may also be gathered from the fact that here and there makers are damping down furnaces rather than go on competing for business, which is only obtainable at unremunerative rates. The only direction in which any stronger tone is noticeable is in material for bridge and ship-building purposes, and for both iron and steel plates the prices now asked are 12 to 15 per cent. above the lowest figures that were being taken a month or so back. This in great measure is to be accounted for by the large weight of railway work recently given out and the Government contracts now being pushed forward, but it can scarcely be considered as any indication of a revival in trade generally.

The Manchester iron market on Tuesday was moderately well attended, but the business doing was again of a hand-to-mouth character, and very limited in extent. The inquiry for pig iron was extremely small, and in the better class local and district brands, for which 40s. to 40s. 6d., less 2½, delivered equal to Manchester, remain the minimum basis of quotations, there was very little doing. A few small orders to regular customers are booked at about the above figures, but where buyers are prepared to give out orders of any weight sellers have to come considerably under 40s. to secure them. In the cheap brands quotations fluctuate according as sales are made. On Tuesday 38s. 6d. to 39s., less 2½, delivered here was being asked for brands for which sellers within only a few days previously had booked fairly large orders for forward delivery at quite 1s. per ton less, but these upward and downward variations in one or two cheap brands have no material affect upon the market, except that where an occasional order of any weight is given out it goes into the hands of the low sellers. Hematites continue very low in price, good foundry brands delivered here being still obtainable at about 52s. per ton, less 2½ per cent.

Manufactured iron makers report a moderate business doing, with forges, if anything, rather better employed than they have been. Trade generally, however, is still only very slow, and with the exception of the firmer tone shown in plates and angles chiefly of North-country make, business is only practicable at very low prices. For delivery into the Manchester district the average basis of quotations remains at £5 7s. 6d. per ton for some qualities of Lancashire and North Staffordshire bars, £5 17s. 6d. for hoops, and £6 7s. 6d. to £7 per ton for sheets, with makers here and there prepared to give way a little on these prices where there are anything like good specifications to be got.

The condition of the engineering trades remains much the same as last reported. Outside locomotive and railway carriage building there is a general tendency towards decreasing activity.

Amongst cotton machinists a fair amount of activity is maintained, and the leading firms are kept well employed. For some time past there has been a good deal of work coming into this district from Scotland, where not only a large quantity of old machinery has been replaced, but new mills are being erected, and further large orders from the same source are now being put into the market.

Recently Government inquiries have been sent out in this district for machinery for the manufacture of solid drawn cartridges. This would seem to indicate a new departure by the military authorities, as hitherto the English Army has been exclusively supplied with the built-up cartridge. Many of the foreign Governments, including Russia, Belgium, and Holland, have already adopted the solid drawn cartridge, for the manufacture of which special machinery has been supplied from this district, and recently, I understand, large orders for similar machinery have been carried out for the Chinese Government.

In the coal trade a steady demand is being kept up for the better qualities for house-fire purposes, and the pits generally are working pretty nearly full time. Other classes of fuel for iron-making and steam purposes meet, however, with only a slow sale, and in common round coal orders are being sought after at very low prices. For house-fire coals prices are maintained at the full list rates of about 8s. to 9s. for best, 7s. to 7s. 6d. for seconds, and about 5s. 9d. to 6s. for common qualities. Common round coals for steam and forge purposes can be got at from 5s. to 5s. 6d.; burgy at 4s. 6d. to 5s.; common slack at from 2s. 9d. to 3s., with the best sorts fetching 3s. 9d. up to 4s. 3d. per ton at the pit.

The shipping trade is very quiet, and it is only for the better qualities of steam coal that 7s. per ton, delivered at the high level, Liverpool, or the Garston Docks, is obtained, medium sorts being offered freely at 6s. 9d. per ton.

A very interesting programme is being arranged for the visit of the Gas Institute to Manchester next month. At a meeting of the executive of the local reception committee, held in the Manchester Town Hall on Tuesday, arrangements were made for visits to the locomotive works of Messrs. Beyer and Peacock, at Gorton; the Otto Gas Engine Works of Messrs. Crossley Brothers, at Openshaw; the cotton mills of Messrs. Richard Haworth and Co., at Salford; and the gasworks of Manchester and Salford—all of which have been kindly thrown open for inspection. The Mayor of Salford has kindly given the Gas Institute an invitation for a *conversazione* in the Peel Park Museum and Fine Art Museum, which has been cordially accepted. Other arrangements are also in contemplation, including a closing day's excursion to some place of interest.

Barrow.—The attitude of the hematite pig iron trade is practically unchanged. There is, in fact, no important variation from the position held by trade during the past few weeks. Makers are partially employed, but are able to dispose of the present output of their works without the necessity of increasing stocks. Most of the trade doing is on home account, and there is a scarcity of orders from the Continent, America, and the colonies. Buyers are, in fact, only purchasing in cases where deliveries are actually and immediately required, and there is little or no speculation on the part of merchants. Prices are quoted at 44s. No. 1 Bessemer, 43s. 6d.; No. 2, 43s.; No. 3, 42s. 6d. and 42s.; forge and foundry qualities, and 42s. white and mottled samples net at works, or f.o.b. prompt deliveries. Forward deliveries of mixed Bessemer samples are quoted at 44s. 6d. per ton net. The steel trade is not briskly employed, although more activity is apparent at the works than was the case this time last year, and more orders are in hand. The contracts, however, which are now held are not sufficient to keep employed the whole of the plant, and short time is the rule in consequence. Makers are not busy in the production of special steel, but efforts are being put forth on a spirited basis for the resumption of the Siemens-Martin's furnaces at Barrow. The shipbuilding trade has received another impetus by the placing of the order for a large new steel steamer for the New York and Mediterranean service with the Barrow Shipbuilding Company. This company has now on hand two 7000-ton Pacific steamers, a full-powered paddle steamer for the Fleetwood and Belfast service, an Isle of Man passenger steamer, a Government cruiser, the new New York steamer, the order for which has just been received, and other orders of lesser importance. The iron mining industry of the district is in a languid state, and raisers find it difficult to sell even at present low prices. The engineering trades are quiet, except in the marine department, where some activity is observable.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THERE are increasing signs of the end of the great strike. At Shireoaks the miners have returned to their work at the reduction of 10 per cent. Kiveton Park, the adjoining colliery, will follow. At Thorncliffe the numbers at work increase. A significant sign at Thorncliffe is the re-starting of the large blast furnaces, which were damped down a fortnight ago owing to the strike. The firm have taken advantage of the stoppage to put the furnaces in a thorough state of repair. About sixty cokeburners and furnacemen will thus resume work. At Swinton on Monday, the Venerable Archdeacon Blakeney, of Sheffield, referring to the Denaby dispute, deplored the state of things in that district, and made the sensible suggestion that a reconciliation might be brought about by the interposition of a powerful third party. While admitting that it was at any time a delicate matter to interfere with the relations existing between the employers and employed, he expressed a strong opinion that the Archbishop of York would be delighted, if he were appealed to, to bring about the end of the dispute. The Archbishop wields great influence, especially among the working classes, and I am positive that his Grace's excellent business capacity—of which, acting on committees with him and otherwise, I have had every evidence, combined with his unquestioned judgment and impartiality, would have a most happy effect.

The resolution of the Government to retire from the Soudan has not excited any surprise here. The tentative, hand-to-mouth way in which the Suakim-Berber rails were called for reflected something of the attitude of the Government. There is no doubt that, in view of the grave difficulty with which we are face to face in Afghanistan, the commercial world realise the prudence of the step now taken. Concentration of our power and resources for the Asiatic fight is the one thing needed. It may be noted as a significant sign that several English people resident in St. Petersburg have returned to this country, and others are expected to follow soon. The Sheffield managers and others employed at the armour-plate works at Kolpino, near St. Petersburg, will no doubt return home, in the event of hostilities breaking out.

Messrs. E. Lucas and Sons, Dronfield Foundry, near Sheffield, have received very extensive orders for war material, including 20,000 of the Wallace patent intrenching implement, 20,000 telegraph pins, and a large number of steel spades and shovels. The telegraph pins, which are galvanised and of great strength, are for Bombay. The Wallace intrenching implements are named after Major Wallace, their inventor, and were of great service in the Egyptian and Soudan campaigns.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

THE Cleveland pig iron trade has fallen into an almost lifeless condition. There was a fair attendance at the market held at Middlesbrough on Tuesday last, but very few sales were effected. Consumers continue to hold back their orders to the utmost, in the belief that in case of a declaration of war against Russia the prices of pig iron would recede still further. In the meantime only small lots required for immediate delivery are being purchased, and prices are certainly lower than a week ago. On Tuesday certain merchants sold No. 3 g.m.b. at as low a figure as 33s. 3d. per ton, being 6d. less than at the market of the previous week, while others quoted 33s. 6d. Makers are not, as a rule, pressing for orders, and the leading firms will not accept less than 34s. for No. 3 g.m.b. There are some, however, who are willing to take 33s. 9d. Forge iron can now be obtained for 33s. per ton. It is worthy of remark that the difference between forge and No. 3 g.m.b. is now only 3d. per ton, whereas a short time since it was 2s., and normally it is 1s.

Warrants are seldom mentioned, and it would not be easy to fix the price.

The stock of pig iron in Messrs. Connal and Co.'s store at Middlesbrough is 50,822 tons, that being a reduction of 10 tons in comparison with the return of the previous week.

Shipments of pig iron from the Tees during the completed portion of April have not been up to the average. The quantity sent away up to Monday last was 64,108 tons, whereof 24,350 tons went to Scotland. Shipments to foreign parts have been extremely poor.

Finished iron manufacturers are now better supplied with orders than they have been for some time, and they are obtaining slightly higher prices. Ship plates are £4 17s. 6d. to £5 2s. 6d. per ton; angles, £4 12s. 6d. to £4 15s.; and common bars, £5 to £5 2s. 6d. All on trucks at makers' works, less 2½ per cent. discount.

The demand for steel plates is almost greater than the supply, and makers are now asking £7 2s. 6d. at works for them. Steel angles are £6 15s. per ton.

The two belted cruisers to be built for the Government by Palmer's Iron Shipbuilding Company, Jarrow-on-Tyne, are to be 300ft. long, 56ft. wide, and 34ft. deep, 5000 tons displacement, and 8500 indicated horse-power. The contract price is £224,000 each. The ironclad to be built by Armstrong, Mitchell, and Co. will cost £604,000.

The strike of shipwrights, joiners, and smiths which has been in progress at the Sunderland shipbuilding yards for nine weeks, seems at length likely to terminate. A meeting of the employers was held on Monday last, and a resolution was passed to the effect that the yards should at once be thrown open to the men at the same rates as were current previous to the strike. This resolution has been communicated to the union secretary, and he will submit it to the men. It is expected that they will be only too glad to resume work on the terms offered. The continual recurrence of strikes for which Sunderland has become notorious has led to a proposal that a Board of Arbitration should be formed on the lines of that which has long worked successfully in the finished iron trade. Both employers and employed seem favourable to the idea, and it is hoped it will before long become realised. Otherwise the river Wear is likely to lose its ship and marine engine building trades, to the gain of other districts where the relations between capital and labour are more wisely and more harmoniously conducted.

Arbitration is not always understood and its principles are not always acted upon by professed members of the Boards bearing its name. A case in point occurred in Cleveland recently at one of the plate mills. The shearmen considered they were being paid below the country rate, and complained to the manager. The principal looked into their grievance, and finding that at certain other works the same rates were also admittedly being paid, he said he could not make any change unless a claim was properly brought before the Standing Committee and adjudicated on by them. This accordingly was done, and a resolution was passed which was supposed would settle the case. On seeking, however, to apply the resolution, it was found to be so vague, as to be capable of three separate interpretations all giving different results. The employers in question submitted to the next meeting of the Committee a statement showing each of these results. Thus assisted, the Committee adopted the result which was least favourable to the employer and most favourable to the operatives. The employer accepted the result and paid what was ordered in a day or two. One would have thought the operatives would have been triumphant at their success. Not so, however. Though they had obtained a portion of their claim, they had not got so much as they desired. They took what was offered them, and then commenced by unfair means to endeavour to extract what they had been unable to secure from the Committee by fair means. They gave in their notices to leave; one or two of the ringleaders absented themselves from work, occasioning loss and annoyance. They induced other workmen who had no grievance to do the same, and finally they put an anonymous advertisement in the daily paper requesting other workmen in their line of business, to keep away during the "dispute." It is only fair to the Operative Secretary of the Iron-workers' Union and of the Board of Arbitration to say that he at once disclaimed all responsibility for this unfair action of the men, and refused to recognise or have any dealings with the perpetrators. How the matter will end is not at present known but it is thought that the places of the malcontents will be supplied without much difficulty.

In view of the possibility, if not certainty, of war with Russia, the thoughts of North-countrymen naturally turn to the consideration of the likelihood of a naval attack on one of our North-country ports. The mouths of the Tyne, Wear, and Tees are all in a sense just opposite to the Sound, whence might issue Russian war ships. The improvements effected during the last twenty years by River Commissioners are such that the very largest vessels can now enter at high water. The banks of each river are thickly lined with works, warehouses, shipyards, and other destructible matter, and the defences are, on the whole, slight. The mouth of the Tyne is fairly well protected by Tynemouth Castle and the Spanish battery. But neither the Wear nor the Tees have any fortifications of any kind. The best and most obvious means of protection will be to keep Russian war ships in the Baltic and the Black Sea by means of superior naval forces. No doubt we shall easily be able to do this; and, indeed, it must be done. But it will not provide against depredations by war ships which may be roaming the ocean at the outbreak of war, nor against those of cruisers and privateers of the Alabama type, which may be bought from other nations, and sent forth on predatory errands against British property ashore or afloat. It is high time, therefore, that torpedo or other efficient defences were prepared ready for placing in position at the entrance to each of our Northern rivers, and that a few guns of heavy calibre were furnished and mounted where they would command the approaches and render sudden attacks impossible.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THERE has been a considerable speculative business in the Glasgow warrant market during the week, chiefly in connection with the settlement of operators' accounts. The inquiry for pig iron for shipment is slow. In the past week shipments were 8896 tons as compared with 10,820 in the preceding week, and 11,834 tons in the corresponding week of 1884. There are ninety furnaces in blast as against ninety-five at the date last year. The stocks of Scotch pigs in Messrs. Connal and Co.'s Glasgow stores exhibit an increase for the week of 550 tons.

Business was done in the warrant market on Friday at 41s. 10d. cash. On Monday transactions occurred at 41s. 10d. to 41s. 11½d. cash. Tuesday's market was quieter, with business at 41s. 10½d. to 41s. 9½d. and back to 41s. 10½d. cash in the forenoon, while the market was idle in the afternoon at 41s. 10½d. cash. On Wednesday business was done at 41s. 10½d. to 41s. 7½d. cash. To-day—Thursday—the market opened quietly, with large sales at the latter figure, and advanced to 41s. 9½d.

In consequence of the backward inquiry for shipping iron, the value of makers' brands are generally easier, the quotations being as follows:—Gartsherrie, f.o.b. at Glasgow, per ton, No. 1, 50s. 6d.; No. 3, 46s.; Coltness, 52s. 6d. and 49s. 6d.; Langloan, 52s. and 49s. 6d.; Summerlee, 50s. 6d. and 46s.; Calder, 51s. 6d. and 46s.; Carnbroe, 48s. and 45s. 6d.; Clyde, 46s. 9d. and 42s. 9d.; Monkland, 42s. and 40s.; Quarter, 41s. 9d. and 39s. 6d.; Govan, at Broomielaw, 42s. and 40s. 6d.; Shotts, at Leith, 50s. 6d. and 50s.; Carron, at Grangemouth, 52s. 6d. and 47s.; Kinneil, at Bo'ness, 44s. and 43s.; Glengarnock, at Ardrossan, 47s. 6d. and 42s.; Eglinton, 42s. and 39s. 6d.; Dalmellington, 46s. and 42s. 6d.

The mild steel trade continues busy, and it is understood that Scotch makers will supply all the steel, with the exception of the armour-plating, for the construction of the two cruisers to be built for the Admiralty by Messrs. Robert Napier and Sons. The effect of the placing of these orders has been to advance the quotations of steel plates and angles. The makers are in a very favourable position with regard to the raw material, as hematite pigs, of which there are considerable accumulations in store, are very moderate in price.

The shipments of iron and steel goods from Glasgow in the past week embraced nine locomotives, valued at £23,200, of which four went to Sydney, three to Calcutta, and two to Bombay; machinery, £2260; sewing machines, in parts, £1066; steel goods, £9400; and iron manufactures, £41,800.

The inland coal trade is quiet, but the shipping demand, notwithstanding the probable hazards to shipping in the future, is brisk. In the past week 26,319 tons were shipped at Glasgow, 5922 at Greenock, 1623 at Irvine, 7187 at Ayr, 7390 at Troon, and 11,679 tons at Grangemouth. Coalmasters are not over anxious to accept large foreign contracts at present. They prefer to deal with small current wants, that can be executed at once, in case it should be necessary to advance prices before long. For steam coals there is a brisk inquiry, and some large contracts for gas coals were being arranged this week.

In some districts the miners are giving trouble on the question of wages, and if the trade keeps active they may likely obtain a part of the recent reduction back. The calling out of the reserves will withdraw a very considerable number of men from the pits.

Arrangements are in progress for holding a national conference in Glasgow to consider what steps should be taken to improve what the miners term "their present low and degraded position."

The position of the coal trade in Fife and Clackmannan is not satisfactory, and the executive board of the Miners' Association have resolved "that in view of the present Russian crisis, which is affecting the shipping trade, the board take no definite action to recover the reduction in wages till next meeting."

At the eighth annual meeting of the Mining Institute of Scotland just held at Hamilton, Mr. J. T. Robinson presiding, it was reported that the members now number 456. The committee appointed to collect information on the mine drainage reported that they had not got the encouragement from mineowners which they expected to receive, but they hoped that they might yet be able to prepare a report. Mr. J. S. Dixon, C.E., who was elected president for the current year, afterwards took the chair, and delivered an interesting address on the position and prospects of the mining industry.

WALES & ADJOINING COUNTIES.

(*From our own Correspondent.*)

HOUSE coal has shown a slightly better tone during the last week, and though prices remain at former quotations, the demand is more brisk. In the neighbourhood of Caerphilly a good deal of satisfaction has been expressed by the acquirement of the Energlyn proprietary of an additional forty acres of coal land. This coal is in esteem for its gas properties, and, with Vipond's and Beddoe's, generally commands a good market. Shipments of steam coal are decidedly better of late, and Mediterranean rates have advanced 1s. 6d. I have noticed large cargoes for Port Said, the Red Sea, and Sebastopol. It is evident that coalowners are on the *qui vive*, and if war continues doubtful for another week or two, and sinister prospects remain, totals from the leading ports of Wales of best steam coal are certain to increase. Patent fuel, too, is looking up, and large consignments have left Cardiff and Swansea during the week. Best small steam retains its firmness in the market, and the demand is good. The Ebbw Vale Iron Company has secured a substantial contract from one of the Irish companies.

The Merthyr Vale Colliery, Nixon and Co., are turning out large quantities of excellent coal from their two shafts. This company are adopting a laudable course by the encouragement of building clubs, and of late quite a township has sprung up. One of the large collieries in the Neath Valley has been restarted lately, and appears to be doing well. In the Swansea district large steam is in less demand than "through and through," but the Swansea coalowners have not much to complain about, the chief grumble there at present being the short supply of steamers and sailers coming into port. This has told on the tin-plate trade somewhat, which, though in good condition, still scarcely satisfies makers, who, with single orders and good make, yet find it difficult to get speedy clearance, and thus have all the trouble and expense of warehousing. Prices firm at last quotations.

9000 boxes come to hand this week. Taking the two districts Newport and Swansea, the latter shows more animation in the tin-plate trade. At Rhinderin the masters' demand of 15 per cent. is to be resisted. Iron and steel are decidedly quiet. Dowlais is pursuing its steel sleeper trade with some degree of briskness. This seems to me a promising branch. The fear that steel will not have the elasticity of timber is soundly laughed at by the Dowlais agents.

Those who have not seen the sleeper, and have run away with the impression that it is as stiff as pig iron, cannot form any just opinion upon the subject. I should say, judging from its comparative thinness, its form, and the ingenious arrangements for securing it in position, that it will give all the elasticity required, and be far cheaper in the end. Dowlais is a good pioneer in the new industry, and the attention that is rivetted upon the movements there show that success will soon beget many imitators. As I expected, and it may fairly be said prophesied, Bilbao ore is going up, and those of our ironmasters who have made contracts at the low prices that prevailed up to a short time ago are to be congratulated.

AT Wilkesbarre, U.S.A., there has recently been manufactured, for colliery haulage, a wire rope, 5780ft. in length, and 2½in. in diameter. Its total weight is thirty-two tons, and its tensile strength has been tested up to ninety-two tons. It is made of six strands of wire rope, each a little over three-fourths of an inch thick, and composed of nineteen wires. These six strands are wound round a hemp rope, which gives flexibility. The iron used is all of the best Swedish variety. Such a cable is estimated to be capable of hauling up the planes 8,000,000 or 9,000,000 tons of coal before being worn out.

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 number of the Specification.*

Applications for Letters Patent.

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

21st April, 1885.

4891. Girders, R. A. Stoffert and T. Dykes, Glasgow.
4892. Controlling Points upon Tramways, &c., J. Boylan, Manchester.
4893. Bicycle and Tricycle Bearings, W. Banning, Birmingham.
4894. Carding Engines, R. Curtis and A. Holden, Manchester.
4895. Paring or Cutting the Edges of Felt, &c., H. Beech, Manchester.
4896. Swing Looking-glasses, P. E. Ayton and J. Pearson, Birmingham.
4897. Carriage Axles and Axle-boxes, J. Grice, Birmingham.
4898. Studs or Fasteners, W. P. Thompson.—(*W. F. Ware, United States.*)
4899. Controlling or Regulating Valves, J. E. Miller, Liverpool.
4900. Letting-off Motion for Looms, E. Barlow, Patricroft.
4901. Spring Hinges, W. Pinkerton, Glasgow.
4902. Obtaining Ammonia in Distilling Oil, &c., A. Neilson and J. Snodgrass, Glasgow.
4903. Forcing Down the Shuttle-boxes of Drop-box Looms, C. Bedford, Halifax.
4904. Neckties, A. Bowman, London.
4905. Combination Collar and Necktie, A. Bowman, London.
4906. Mounting the Steering Wheels of Velocipedes, J. H. Dearlove and H. Thresher, London.
4907. Circular Combs for Wool, &c., J. Ainsworth, Bradford.
4908. Nitrous and Nitric Acids, G. Jarvis, London.
4909. Utilisation of Basic Slags, G. A. Jarvis, London.
4910. Steam Engines, A. Payne, Stroud.—*15th April*, 1885.
4911. Lock-nuts, E. C. Ibbotson, London.
4912. Electric Lighting and Electric Lamps, A. N. J. Contarini and G. M. Biaggiotti, London.
4913. Velocipedes, P. L. C. F. Renouf, London.
4914. Match-boxes, M. Boyd, London.
4915. Ringing and Alarm Bells, J. and C. E. Challis, Haggerstone.
4916. Making Infusions of Coffee, S. P. Wood, Littlehampton.
4917. Curtain Stretcher, W. Francis, London.
4918. Facilitating Lighting of Pipes, M. Wilson, London.
4919. Converting Quotations of Foreign Monies, E. L. Walford, London.
4920. Water-bottle for Military Purposes, W. de W. Cater, London.
4921. Brushing, &c., Leather, A. G. Brookes.—(*G. H. Maddock, United States.*)
4922. Binding or Holding Documents, H. R. Stutchbury and G. Thomas, London.
4923. Extinguishing the Flames of Candles, T. S. Howie, London.
4924. Repeating or Magazine Rifles, G. E. Vaughan.—(*The Austrian Small Arms Manufacturing Company, Austria.*)
4925. Furnaces, L. and D. Roberts and J. Colquhoun, Sheffield.
4926. Water-closets, &c., G. F. Wells, Sheffield.
4927. Tobacco Pipes, F. Braden, London.
4928. Electric Generators, B. A. Raworth, London.
4929. Bicycles, H. J. Haddan.—(*W. Clemson, U.S.*)
4930. Sewing Machines, A. J. Boult.—(*C. A. Dearborn, United States.*)
4931. Pavements, W. C. and E. F. Murdock, London.
4932. Mail-bag Catchers, H. de Lanoy, London.
4933. Numbering or Marking Paper, &c., A. J. Boult.—(*J. R. Carter, United States.*)
4934. Opening, &c., Carriage Doors, W. R. G. Roebuck, London.
4935. Padlock Protector, H. P. Lavender, London.
4936. Fire Alarm and Extinguishing Apparatus, W. Lindsay, London.
4937. Raising and Lowering Windows, J. E. Hopkinson and O. Gibson, London.
4938. Handles of Bicycles, T. Bayliss, J. Thomas, and J. Slaughter, London.
4939. Burglar-proof Safes, E. P. Alexander.—(*H. Gross, United States.*)
4940. Lock Mechanism for Burglar-proof Safes, E. P. Alexander.—(*H. Gross, United States.*)
4941. Ordnance, A. W. L. Reddie.—(*B. T. Babbitt, United States.*)
4942. Web Printing Machines, W. Conquest.—(*R. Hoe and Co., United States.*)
4943. Joint for Pipes, F. Humpherson, London.
4944. Motor, J. Cowan, Glasgow.
4945. Stirrup Irons, R. Wright, London.
4946. Changeable Button, O. Imray.—(*F. A. Fox, United States.*)
4947. Forming Sewing Machine Stitches, J. B. Robertson, London.
4948. Starch Meal, W. R. Lake.—(*W. T. Jebb, United States.*)
4949. Spindles of Stop Valves, J. Etherington, London.
4950. Stirring Devices for Drying Apparatus, E. A. Striebeck, London.
4951. Driving Chains, G. S. Richmond, London.
4952. Secondary Galvanic Batteries, G. F. Redfern.—(*M. and J. B. Glaesener, Belgium.*)
4953. Treating the Fruit of the Mauritia Vinifera, E. de Pass, London.—(*F. Kugelmann, France.*)
4954. Starch Meal, W. R. Lake.—(*W. T. Jebb, United States.*)
4955. Gearing Wheels of Velocipedes, F. Jones and T. Reading, Birmingham.
4956. Malt Liquors, W. R. Lake.—(*W. T. Jebb, United States.*)
4957. Treatment of Maize, W. R. Lake.—(*W. T. Jebb, United States.*)
4958. Decorating Walls and Ceilings, W. R. Lake.—(*E. S. Miragoli, United States.*)
4959. Presses for Compressing Silage, T. Cardwell, London.
4960. Lace Machines, J. Jardine, London.

22nd April, 1885.

4961. Fasteners for Securing Cords on Wagons, A. M. Grimond, Bowbridge.
4962. Metal Wedges, S. W. Smith, Coventry.
4963. Electrical Couplings for Railway Trains, W. E. Langdon, Derby.
4964. Combining a Pianoforte and Harmonium, R. Eccles, Halifax.
4965. Ships' Pumps, J. Broadfoot, Glasgow.
4966. Ships' Pumps, J. Broadfoot, Glasgow.
4967. Forcemeat Passer, S. Arnaud, London.
4968. Combination Writing and Work Table, C. Crestman and A Lloyd, London.
4969. Mandozer Catch Motion, J. Eckersley and R. Turner, Preston.
4970. Steam Valves, H. H. and G. H. Taylor and J. Bates, London.
4971. Spring Boxes for Powders, C. Maples, London.
4972. Eclipse Fastener, W. Rushton and G. H. Hall, Edgbaston.
4973. Warp Lace Machines, A. Dawson and E. Smith, London.
4974. Triplicate Cultivator, J. E. Brown, Saxilby.
4975. Clutch Spindle for Door Furniture, C. G. and F. Smith, Birmingham.
4976. Coloured Pencil Leads, J. H. Johnson.—(*The Eagle Pencil Company, United States.*)
4977. Link Belting, D. Tullis, Glasgow.
4978. Coffee-pot, S. Martin, Clapham.
4979. Producing Designs on Fabrics, &c., J. Hebblewaite and E. Holt, Manchester.
4980. Tilting Beer and other Casks, S. Scothern, London.
4981. Disinfecting Apparatus, F. J. Austin, Clapham-common.
4982. Combined Brush and Scraper, C. G. Cross, London.
4983. Delivering Tickets on Tramcars, &c., T. Grimbleby, London.
4984. Purifying Foul and Filthy Water, R. H. Radford, Sheffield.
4985. Brushes and Brooms, J. Bidwell, London.
4986. Doors or Covers for Coal-boxes, &c., C. Sims, London.
4987. Locking Railway Facing Points, S. T. Dutton, London.
4988. Drying Malt, &c., H. J. Haddan.—(*P. Lauth, France.*)
4989. Compound Coupling for the Draw-bars, &c., of Railway Carriages, H. J. Haddan.—(*H. Lippmann, Saxony.*)
4990. Indicator Door Bolt, A. E. Barrett, London.
4991. Discharging Dynamite, &c., M. F. H. Kiernan, Hounslow, and W. B. Neale, Upper Norwood.
4992. Electric Lamps and Lamp Fittings, T. T. Smith, London.
4993. Lighting Houses, &c., by Electricity, T. T. Smith, London.
4994. Velocipedes, C. M. Linley, J. Biggs, and G. G. Tandy, London.
4995. Governor for Steam Engines, J. McConnell, London.
4996. Replenishing, Withdrawing, or Adjusting Fire-bars in Furnaces, W. H. Gales and J. T. Medhurst, London.
4997. Disengaging Hooks for Ships' Boats, W. F. Rees, Greenwich.
4998. Bobbin Winders for Sewing Machines, P. Langrock, London.
4999. Retaining Cravats in Position, W. O. Wedlake, London.
5000. Packing, &c., Piston Rods, V. Holliday, London.
5001. Voltaic Cell, J. D. F. Andrews, London.
5002. Hydraulic Mains, H. Simon and W. Charlton, London.
5003. Cooling, &c., Slag, W. Cochrane, London.
5004. Preserving Wood, W. R. Lake.—(*A. van Berkel, Germany.*)
5005. Electric Meters, H. Watt.—(*E. Weston, United States.*)
5006. Electric Meters, S. F. Walker, London.
5007. Caisson, A. M. Clark.—(*J. McGovern and P. Jeffrey, United States.*)
5008. Child's Seat for Tricycles, A. M. Clark.—(*F. A. Mackie, United States.*)
5009. Adding Machines, A. M. Clark.—(*J. L. Richardson, United States.*)
5010. Storing Steam-power, A. M. Clark.—(*M. Honigmann, Germany.*)
5011. Looms, W. R. Lake.—(*G. H. Hodges and T. Lonergan, United States.*)

23rd April, 1885.

5012. Batting Potter's Clay, R. Clark, London.
5013. Utilisation of Electricity, H. Watt.—(*E. Weston, United States.*
5014. Shutters of Photographic Cameras, J. Kershaw, Buxton.
5015. Spinning, &c., A. M. Clark.—(*J. J. Bourcart, Switzerland.*)
5016. Calculating Apparatus, J. W. Stanley.
5017. Anvils, A. Brooks, Wolverhampton.
5018. Cupboard Turns, J. Walker, Birmingham.
5019. Jointed Mandril, G. Round, Birmingham.
5020. Tumblers, T. Walton, Liverpool.
5021. Velocipedes, J. H. Schulze, Liverpool.
5022. Burners, G. R. Postlethwaite, Birmingham.
5023. Steering Indicator, J. D. Scally, Birmingham.
5024. Watches, W. R. Lake.—(*L. Holuska, Austria.*)
5025. The Suez Propeller Guard, G. Molyneux, Great Grimsby.
5026. Trucks, R. Caldwell, Dublin.
5027. Stench Traps, J. Smith, Manchester.
5028. Weaving Ornamental Fabrics, A. H. Lee, Manchester.
5029. Steel Tools or Dies, H. P. Boyd, Southampton.
5030. Mechanism of Venetian Blinds, J. Simpson, Heaton Chapel.
5031. Guide or Indicator for the Keyboards of Pianofortes, J. Saville, Manchester.
5032. Kiln for Drying Brewers' Grains, &c., H. E. Brittin, Swindon.
5033. Fastenings for Boxes, &c., T. Burns and J. S. Dumbell, London.
5034. Dial Plates for Clocks, Watches, &c., A. Nisbett, Glasgow.
5035. Folding Heads of Carriages, J. G. Harrison, Edgbaston.
5036. Advertising Show Case, E. B. Cox, London.
5037. Face-plates, A. Malpas, Birmingham.
5038. Lamps, W. Stobbs and E. L. White, London.
5039. Grinding Circular Milling or other Cutters, H. Lindley, London.
5040. Taps, Cocks, and Valves, W. H. Rodley and J. Puttrell, Sheffield.
5041. Ventilating Buildings, T. S. Howie, London.
5042. Water-waste Preventing Cisterns, &c., J. Howlett and T. Panario, London.
5043. Combined Pianoforte, Harmonium, and American Organ, C. F. Cullum, London.
5044. Storing Force, B. W. Maughan, London.
5045. Galvanic Batteries, T. J. Jones, London.
5046. Steel, L. A. Groth.—(*R. Verkbecker, Luxemburg.*)
5047. Actuating Mechanism for Jewellery, L. A. Groth.—(*H. and G. Gaenslenn, Germany.*)
4048. Locking Mechanism for Safes, J. Walker and H. B. Worsey, London.
5049. Cocking Mechanism of Drop-down Small-arms, J. Deeley, jun., and F. J. Penn, London.
5050. Lamps for Burning Mineral Oils, J. Thomas, London.
5051. Cartouch Box, J. C. Mewburn.—(*A. Beer, France.*)—*14th February*, 1885.
5052. Producing Pictures by Photography, J. C. Mewburn.—(*L. J. H. Cellérier, France.*)
5053. Hangers or Carriers for Shafting, M. Finney, London.
5054. Trenails for Securing Railway Chairs to the Sleepers, W. Cannon, London.
5055. Adjusting the Tension of Wires of Pianos, &c., W. S. Naylor, London.
5056. Churns, F. T. Morrelle, J. H. Redstone, and J. A. Obermüller, London.
5057. Maps and Sun Dials, H. J. Haddan.—(*J. Adler, Saxony.*)
5058. Ventilating Boots, H. J. Haddan.—(*E. Tesch, Saxony.*)
5059. Window Fastener, H. J. Haddan.—(*N. M. Hansen and J. C. Pederson, Denmark.*)
5060. Opening and Closing Sashes, &c., H. Pearce, London.
5061. Electro-magnets, D. L. Salomons, London.
5062. Coal-boxes, A. G. Brams, London.
5063. Lamps, E. A. Rippingille, London.
5064. Muriate of Ammonia and Alum, A. A. Croll, London.
5065. Water Meters, H. A. Fleuss, London.
6066. Permanent Way of Railways, W. H. Lindsay, London.
5067. Automatically Collecting the Balls from the Pockets of Billiard Tables, H. Harvey, London.

5068. COCKS for BOTTLES, W. R. Lake.—(*G. Jockin, Belgium.*)

24th April, 1885.

5069. SECONDARY BATTERIES, G. E. Dorman, Stafford.
5070. DRIVING and RIDING REINS, E. W. Gough, Bloxwich.
5071. CURLING-IRON HOLDERS, T. Singleton, Darwen.
5072. RAILWAY SIGNAL LAMPS, P. Rickard, Halifax.
5073. GAUGE for the PERMANENT WAY of RAILWAYS, P. Rickard, Halifax.
5074. ACTUATING RAILWAY OBTUSE SWITCH CROSSINGS, P. Rickard, Halifax.
5075. METALLIC TANG for WOOD WHEELS, O. S. Evans, Brierley Hill.
5076. TUNING ORGAN REEDS, W. Kempe, Leeds.
5077. FITTING FEET on CHAMBER PAILS, &c., E. Priest, Wolverhampton.
5078. PERAMBULATORS and BASSINETTES, J. E. Fitzgerald, Manchester.
5079. LOOMS for WEAVING, D. Leggett and W. Ackroyd, Halifax.
5080. PERIODIC WATERING, &c., J. Enright, London.
5081. SPINDLES of RING SPINNING MACHINES, B. Fallows, Manchester.
5082. ENVELOPES, J. Fielding, Manchester.
5083. AUTOMATIC GRIP VICE, J. Barlow, Nottingham.
5084. SAFETY RAILWAY CARRIAGES, J. Farrimond, Liverpool.
5085. STEAM ENGINES, F. W. Crohn, London.
5086. CIRCULAR STAIRCASES, W. W. Taylor, Ripon.
5087. EPICYCLOIDAL CLOCKS and WATCHES, W. W. Taylor, Ripon.
5088. FISHING and other NETS, A. J. Allan, Glasgow.
5089. HORSESHOE NAILS, R. O. Grischotti.—(*A. G. Frykman, Sweden.*)
5090. ALCOHOLIC BEVERAGES, J. H. Loder, Netherlands.
5091. DRAW TUBES, J. Lea and J. Osgerby, London.
5092. CONTROLLING the VOLUME of the BLAST in CONVERTERS, W. E. Wynne.—(*H. W. Oliver, jun., and J. P. Witherow, United States.*)
5093. PROTECTING LIGHTNING CONDUCTORS, T. Massingham, London.
5094. TILE HEARTHS, S. B. Sutcliffe, London.
5095. FRAMES for CUTTING PILE FABRICS, J. Hallworth and G. Roger, London.
5096. WORM SHAFTS, J. Holgate and J. B. Holgate, London.
5097. DEEP FLOODING CLOSETS, S. Jackson, Halifax.
5098. BOTTLES, J. Collins and C. Brearley, Halifax.
5099. OPENING the WRAPPERS for ENVELOPES, &c., H. Chattell, London.
5100. STRETCHING TROUSERS, &c., T S. Howie, London.
5101. LOOKING-GLASS MOVEMENT, H. Agar, Worcester Park.
5102. PAINT or PIGMENT, H. W. Smith, London.
5103. REPRODUCTION of ENGRAVINGS, &c., G. F. Redfern.—(*P. E. de St. Florent, France.*)
5104. SAFETY BICYCLES, H. Smith, London.
5105. DRESS FASTENINGS, G. T. Evans, London.
5106. SUBDUING or MODIFYING LIGHT, A. J. Littleton, Sydenham.
5107. LIGHTING and HEATING by PETROLEUM, &c., OILS, S. Hallett, London.
5108. COMBINED TABLE and MANGLE, M. Burtt.—(*N. Torkilsen, Norway.*)
5109. SHAFT TUGS, G. Williamson, London.
5110. RETARDING and RESTARTING TRAM-CARS, A. J. Parker, London.
5111. TRAM and LOCOMOTIVE STEAM ENGINES, T. Green, London.
5112. CONNECTING FIRE-GRATES to FLUES, J. Bonny, London.
5113. KNITTING LOOMS, J. Poole and H. Aldwinckle, London.
5114. PARALLEL VICE, J. Parkinson, London.
5115. PAPER BAGS, T. Coates, London.
5116. HAND LAMPS, &c., C. Barton and W. W. Popplewell, London.
5117. TELEPHONIC APPARATUS, R. Theiler, London.
5118. AERIAL NAVIGATION, A. C. Henderson. — (*B. Bontems, France.*)
5119. MATHEMATICAL DRAWING INSTRUMENT, I. Beutelrock and H. v. Seilern, London.
5120. ELECTRODES for SECONDARY BATTERIES, M. H. Hurrell, London.
5121. PREVENTING the RACING of MARINE ENGINES, P. M. Justice.—(*B. J. Carroll, United States.*)
5122. WAR SHIP, T. Cornish and B. Finch, London.
5123. EXCITING the FIELD MAGNETS of SERIES-WOUND DYNAMO MACHINES, W. H. Allen, R. Wright, and G. Karp, London.
5124. BOTTLE STOPPERS, H. J. Haddan —(*A. Cubat, France.*)
5125. UMBRELLAS and PARASOLS, H. J. Haddan.—(*C. A. M. Kremer, Saxony.*)
5126. TRANSMISSION of ROTATORY MOTION, J. Harris, London.
5127. STEAM BOILERS, W. Y. Fleming and P. Ferguson, Glasgow.
5128. EMBROIDERING MACHINES, S. Louis.—(*Messrs. Dognin and Co., France.*)
5129. PARALLEL VICES, &c., R. P. Strachan and G. Henshaw, London.
5130. GLASS BOTTLES, H. Codd, London.

25th April, 1885.

5131. MOTOR for WASHING MACHINES, H. G. D. Ashley, Birmingham.
5132. REED KEY MUSICAL INSTRUMENTS, E. C. Griffin, London.
5133. STRETCHING LAWN-TENNIS NETS, G. L. Scott, Manchester.
5134. STOP MOTIONS for WINDING, &c., FRAMES, A. H. Dixon and W. J. Gradwell, Manchester.
5135. SPORTING GUNS, W. Ford, Birmingham.
5136. METALLIC BEDSTEADS, E. Billington, jun., Liverpool.
5137. WINDOW FASTENER, R. W. Roberts, Anglesey.
5138. REPAIRING METALLIC BEDSTEADS, W. Struthers, Glasgow.
5139. WOOD CLIPS for LETTERS, F. W. Brampton, Birmingham.
5140. PUDDLED IRON and STEEL, J. Gilligan, London.
5141. ACTUATING JACQUARD MACHINES, W. Hardaker, London.
5142. FLYERS for SPINNING, &c., FIBRES, A. W. J. Morris, Halifax.
5143. ELECTRIC ARC LAMPS, F. Fenton, London.
5144. SHIRT STUDS, S. P. Spray, London.
5145. MAKING NIGHT SIGHTS, &c., for GUNS, C. W. Heaton and T. Bolas, London.
5146. FIRE-BARS for FURNACES, T. S. Dobson and A. Murfet, London.
5147. ELECTRIC ARC LAMPS, J. G. Statter, London.
5148. WEIRS and SLUICES, A. W. L. Reddie.—(*M. D. Czvetkovics, E. Horbaczewski, and W. von Kopal, Austria.*)
5149. PURIFYING the FEED WATER for STEAM BOILERS, H. E. Newton.—(*A. L. G. Dehne, Germany.*)
5150. GOVERNOR for MARINE ENGINES, G. Burnett, London.
5151. PUMPS, J. W. H. Gray, London.
5152. BOOTS and SHOES, L. and J. Haylock, London.
5153. TREATMENT of EXCRETA, J. Hewes, London.
5154. KNIVES for CUTTING PILE FABRICS, J. J. Mann, Salford.
5155. HAULING IN FISHING LINES, G. W. Murray, Glasgow.
5156. SPINNING, &c., FIBROUS MATERIALS, S. A. Luke, London.
5157. SUSPENDING and WINDING CHRONOMETERS, V. Kullberg, London.
5158. DRUM TAMBOURINE, C. Henshaw, Manchester.
5159. JOINT for RAILWAY RAILS, W. R. Lake.—(*J. Weitz, France.*)
5160. SAIL HANK, J. Lapthorn, Greenock.

27th April, 1885.

5161. APPLYING AUTOMATIC PULLEYS to the STRAPPING MOTION of MULES and TWINERS, S. Broadbent and I. Bamford, Oldham.
5162. LINK and TINE CHAIN HARROW, P. J. Parmiter, Ansty.
5163. WASHING MACHINES, G. Whalley, Keighley.
5164. ORDNANCE and CARTRIDGES, W. Tranter, Birmingham.
5165. EASILY TRANSPOSING the KEY of MUSIC PLAYED on any MUSICAL INSTRUMENT, E. Inchbold and C. W. Richardson, London.
5166. WARMING and COOLING BUILDINGS, &c., J. King, Liverpool.
5167. COMBINED HANDLE and NAME-PLATE for DOORS, E. Kent, London.
5168. HAT FELTING and SIZING MACHINE, T. Longshaw, London.
5169. METALLIC FENCE, G. Q. Adams, New York.
5170. PLAYING CARDS, J. Farwell, London.
5171. FUZEE KEYLESS WATCHES, F. J. Hough, London.
5172. WATCHES, C. R. Fitt, Old Charlton.
5173. SAFETY BOTTLE OPENER, &c., W. H. Mansfield, London.
5174. RECORDING APPARATUS for STEAM ENGINES, J. B. Moscrop, London.
5175. EARTHENWARE, &c., BATHS, W. M. Brown and H. Clayton, Halifax.
5176. ORGAN PEDAL ATTACHMENTS, &c., J. Ainsworth, Halifax.
5177. STRINGING LAWN-TENNIS BATS, W. D. Nightingale, London.
5178. FUMIGATOR, A. E. Hubert, London.
5179. FUMIGATING and DISINFECTING COMPOSITION, A. E. Hubert, London.
5180. TREATING PHOSPHATES of ALUMINA, W. A. Hills, London.
5181. INSTANTANEOUS SHUTTERS for PHOTOGRAPHY, G. S. Grimston, Greenwich.
5182. FEEDING COTTON to MACHINES, W. Richardson and J. Fidler, Manchester.
5183. PORTABLE DISINFECTING APPARATUS, A. W. L. Reddie.—(*W. W. Rosenfeld, U.S.*)
5184. SAFETY LINK for RIDING SADDLES, G. Nobes, London.
5185. LAMP STOVES, E. A. Rippingille, London.
5186. FURS, B. J. B. Mills.—(*Messrs. Fustier, Regensburger, and Co., France.*)
5187. ILLUMINATING TILES, A. W. Lake.—(*T. Hyatt, United States.*)
5188. ILLUMINATING COMBINATION TILES, A. W. Lake. —(*T. Hyatt, U.S.*)
5189. CONCRETE LIGHTS, A. W. Lake.—(*T. Hyatt, U.S.*)
5190. ADVERTISING TABLETS or SHOW CARDS, A. Martyn, London.
5191. PERMANENT WAY of RAILWAYS, G. F. Redfern.—(*L. J. B. Lanfrey, France.*)
5192. FASTENERS for DRIVING BANDS, G. F. Redfern.—(*H. E. Hauger, France.*)
5193. SASH HOLDERS, H. H. Lake.—(*A. L. Wilkinson, United States.*)
5194. TYPE WRITERS, C. R. Blathwayt, London.
5195. LATCH, C. R. Blathwayt, London.
5196. CONTROLLING PUMPING ENGINES, C. Burnett, London.
5197. COAL GETTING, C. Burnett, London.
5198. TOOLS for BREAKING UP COAL, C. Burnett, London.
5199. PREVENTING the JAMMING of CARTRIDGES in MACHINE GUNS, H. S. Maxim, London.
5200. ORGANS, A. Gern, London.
5201. TRANSFORMING ELECTRIC CURRENTS, C. D. Abel. —(*C. Zipernowski, M. Déri, and O. T. Bláthy, Austria.*)
5202. GALVANIC BATTERIES, A. Schanschieff, London.
5203. PORTABLE HOUSES, C. E. Few, London.
5204. MAKING PLATES, &c., W. Boulton, London.
5205. COUPLING RAILWAY CARRIAGES, T. A. Brockelbank, London.

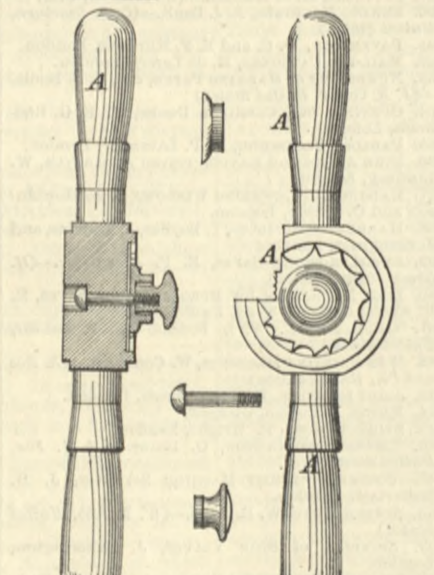
SELECTED AMERICAN PATENTS.

(From the United States' Patent Office Official Gazette.)

313,617. TOOL FOR MAKING BEADINGS OR MOULDINGS, *Lawrence V. Poole and Orlando E. Williams, Windsor, Vt.—Filed November 28th*, 1884.

Claim.—(1) In a hand beader, the tool stock perforated centrally for a screw clamp, having the tool seat around said perforation, and provided with an angular recess A^1, the latter arranged in a plane at

313,617

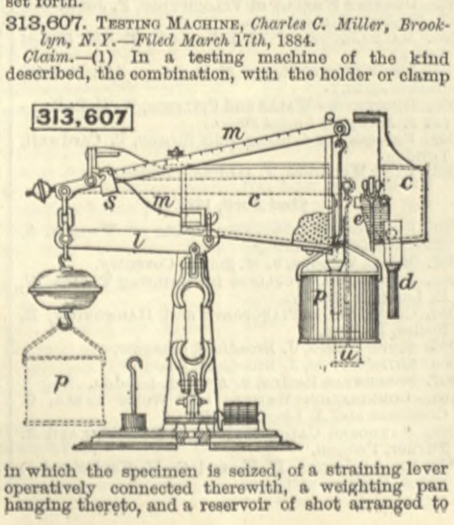


right angles to the plane of the seat, as shown, and for the purpose described. (2) A hand beader having two diametrically opposite handles, an intermediate centrally perforated stock provided with recess A^1, and a suitable screw clamp, the tool seat being arranged around said perforation, as shown, and for the purpose set forth.

313,607. TESTING MACHINE, *Charles C. Miller, Brooklyn, N.Y.—Filed March 17th*, 1884.

Claim.—(1) In a testing machine of the kind described, the combination, with the holder or clamp

313,607

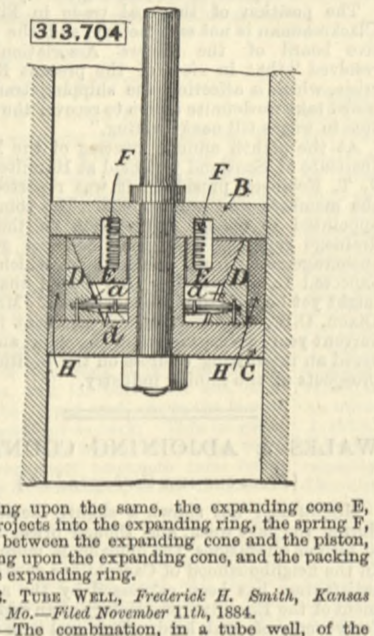


in which the specimen is seized, of a straining lever operatively connected therewith, a weighting pan hanging thereto, and a reservoir of shot arranged to deliver into the pan, with means for shutting off the flow of shot on the breakage of the specimen and falling of the pan, the said pan being changeable from one end of the lever system to the other, and the said lever being graduated and provided with a sliding poise, whereby the strain exerted at the breakage of the specimen may be subsequently weighed through the same mechanism employed to apply the strain, substantially as herein set forth. (2) In a testing machine, the combination, with suitable clamps in which the specimen is held, of the combined weighing and straining lever *m*, graduated and provided with a sliding poise, and operatively connected at one end with the specimen clamp, with the changeable weight pan *p*, adapted to be hung on either end of the lever, the counterbalance *u*, adapted to be hung on the long end of the lever in place of the weight pan, and a reservoir of mobile weighting material arranged to discharge into the said pan, substantially as and for the purpose set forth. (3) The combination, in a testing machine of the character described, with clamps holding the specimen, and with the reservoir *c*, spout *d*, and valve *e*, of the lever *l*, connected with the clamp, and the graduated lever *m*, coupled to the lever *l*, the poise *s*, reversible weight pan *p*, and counterbalance *u*, arranged and operating substantially as and for the purpose set forth.

313,704. PISTON PACKING, *Thomas Barber, Flatbush, N.Y.—Filed October 30th*, 1884.

Claim.—The combination, substantially as hereinbefore described, with the piston B and the follower C, of the expanding ring D, composed of a number of wedge-shaped sections *a*, the spring *d*, inclosed thereby

313,704

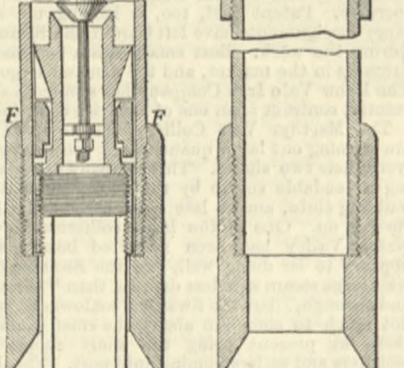


and acting upon the same, the expanding cone E, which projects into the expanding ring, the spring F, situated between the expanding cone and the piston, and acting upon the expanding cone, and the packing H on the expanding ring.

313,893. TUBE WELL, *Frederick H. Smith, Kansas City, Mo.—Filed November 11th*, 1884.

Claim.—The combination, in a tube well, of the pump cylinder, the check tube provided with a smooth surfaced cone near its upper end, the packing

313,893

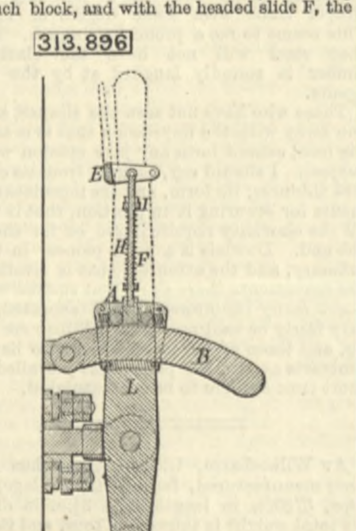


ring having a flaring inner surface encircling the cone, and the ring F, upon the upper edge of which the said cone rests when the check tube is in place, substantially as specified.

313,896. THROTTLE VALVE LEVER, *Allison M. Stickney, Watertown, Mass.—Filed May 26th*, 1884.

Claim.—(1) The combination of the block A, fixed to the throttle lever L, and chambered and provided with springs and rollers, and inclined planes arranged in the chamber, substantially as set forth, with the said throttle lever L and the curved arm B, extending through such block, and with the headed slide F, the

313,896

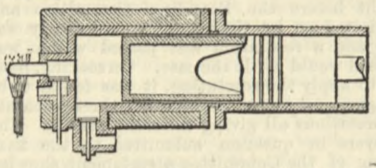


auxiliary lever E, and the spring H, arranged with and applied to the said block A and lever L, all being as and to operate essentially as described. (2) The combination of the adjustable collar I, provided with a set screw and arranged on the slide F, as described, with such slide and its guide and operative spring, and with the block A, adapted to the throttle lever L and the curved arm B, and chambered and provided with rollers, springs, and inclined planes, as set forth, all being to operate essentially in manner and for the purpose or purposes as represented.

313,922. GAS ENGINE, *Gottlieb Daimler, Cannstadt, Würtemberg, Germany.—Filed March 25th*, 1884.

Claim.—(1) In a gas motor, the combination, with an exteriorly-insulated cylindrical gas chamber fitted with a supply and an exhaust port controlled by valves, and an igniting chamber, of a piston having

313,922

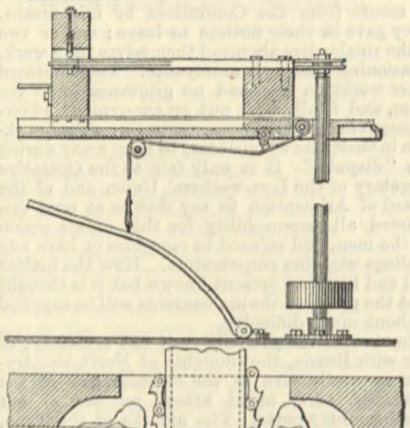


its end projecting into the igniting chamber interiorly insulated and working within said chamber to draw in the gas and to compress the same to its point of ignition by the walls of the igniting chamber and to receive the force of the explosion of the gases, substantially as described.

313,924. CHAIN MORTISING MACHINE, *Taylor E. Daniels, Chicago, Ill.—Filed January 28th*, 1884.

Claim.—In a chain mortising machine, the combination, with the supporting frame, endless chain cutter mounted upon a bar, mechanism for driving the chain

313,924



cutter, and support for the object to be mortised, of guides bearing against the sides and edges of the chain carrying bar, whereby the chain cutter is prevented from deviating from a straight line, substantially as described.

314,056. CORD HOLDER FOR GRAIN BINDERS, *Noah T. Remy, Milton, Ind.—Filed October 22nd*, 1883.

Claim.—(1) In a cord holder for grain binders, the combination of the rotary disc with the shoe having flanges to embrace the edge of the disc, the flange on the side of the disc away from the knotter being cut

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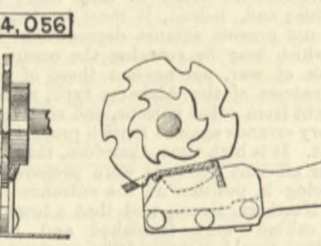

away at its rear end, substantially as described. (2) In a cord holder for grain binders, the combination of the notched rotary disc with the grooved or flanged shoe, the flanges of which straddle or embrace the edge of the disc, and the flange on the side of the disc away from the knotter cut away at its rear end, substantially as described.

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