THE ENLARGEMENT OF LIVERPOOL-STREET STATION, GREAT EASTERN RAILWAY.

No II.

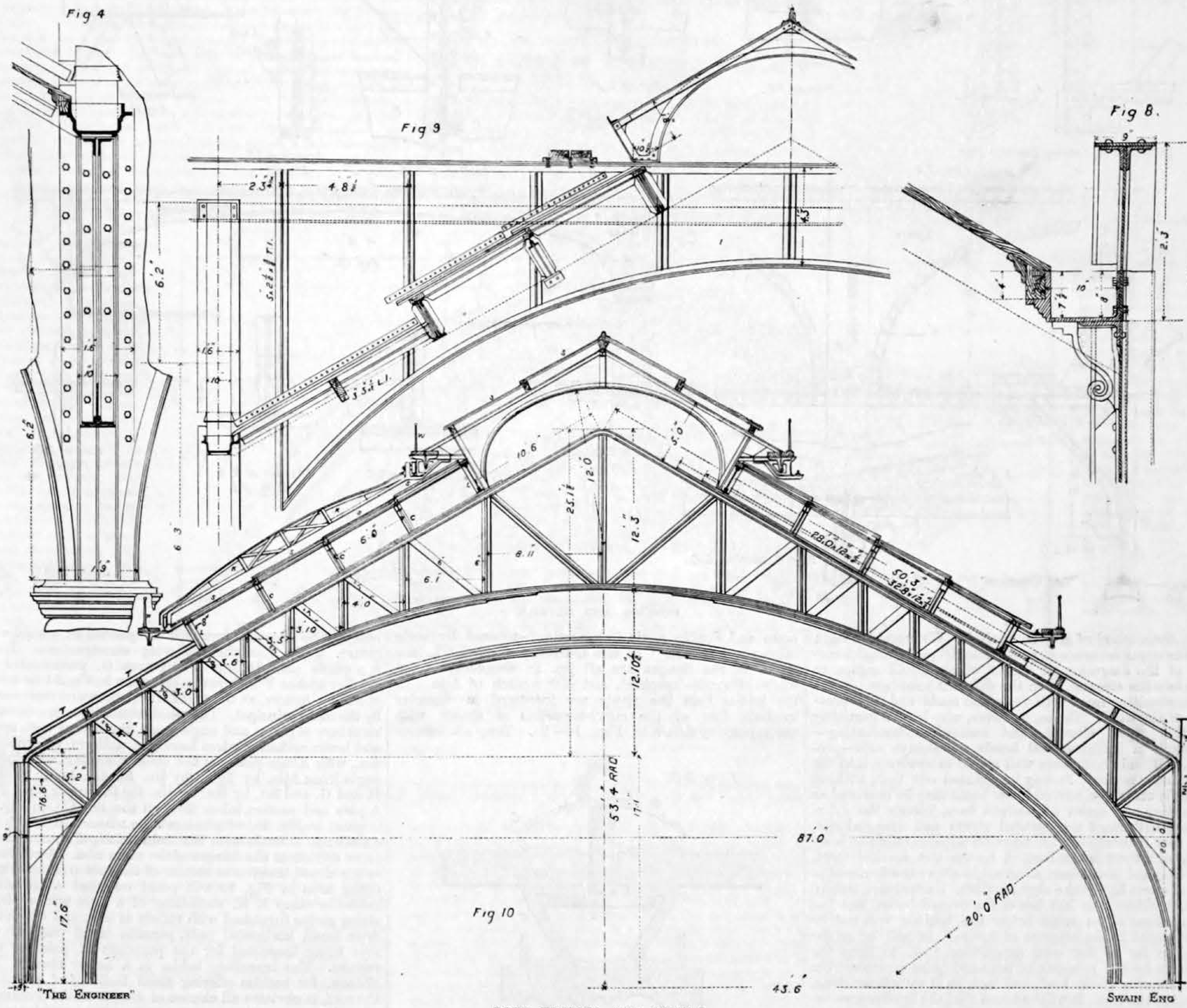
IN our last number we alluded briefly to the origin, incorporation, and subsequent progress of the Great Eastern Railway, and in the Key Plan published therein will be found an accurate representation of the general features of the whole site. Within its extensive area is included both the part of the terminus first constructed, and recently the new enlargement. But as we have already drawn attention to the former sufficiently to indicate the manner in which it is inseparably connected with the latter, it is with the extension we are now more immediately concerned, and shall proceed to describe and illustrate.

The new part, or widening of the station.—The principal works comprised under this heading consist of additional station offices, and buildings, the erection of new roofs, extra platforms, and eight tracks, together with the necessary accompanying traffic accommodation and facilities. A new Parcels' Office has also been built entirely over the eight tracks, and connected with the first part of the station by the "Passage Gallery" shown on the Key plan. These offices are built upon massive wrought iron plate girders, to the details of which we shall draw the attention of our readers when the drawings are published. The whole extension, estimated lineally, commences opposite New-street, near the junction of Liverpool and Bishopsgate-streets, and terminates at Worship-street in Norton Folgate, a total distance of 1700ft., of which 700ft. constitute a first storey façade in Bishopsgate-street. The electric light installation, including engine, boiler-house, and shaft, are situated on the far or northern side of Worship-street. There are three heavy wrought iron bridges—as all bridges must now be that are intended to carry metropolitan traffic—over Skinner, Primrose, and Worship-streets, which we shall describe and illustrate. It will be seen on referring to the Key plan, that the widening has been arranged on the second of the methods alluded to, and that the offices and station buildings are placed on an upper storey at the dead end of the eight new tracks. Access is gained to them by the stairs and foot-bridge shown on the Key plan. On the lower floor at the level of the platforms the bookstalls are placed, and the descent to the lavatories, which are all placed underground, as is becoming now the universal practice elsewhere. The whole of this space, marked C A on the key plan, has an area of 15,000 square feet. It is known as the Circulating Area, and is common to nearly all stations laid out on the same principle. Cranes, lifts, and all other necessary machinery and mechanical appliances are distributed throughout the station wherever required, and are all worked by hydraulic power.

As soon as it was perceived that the first part of the terminus in spite of its magnitude, and including an area of some nine and a-half acres, was certain to be inadequate for future traffic, the company commenced to acquire, as occasions presented themselves, land and property in the vicinity. In 1888 an Act was obtained conferring the usual powers of compulsory purchase, by the exercise of which the whole block fronting Bishopsgate-street Without was made available for the new site. Notwithstanding that the expenditure already incurred for the terminus had amounted to over £2,000,000, the consent of the shareholders was readily given to the raising of the additional funds for the extension, and the work of widening commenced in 1890. The result is that the Great Eastern Company now possesses a metropolitan terminal station peculiarly its own, and unequalled for size, position, and extent of local and suburban traffic by any of its compeers.

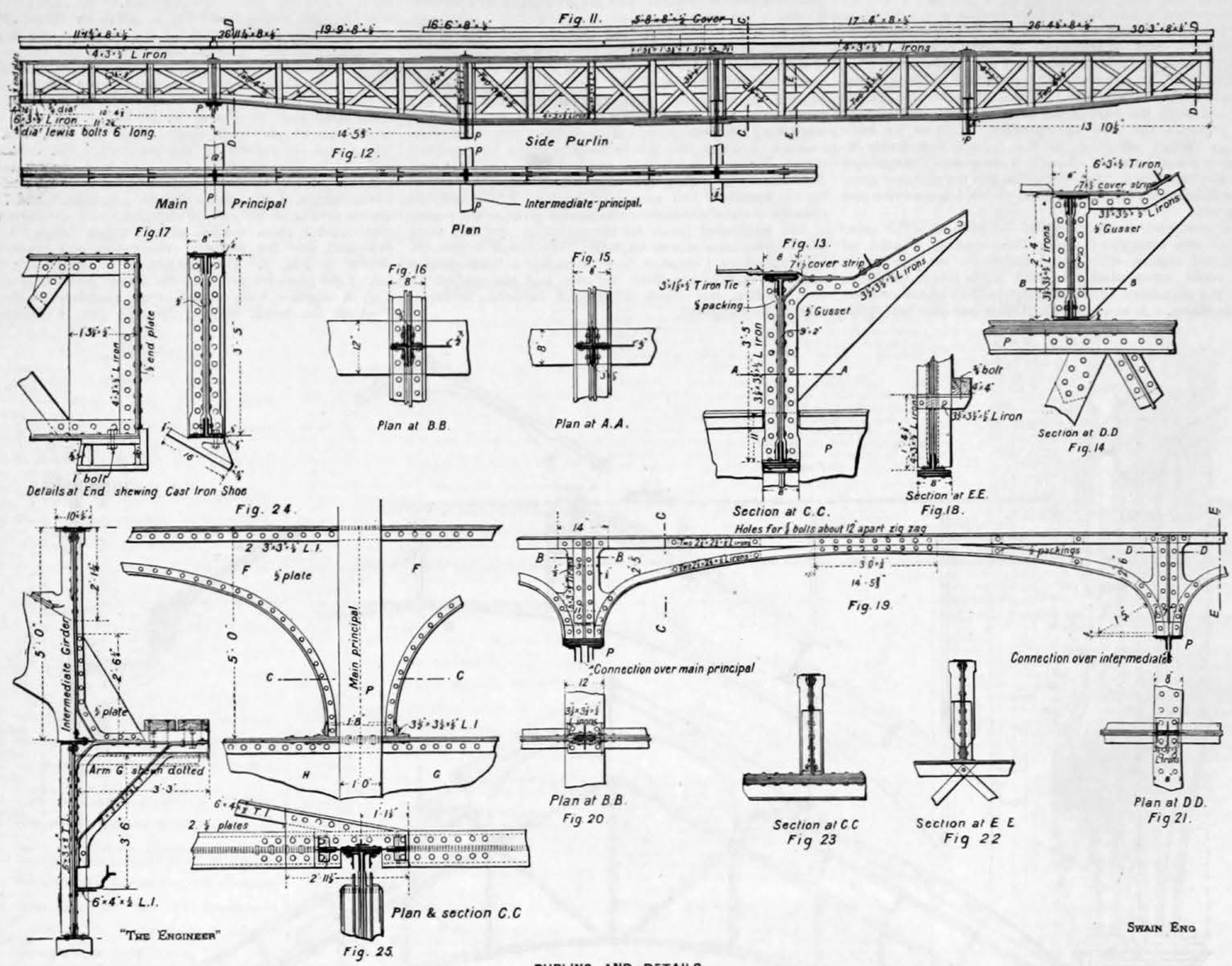
Roof of the new station.—This roof, which is similar to its neighbours, is of wrought iron, extends from the booking hall in the Key plan to the Parcels Office, and is divided into two principal parts, the first or transverse portion of which covers, with a span of 87ft., the Circulating Area C A, and is placed at right angles to the second, constituting the longitudinal or platform bays, which are thirteen in number, and carried on cast iron columns 30ft. apart from centre to centre. From the intermediate wall to that on the other side, which separates the offices and shops fronting Bishopsgate-street from the station, the length from out to out is 188ft. There is an extension of this part of the roof on the far or north side of the Parcels Office. In Fig. 1, p. 524, is represented a longitudinal section of the roof over the Circulating Area looking north, or down the tracks, and Fig. 2 shows a similar view looking in the opposite direction, or facing the booking hall. Fig. 3 is a cross section of the same roof, including its junction with the bays of the platform roof. In Fig. 1 is shown the arched screen girders, S S S, carried upon cast iron columns 1ft. 6in. in diameter, which although consisting of spans of different dimensions, have a uniform rise of 15ft. 9in. from the springings to the soffits, a height from the springings to the ridge of 20ft., and a depth at the crown itself of 4ft. 3in. The arch of the east bay is struck from a central radius of 36ft. 4in., and from two side ones each of 12ft.; that of the west bay has similar dimensions of 33ft. 3in. and 12ft., and that of the two central spans 23ft. 3in. and 12ft. 3in. Both the lower curved and the upper horizontal flanges of the wrought iron screen girders are composed of a pair of angle irons 3½in. by 3½in. by ½in., and a plate 9in. by ½in., and the web is of ½in. plate throughout—Fig. 7. All rivets, unless otherwise specified, have a pitch of 4in. in these girders and a diameter of ¾in. The manner in which the junction of the principals and the girders, with the gutters, stiffening-plates, and angle irons, is arranged over the columns is shown in Fig. 4, which is an elevation of a part of the main principals or ribs at T, in Fig. 1. A cast iron down-pipe of an oval shape, 10in. by 4in., and of ⅝in. metal, is carried in the interior of the columns, and Fig. 5 shows a section of it, a plan of the capital of the column, and the cross section of the main rib and the lower flanges of the screen girders. In Figs. 6 and 7 are shown details of the end of the girders in elevation and plan, and a cross section of the upper flange of the principal, and the fixing of the gutter and bracket is shown in Fig. 8. The junction of a part of the first bay of the platform roof with the screen girder is given in Fig. 9, together with a part of the ventilator or louvre. Vertical tee-irons, 5in. by 2½in. by ⅜in. in thickness, placed 4ft. 8½in. from centres, serve to stiffen the web of the screen girder, and at the same time to strengthen the connections.

Main ribs.—In the roof over the Circulating Area there are four principal or main ribs, marked P P in Figs. 1 and 2, and shown in elevation in Figs. 3 and 10, and ten smaller or intermediate ribs *p p p*. These main ribs are of the trussed form shown in detail in Fig. 10, with a lower curved boom struck from a central radius of 53ft. 4in., sharpened to 20ft. near the springings, which are thus caused to meet tangentially the vertical axis of the supporting columns. The corner or re-entering angle made by the lower arched boom with the centre of the screen girder at one end, and the upright at the other—in Fig. 10—is strengthened by the riveting up of an additional piece of plate iron 1in. in thickness. Both booms are composed of a pair of angle irons 5in. by 5in. by ½in., another pair 4in. by 3in. by ½in., and two wrought iron plates 12in. by ½in. At the haunching, this section—see Fig. 10—which also gives a diagram of the plates of the curved boom, is increased by an additional couple of plates 12in. by ½in. The depth of the truss is 12ft. 3in., and the web consists of vertical tee iron struts, spaced at different intervals and connected with flat diagonal bars varying in width from 6in. to 9in. according to their position and the resultant stresses induced on them. A roof truss of the form represented in Fig. 10, in which there are no redundant members, will furnish to the student and young engineer a very favourable example for the determination of the stresses upon



ROOF TRUSSES AND DETAILS

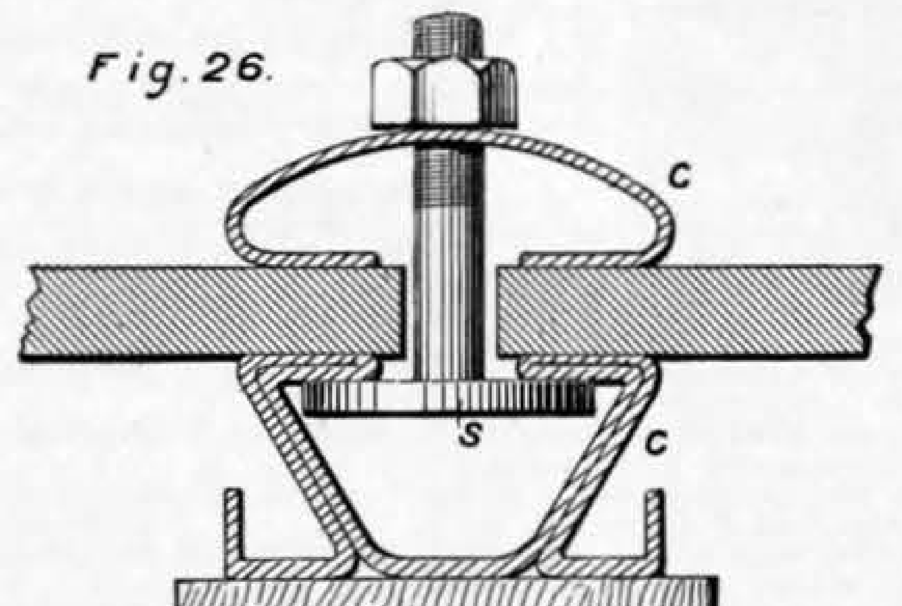
THE ENLARGEMENT OF LIVERPOOL STREET STATION



PURLINS AND DETAILS

it, by the method of graphic analysis. We regret we have not the requisite space at present to devote to the delineation of the diagrams of forces which would suffice to ascertain the stresses upon the different members of the truss, resulting from both the static loads and the pressure of the wind. Those, however, who have a partiality for this rapid, elegant, and somewhat fascinating—although in inexperienced hands not always safe—process, will find themselves well repaid in applying it to the case under notice. It may be pointed out that, without sensible error, the curved lower boom may be regarded as consisting of a series of straight bars, joining the intersection with it, of the vertical struts and diagonal ties, and that theoretically the truss terminates over the bearings, with the triangle formed by the last vertical strut, the diagonal tie inclined at an angle above the horizontal, and the last bay of the sloping rafter. Under this assumption, therefore, the last bar of the curved boom and the bar inclined at an angle below the horizon will not be represented in the diagram of forces. It will be advisable, so far as our own experience goes, to keep the diagram for the pressure of the wind quite separate from that for the static load, and not, as is sometimes done, combine the two. It will be found that the lines representing the central vertical strut will close the polygon of forces if correctly drawn.

Purlins. — There are two distinct descriptions of purlins carried by the principals of the roof of the Circulating Area, the side or lantern purlins L L L in Figs. 1, 2, 3, and 10, and the curved specimens C C C C. Of the former there is an upper and lower tier, and of the latter three tiers placed between the others. One of the longest of the side purlins is shown in elevation in Fig. 11, and partly in plan in Fig. 12. They are lattice girders, and are continuous over both the principal and intermediate girders P and *p*, and have a depth of 2ft. 5in. where they meet the mainribs, and of 3ft. 6in. at their intersection with the smaller ribs. Both flanges consist of two horizontal angle irons 4in. by 3in. by ½in., and three plates each 8in. by ½in., two of which are dropped at the ends D D, as shown in the diagram of the plates of the upper booms in Fig. 11. Angle iron uprights 4in. by 3in. by ½in., and double diagonal struts of bar iron 3½in. by ½in., crossed by single tie bars of the same scantling, compose the members of the web. Timber stringers 4in. by 4in. are bolted to angle irons as shown in Fig. 11, and in detail in Fig. 18. The manner in which the side or lantern purlins are riveted to the intermediate, and the principal main ribs of the roof by gusset pieces ½in. thick and double angle irons 3½in. by 3½in. by ½in., is shown in elevation and section —Figs. 13 and 14, and in plan in Figs. 15 and 16. At the ends the purlins rest upon a cast iron shoe of ⅞in. metal, to which they are secured by a ⅞in. bolt seen in Fig. 17, elevation and section. The intermediate principals are of the solid or plate web form, with flanges 8in. broad of the usual plate and double angle iron section, stiffened by angle irons at intervals. In the trussed purlins L L L, the rivets in the flanges are all ⅞in. in diameter, except where otherwise specified, and with a pitch of 3½in. In the lattice bars the rivets are increased in diameter to 1in. One of the curved purlins is shown with accompanying details in Figs. 19—23. They are formed



DETAIL OF GLAZING

with one curved and one horizontal flange, each 2½in. by 2½in. by ½in., and are stiffened by strong gusset plates and double tee irons 6in. by 3in. by ½in. at the junctions over the main and intermediate ribs respectively. The depth varies from 5in. at the centre to 2ft. 6in. at the springings, and they are bolted together at the centre, but the haunchings are open.

Arch girder over cab approach.—In Fig. 2, p. 524, the entrance to the cab approach is spanned by a solid arch girder, which has the following construction. There is a whole arch H and a half arch G, surmounted by smaller arches F F shown in elevation in Fig. 24 by corresponding letters, at the point where they are intersected by the main principal. The whole constitutes one built-up structure of plates and angle irons, the web of both upper and lower arched girders having a uniform thickness of ½in., with flange-plates of the same scantling, and double angle irons 3½in. by 3½in. by ½in. for the lower girders H and G, and 3in. by 3in. by ½in. for the upper ones F F. A plan and section taken through the line C C in Fig. 24 is given in Fig. 25, which shows the manner in which the connection is made with the main principal P, and also a cross section of the flanges of the main ribs. A reference to the detail transverse section of the roof over the circulating area in Fig. 10 will point out that a travelling ladder or ramp K K, consisting of a light trussed bowstring girder furnished with rollers at each end which run upon small horizontal rails, permits of all parts of the roof being inspected for the purposes of painting and repairs. The travelling ladder is a happy idea of Mr. Wilson, for besides offering great facilities of access to the roof, it obviates all chance of danger to the workmen, who have sometimes met with fatal accidents in endeavouring to maintain their footing on the curved or sloping surface of lofty roofs. Gangways, W W W, with protecting railings, are also attached to the principals. The method adopted for glazing the roof, in the execution of which no putty is employed, is that known as Rendle's patent invincible glazing, and is similar to that previously used in the first part of the roof of the present terminus. The glass, Fig. 26, is gripped between copper strips bent as shown, which can be tightened up as required by the screw S and the small plate or washer attached to it.

THE TORPEDO DESTROYER HORNET.

ON Saturday last Mr. Yarrow entertained a large number of guests on board the just-completed torpedo destroyer Hornet, while she made a short cruise in the estuary of the Thames. As the proceedings were entirely unofficial, and partook more of the nature of a private view, nothing was done to eclipse the vessel's previous performance when undergoing her official trials on the 19th March, which were duly reported in our impression of the 23rd of that month. The stokehold hatches were open for the greater part of the time, and when closed the pressure did not exceed half an inch. Her speed, consequently, did not exceed 23 knots, the engines turning at 320 revolutions per minute. As our descriptions of this vessel have hitherto been brief, the following details may not be out of place.

H.M.S. Hornet is the second torpedo boat destroyer as yet completed for the British Admiralty. As regards size and general arrangement she is similar to the Havock, the only difference of any importance being the adoption in the Hornet of Yarrow's patent water-tube boilers, the Havock having been provided with boilers of the locomotive type. The introduction of water-tube boilers has given the Hornet an additional speed of over a knot an hour as compared with her sister boat, the speed of the Havock being in round numbers 26½ knots per hour, and that of the Hornet 27¾ knots per hour.

The general particulars of the Hornet are as follows:—Length, 180ft.; breadth, at water line, 18ft. 6in. The hull is built throughout of mild steel, and is divided by ten water-tight bulkheads into eleven compartments, the utilisation of which from forward to aft is as follows:—Quite forward, chain locker and bow torpedo tube; then a forecastle with berths, &c., for the crew; at the after end of these and terminating the turtle deck is the conning tower, containing the forward steering wheel; next to this is a large cabin with berths, to accommodate the petty officers, and below are the magazines. The next compartment is a smaller one, being devoted to cooking and stowage of stores. We now come to two large water-tight compartments, each containing four Yarrow water-tube boilers, which supply steam at 180 lb., or more, developing, with remarkable ease, 4000-horse power, yet the total weight of these eight boilers with water is less by 11 tons than that of the two locomotive boilers in the Havock, which only indicated, when pressed, 3600-horse power. In each boiler compartment is a powerful over-head fan and fan engine for forced draught, working on the closed stokehold system. On each side of the boilers are the coal bunkers, containing about 55 tons of coal. The next compartment contains the main engines, consisting of two sets of inverted triple-expansion engines, with their condensing apparatus. These engines are carefully balanced, so that although running at times 400 revolutions per minute, no vertical vibration is apparent at any speed. This immunity from vibration is an undoubted advance in naval construction, as the health and comfort of the crew are in a great measure dependent upon it, it having been found that the vibration so common up till now in vessels of light construction and abnormal power seriously affects the health and energy of the crew. In the engine compartment is also found the steam steering engine, air-compressing engine for charging torpedoes, dynamo and engine for electric light, and distilling apparatus for making feed-water for the boilers and for drinking purposes. Next to the engine-room are two cabins for the engine-room artificers, and aft of this are the quarters for the officers, consisting of a large mess-room, sleeping cabin, and pantry. Quite aft is fitted up as a bread and store room. The total number of officers and men for whom there is accommodation is forty-three.

The armament consists of a 12-pounder quick-firing gun, mounted on the conning tower forward, having an all-round fire, which from its elevated position would no doubt be most effective; two 6-pounder quick-firing guns abaft the conning tower, one each side, having a range from direct ahead to well aft of the beam; also one 6-pounder quick-firing gun on a pedestal aft. The torpedo armament consists of a bow torpedo tube under the forward turtle deck, and two swivel torpedo tubes on a turntable aft. The vessel is steered by steam, either by the steering wheel inside the conning tower forward, or by a secondary steering wheel placed on deck aft.

The speed of the Hornet was recently tested on the official trial by a continuous run of three hours' duration, in the presence of the Admiralty authorities, at the mouth of the Thames, when the mean speed was found to be 27·628 knots per hour, carrying a load of 30 tons, which magnificent result is in a great measure due to the efficiency of the Yarrow boiler. It may be interesting to note that from 130 to 140-horse power can be obtained per ton weight of boiler, including water and all fittings.

A coal consumption trial of eight hours' duration showed that these destroyers can steam at a ten-knot speed on a consumption of 3½ cwt. per hour. They, therefore, have the means of running a distance of from 3000 to 3400 knots without requiring a fresh supply of fuel. In addition to that contained in the bunkers, an extra quantity could easily be taken in the stokeholds and on deck, sufficient under exceptional conditions, to enable this little vessel to steam from 4000 to 4500 miles. We may here remark that competitive experiments show that in point of economy of fuel at the same speed the water-tube boilers of the Hornet and the locomotive boilers of the Havock are practically on a par.

Since the successful trial of the Havock the Admiralty authorities have been so much impressed with the success and utility of vessels of this class, that they have already ordered throughout the country no less than forty-two similar vessels, making good a well recognised want for an increase in our torpedo flotilla; and great credit is due to the authorities at Whitehall for the energetic action they have taken in the matter, and we have the satisfaction of knowing that shortly, as regards this class of vessel, we shall be far ahead of any other nation.

The Hornet proceeded as far as the Mouse Lightship on Saturday, where she turned, and on her way home did some circle turning, which was very interesting to the guests, among whom were Lord Charles Beresford, Sir Edward Reed, Sir Edward Harland, the Astronomer Royal, and representatives from many of the leading shipbuilding firms. The water-tube boilers have been fully described in our pages.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT CAMBRIDGE.

THE engraving given below shows the arrangement of the show ground of the Royal Agricultural Society, at Cambridge, for the meeting which opens on the 23rd inst. The show ground and the shedding for machinery occupy a larger space than at any previous meeting since Kilburn. Of ordinary shedding, in the implement yard there will be 8435ft., for machinery in motion 2539ft.; for special shedding, 2428ft.; the total number of feet of shedding being thus 13,402, comprising 442 separate stands. Last year at Chester the total number of feet of shedding was 13,018, and the number of stands 408.

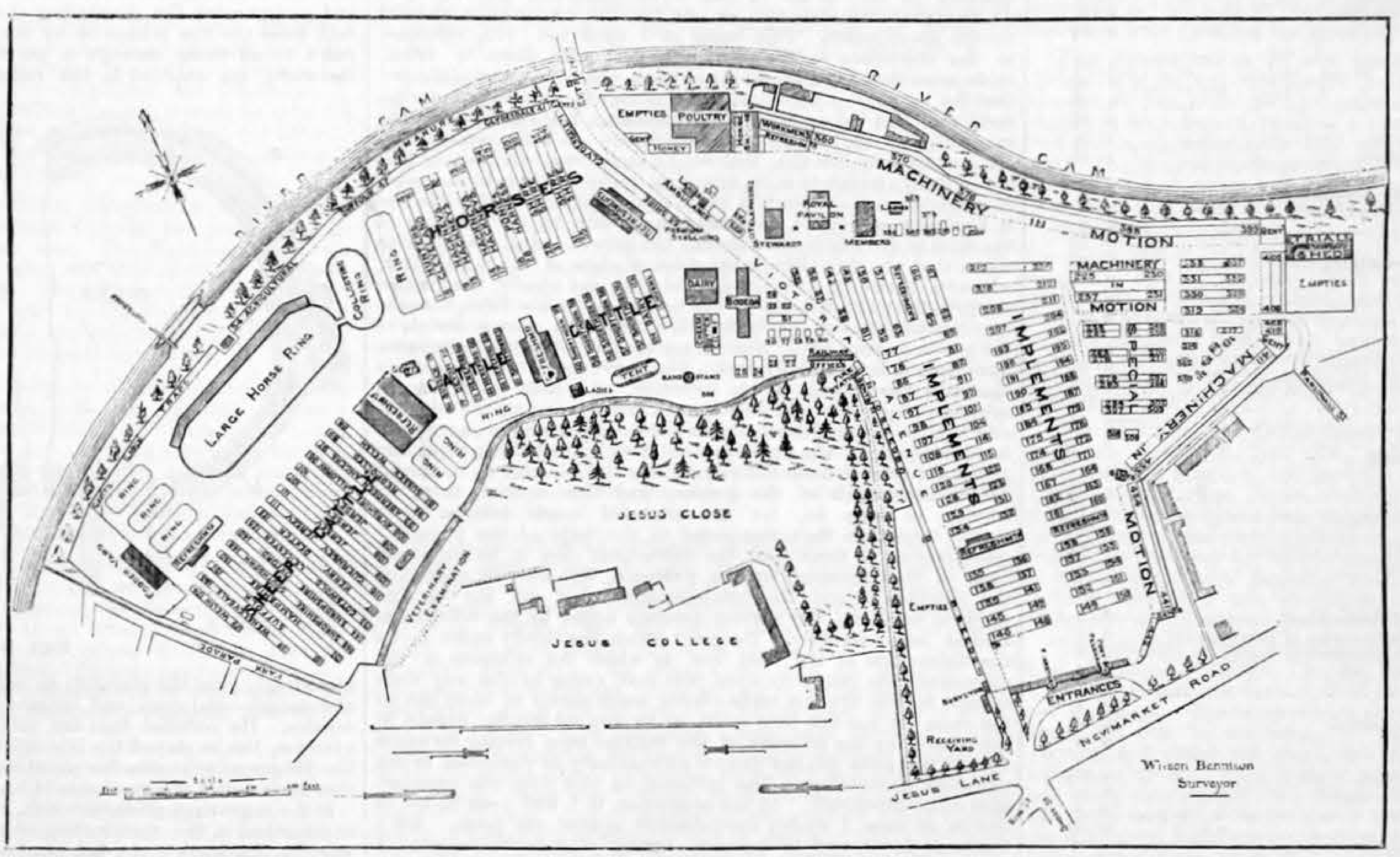
We may here add that the trials of oil engines will commence on the 18th inst., and that there will also be trials of machines for distributing Bouillie Bordelaise and other mixtures on potatoes, machines for distributing insecticides on fruit trees, churns capable of dealing with ten quarts of cream and upwards, not to exceed one-man power, and churns capable of dealing with five to ten quarts of cream.

In connection with the Darlington meeting of 1895, the following prizes are offered by the Society:—Class 1.—For the best hay-making machines, first prize, £20; second prize, £10. Class 2.—For the best clover-making machines, first prize, £20; second prize, £10.

SPEED TRIALS OF THE CHILIAN CRUISER BLANCO ENCALADA.

IN our issue of June 1st we gave an account of the gunnery trials of the cruiser Blanco Encalada, constructed by Sir W. G. Armstrong, Mitchell and Co. for the Chilian Government. We are now able to give particulars of the speed trials which have since been most successfully completed.

The principal dimensions of the vessel are as follows;—Length, 370ft.; breadth, 46ft. 6in.; mean draught, 18ft. 6in., with a displacement of 4500 tons. She is built entirely of steel, and is sheathed with wood and coppered. A steel protective deck runs throughout her whole length, varying in thickness from 4in. on the sloping sides to 1½in. on the flat parts. The propelling machinery, which has been constructed by Messrs. Humphrys, Tennant and Co., of Deptford, consists of two complete sets of twin-screw triple expansion engines. The trial under natural draught was the first taken, and was continued for twelve consecutive hours, the resultant mean of six consecutive runs over the measured mile (near the mouth of the Tyne) with and against the tide, giving a speed of 21·75 knots, with an indicated horse-power of about 11,000. The forced draught trials were successfully completed on a subseqent day, the mean speed attained on the mile with and against the tide being 22·78 knots, or a quarter of a knot in excess of that guaranteed by the contractors, the horse-power realised during the runs being about 14,500 indicated. The final trials, including the testing of the anchor-gear and other auxiliary, were completed on Tuesday last. The manœuvring qualities of the ship were thoroughly tested, and it was found that she could turn through 360 deg. at full speed in 3 min. 47 sec., the diameter of the circle being 405 yards, or little more than three times her length. The steam trials took place under the superintendence of the Chilian Commission consisting of the same officers as were present at the gunnery trials, and they expressed their satisfaction at the excellent results obtained.



THE ROYAL AGRICULTURAL SOCIETY'S SHOW YARD, CAMBRIDGE

THE MANCHESTER ASSOCIATION OF ENGINEERS.—At the half-yearly meeting on Saturday, the president—Mr. Thomas Daniels—intimated that he had attended the Royal opening of the Manchester Ship Canal as the representative of that Association, which included amongst its members several well-known engineers, whose names are inseparably associated with the great undertaking, and who had rendered invaluable service in the completion of the canal, and the members would regard with gratification the honour which had been conferred upon the Mayor of Salford, Sir William H. Bailey, a life-honorary member of the Association; who had been connected with it since 1870, and had for two years—1885-7—filled the office of president. He—Mr. Daniels—had therefore great pleasure in moving that a vote of congratulation be sent from that Association to their esteemed life-honorary member, Sir Wm. H. Bailey, Mayor of Salford. Mr. Walthew, in seconding the proposal, said he was sure the members of the Association would recognise that the distinction conferred upon Sir Wm. Bailey was a thoroughly well-merited honour, and his connection with their Association—of which he had so long been an honoured member—was a source of gratification to them. The motion was then put to the meeting and carried with acclamation.

FOUR-COUPLED BOGIE TANK ENGINE.

THIS type of engine has been designed by Mr. W. Adams, locomotive superintendent of the London and South-Western Railway, and built at the company's works at Nine Elms, and is intended for working the lighter suburban and branch traffic of the railway. As will be seen from our supplement, the engine has the leading and driving wheels coupled, 4ft. 10in. in diameter, whilst the back of the engine is carried on a four-wheeled bogie of the "Adams" type, having wheels 3ft. in diameter. The cylinders are 17½in. in diameter, with a stroke of 24in. The tractive force developed is accordingly $\frac{17\frac{1}{2}^2 \times 24}{58} = 126·7$ lb. for every pound of mean effective pressure on the pistons. The cut-off varies from 77 per cent. in full gear to 28 per cent. under usual running conditions.

The boiler pressure is 160 lb. per square inch, hence the total tractive effort available is about 17,000 lb. at starting, and 11,000 lb. under ordinary running conditions. The total weight on the coupled wheels, with the engine in working order, is very nearly 30 tons, which, with a coefficient of adhesion of one fourth, is sufficient to prevent slipping. The boiler is constructed of steel plates with butt joints, the top of the fire-box casing being flush with the barrel. The mild steel plates are specified to be free from silicon, sulphur, and phosphorus, and to have a tensile strength of not less than 25 tons, and not more than 30 tons per square inch, with an elongation of at least 23 per cent. in 10in. The longitudinal joints have inner and outer cover strips, with zig-zag double riveting. The transverse joints are made with an external weldless ring, double riveted to the barrel, the ring being turned to gauge and shrunk on the barrel. The joint between the smoke-box and the barrel is also made in a similar way with a weldless angle ring. The rivets, ⅞in. in diameter, are of the best Yorkshire iron, closed by hydraulic pressure. They are pitched at 1⅞in. The fire-box is of copper, and contains a fire-brick arch. It is connected to the outer casing by copper stays 1in. in diameter, twelve threads per inch, pitched at intervals of 3⅞in. The roof is stayed by eight cast steel girder stays, the four centre ones being slung from the casing. The tube plate, which is ⅞in. thick at the tubes, is stayed to the barrel by six palm stays. The foundation and fire-hole rings are of wrought iron, and the fire-bars are of cast iron. The regulator is of cast iron, 4½in. diameter, with a main slide valve of brass and an easing valve of cast iron. The dome is of ½in. boiler plate, butt jointed, with inner and outer strips single riveted. It is flanged to fit the barrel, and double riveted to it with a ½in. strengthening plate. The boiler is fitted with a Ramsbottom duplex safety valve.

The frames are of steel, of boiler plate quality, 1in. thick. They are connected under the cab by a strong steel casting to carry the bogie centre pin, and transmit the weight to the bogie, the frames of which are of steel, 1in. thick, and stayed together by a strong steel casting, which forms a slide to give transverse play to the centre pin, this being controlled by laminated plate springs. All the wheel centres are of cast steel. One casting in forty is tested to destruction by dropping weights in order to determine its breaking strength. The tires are of steel, supplied by Vickers and Co., of Sheffield, and are 3in. thick on the tread. They are secured to the wheels with a lip and 1¼in. set screws. The axles are of steel, and are specified to have a tensile strength of not less than 32 tons per square inch, with an elongation of not less than 25 per cent. in 2in.

The cylinders are of the twin type, being one casting, and special arrangements have been made for machining them. The steam ports are 1⅜in. wide and 14in. long; the exhaust ports are 3½in. wide, and the bars between the ports 1in. wide. The slide valves are of Stone's bronze, with recesses on the working faces. The pistons are of cast iron, with two cast iron rings each, each ring being ⅝in. wide and ½in. thick. The piston-rods are forged from the best cast steel with a breaking strength of 30 tons per square inch. They are packed with "United States" metallic packing. The slide bars, one to each cylinder, are of wrought iron case-hardened, and 6in. wide by 3in. deep. The crossheads are of cast steel, with cast iron caps and rubbing pieces. The cap is secured to the main casting by ⅞in. bolts, a liner being introduced to permit adjustment for wear. The valve motion is of the curved link type, and made of best Yorkshire iron, the working parts being case-hardened. The links are hung from their centres, and connected at their extremities to the excentric rods. The excentric pulleys are in two parts, and are made of cylinder metal. They are fastened to the crank axle by keys and set screws. The straps are of cast iron.

The engine is reversed by a lever and sector on the right-hand side of the engine. The reversing shaft is of Yorkshire iron, the levers being forged solid with the shaft. All working parts of the shaft are case-hardened. The connecting-rods are of Yorkshire iron, and measure 5ft. 5in. between centres. The big ends are fitted with straps and adjustable brasses. The small ends are fitted with plain gun-metal bushes forced in by hydraulic pressure. The coupling rods are of Yorkshire iron forged solid and milled to an H section, and fitted with gun-metal bushes with white metal strips. The crank pins are of Yorkshire iron case-hardened, and are forced into their places in the wheels by hydraulic pressure, and riveted over on the inside. The crank axle is of the very best cast steel forged solid. All four crank webs are hooped with steel bands, 3½in. by 1½in., shrunk on. All crank axles are supplied by Messrs. Vickers and Co.

The engines are fitted with the Adams vortex blast pipe, with a variable annular steam opening, regulated by a cap in the top of the blast pipe, which is raised or lowered by means of a small lever and sector in the cab. When the cap is raised the annulus is widened, the maximum opening having an area of 20·07 square inches, which is equivalent to a plain pipe of 5$\frac{1}{16}$in. in diameter. The minimum opening is 14·19 square inches, or equivalent to a plain pipe of 4¼in. in diameter, the increase in area being 41 per cent. This pipe has given economical results in working local traffic, facilitating the management of the fire in starting and when running. The lever is placed on the fireman's side of the cab. All working parts in the smoke-box are an easy fit, and are free from any tendency to seize. The vortex blast pipe is successful in softening and utilising the exhaust steam to obtain a good vacuum in the smoke-box, its effect being equally distributed over the tubes, the lower tubes being thus kept free and their efficiency unimpaired by becoming blocked up, as is the case when an ordinary pipe is used.

The engine is fitted with a steam brake worked in conjunction with the automatic vacuum brake on the train. Two No. 8 injectors—Dewrance's—are fixed one on each side of the engine. The tanks are made of best best Staffordshire iron, with ½in. rivets at about 1½in. pitch. They have a water capacity of 800 gallons. The coal bunker has a capacity of 80 cubic feet, being equivalent to nearly two tons of coal. Fifty of these engines have been constructed at the company's Nine Elms Works and are now running, giving great satisfaction and being remarkably free from defects in working.

The following are the principal dimensions of the engine:—

	ft.	in.
Cylinders—		
Diameter	1	5½
Stroke	2	0
Length of ports	1	2
Width of steam ports	0	1½
„ exhaust ports	0	3½
Centre to centre of cylinders	2	4
„ „ valve spindles	0	3¾
Centre line of cylinder to valve face	0	11½
Diameter of piston-rods	0	3¼
Motion—		
Lap of valves	0	0⅞
Lead „	0	0⅛
Maximum travel of valves	0	3¾
Throw of excentrics	0	5¼
Diameter of excentric sheaves	1	3½
Length of crosshead slide block	1	1¾
Wheels (cast steel)—		
Leading and driving wheels—diameter on tread	4	10
Bogie wheels—diameter on tread	3	0
Thickness of tires	0	3
Width of tires	0	5¼
Diameter of crank pins for coupling-rods	0	3¾
Length of bearing „ „ „	0	4$\frac{1}{16}$
Diameter of cranks	0	7
Length of cranks	0	4
Axles (steel): Bogie—		
Diameter of wheel seat	0	7
Length „ „	0	5⅞
Diameter of journals	0	5½
Length „	0	10
Diameter at centre	0	5¼
Centres of journals	3	7
Axles (steel): Leading and driving—		
Diameter of wheel seat	0	8½
Length „	0	6⅝
Diameter of journals	0	7
Length „	0	7½
Diameter at centre—leading	0	6¾
„ „ driving	0	7
Centres of journals	3	11½
Frames (steel)—		
From front end to centre of leading axle	5	6
From centre of leading axle to centre of driving axle	6	10
„ „ of driving axle to centre of bogie	11	0
„ „ of bogie to back end	4	3
Total length of frames	27	7
Thickness of frames	0	1
Total length of engine over buffers	30	8½
Width over platform	8	3
Boiler (steel)—		
Height of centre from rail	6	10½
Length of barrel	9	5
„ between tube plates	9	9
„ over all	14	5
Diameter of barrel (outside)	4	2
Thickness of plates	0	0½
„ smoke-box tube plate	0	0¾
Fi e-box casing (steel)—		
Length outside	5	0
Width outside at bottom	3	10½
Depth below centre line of boiler	4	9
Thickness of crown and side plates	0	0½
„ throat plate	0	0$\frac{9}{16}$
„ back plate	0	0$\frac{9}{16}$
Centres of stays (copper)	0	3⅝
Diameter „ „	0	1
Pitch of rivets	0	1¾
Diameter of rivets	0	0¾
Fire-box (copper)—		
Length at bottom (inside)	4	3⅞
„ top „	4	2$\frac{9}{16}$
Width at bottom (inside)	3	2⅛
„ top „	3	5½
Depth (inside)	5	5
Centre of boiler to top of box (inside)	0	8
Thickness of crown and side plates	0	0½
„ tube plate at top	0	0⅞
„ „ bottom	0	0½
„ back plate	0	0½
Tubes (steel)—		
Number, 201		
Diameter outside	0	1¾
Height—Top of chimney to rail	13	2¾
Tanks—Contents of two tanks, 800 gallons.		

Heating surface—		
Tubes	897·76	square feet.
Fire-box	89·75	„
Total	987·51	„
Grate area	13·83	square feet.
Flue area (201 tubes)	2·24	„
Chimney area	1·23	„
Cylinder area	1·67	„
Ratio of sectional area of chimney to grate area	1 : 11·27	
„ grate surface to heating surface	1 : 71·4	
„ flue area through tubes to grate area	1 : 6·17	
Ratio of cylinder area to grate area	1 : 8·28	

	Tons	cwt.	qr.
Weight of engine empty—			
Leading	12	8	2
Driving	13	8	2
Bogie	11	13	0
Total	37	10	0
Weight of engine in working order—	Tons	cwt.	qr.
Leading	14	10	2
Driving	15	0	0
Bogie	15	1	0
Total	44	11	2
Weight of engine per foot run	1·45 tons.		

THE new Italian warship Umbria has successfully passed her speed trials at Spezzia, attaining a speed of 19 knots per hour.

LEGAL INTELLIGENCE.

IN THE HIGH COURT OF JUSTICE, CHANCERY DIVISION.

Before MR. JUSTICE ROMER.

12th June, 1894.

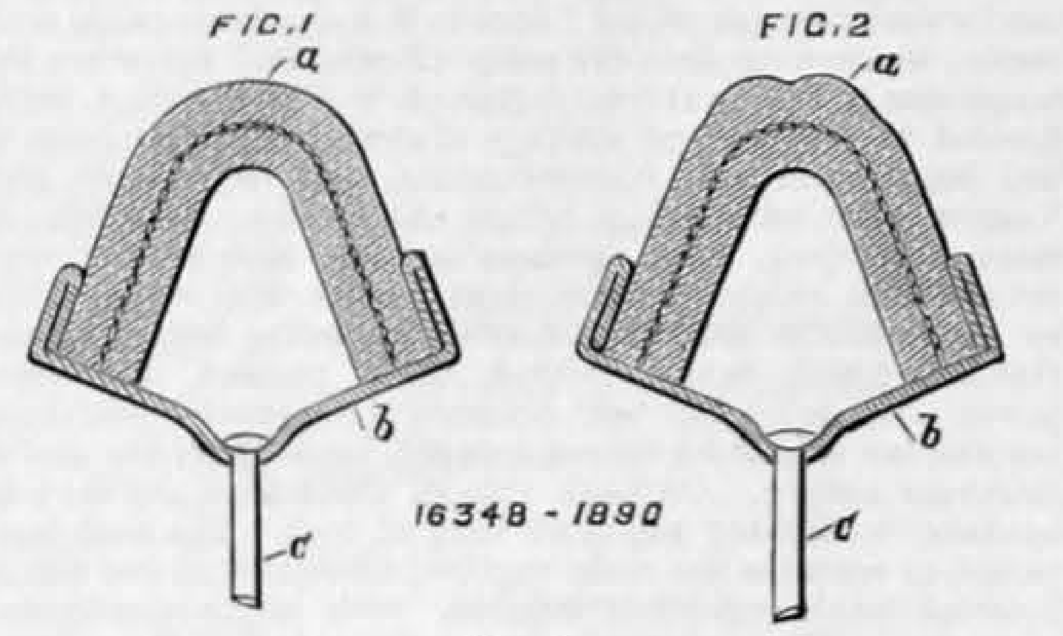
THE NORTH BRITISH RUBBER COMPANY, Ltd. *v.* MACKINTOSH AND COMPANY, Ltd.

IT will be remembered that this case, known briefly as the "Clincher" case, was commenced some months ago, and after several days of argument before Mr. Justice Romer, it was adjourned for the appointment and report of a technical assessor. Mr. James Swinburne was appointed, and he experimented with the several tires, and made his report upon the several questions involved, considered as from an engineer's point of view. Subsequently this report formed the basis of ument by the counsel on both sides.

The action was brought by the North British Rubber Company, as the registered legal owner, and Mr. W. Erskine Bartlett, as the grantee, of letters patent—16,783 of 1890—for "Improvements in tires or rims for cycles and other vehicles." The plaintiffs claimed (1) an injunction to restrain the defendants from manufacturing, selling, supplying, letting on hire, or using any rims and tires for cycles or other vehicles manufactured according to or in the manner described in, and claimed by the plaintiff's specification; (2) damages, or, at the plaintiffs' option, profits; (3) delivery up, for destruction, of infringing rims and tires; (4) and (5) incidental relief. The plaintiffs in particular complained of the defendants' manufacturing and selling grooved tires or rims in combination with an arched tire of india-rubber or other flexible material held in the groove of the rim by the pressure of an inflated tube within the arch which forced its edges against the sides of the groove. This latter will be recognised as a description of the celebrated and favourite tire, known as the "Clincher." The defendants denied infringement, and also set up the defence that the plaintiffs' patent was invalid, but in the result the question to be decided was whether the defendants had infringed the plaintiffs' patent.

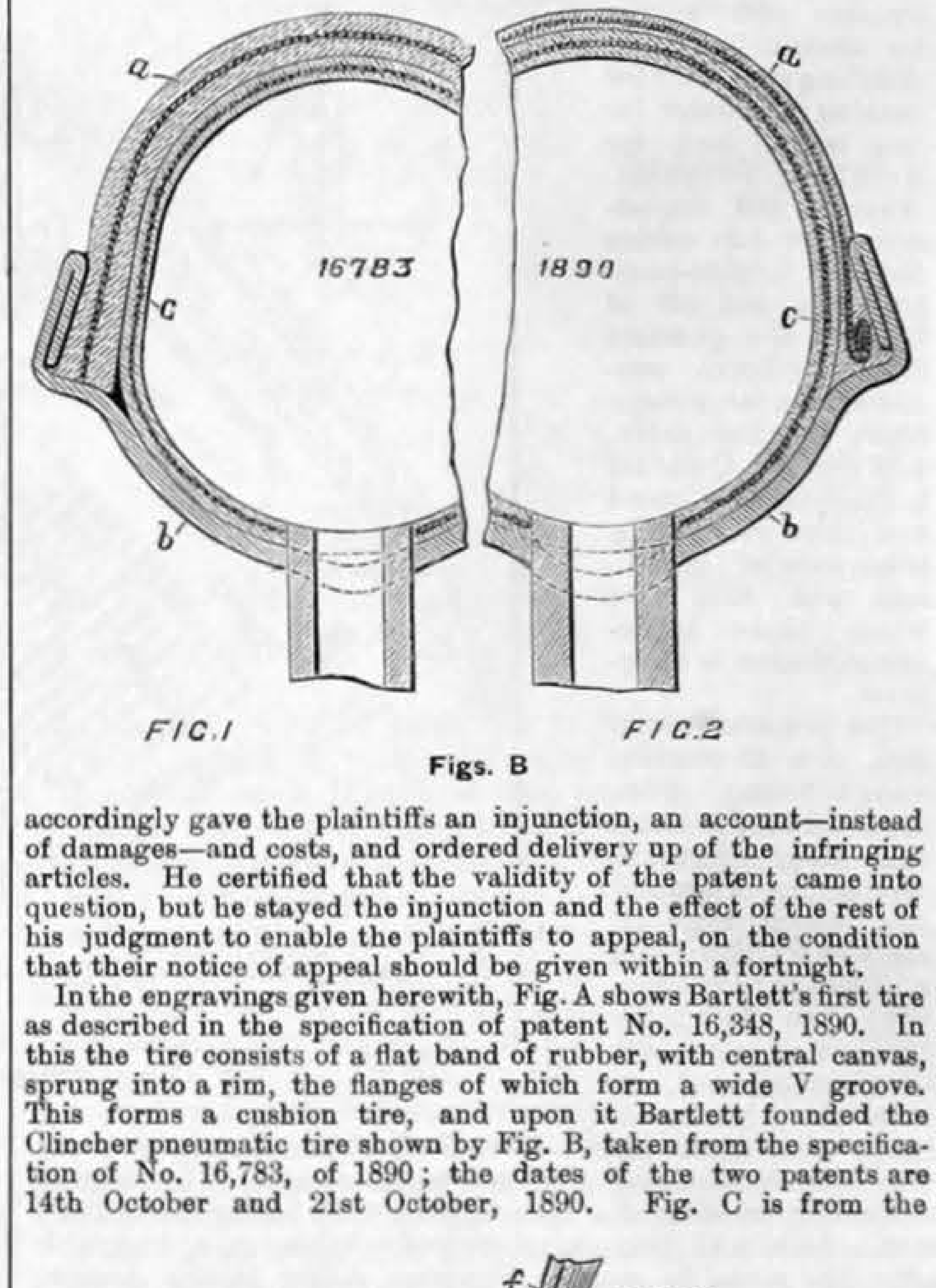
Mr. MOULTON, Q.C., Mr. BOUSFIELD, Q.C., and Mr. A. J. WALTER, were for the plaintiffs; and Sir RICHARD WEBSTER, Q.C., Mr. NEVILLE, Q.C., and Mr. J. C. GRAHAM, for the defendants.

Mr. JUSTICE ROMER delivered judgment on the 12th inst., which was the seventh day of the case in Court. The judgment, as printed from the shorthand notes of Messrs. Marten and Meredith and Messrs. Snell and Son, is as follows:—The only real question in this action is one of infringement, treating as I do the patented invention as one for the combination claimed by the specification. This being so I need not, with reference to the objections to the pleadings, deal with them in detail, or do more than say that, in my opinion, those objections fail, and that the patent is a valid one, and the invention a valid and meritorious one. On the question of infringement, I will first state what in my view is the essence of the invention. It is the combination of an outside flexible tire, that can be easily removed because it is not in itself a complete tube, and of an inside complete tube capable of inflation, so that when the inside tube is inflated the flexible tire is kept on the grooved dovetailed metal tire by the pressure of the sides of the flexible tire against the groove. And the patentee shows that you may thicken the sides or edges of the flexible tire, whereby, obviously, you increase the grip, and clearly, the greater the grip the more difficult it will be for the inside tube, if made very elastic, to force the flexible tire out of the narrow mouth of the grooved metal tire. Now, in my opinion, what the defendants have done is substantially this. They have taken the patentee's idea and the essence of his invention. All they have done in substance, by way of alteration, is to increase the size of the outside flexible tire and the thickening of its edges, and to exaggerate the dovetailing of the metal grooved tire, so as to give a greater grip and render it more difficult for the flexible tire to be forced out of the mouth of the groove; and this enables them to employ, as they do, for the inflatable inside tube a more elastic tube than that mentioned in the body of the plaintiffs' specification. I think that the defendants' tire is an improved form of that invented by the patentee, but still in substance the patentee's, and an infringement. Let me say a few words in detail on the various grounds urged by the defendants against the above view. The point which was chiefly relied on by the defendants at the trial, and to which the evidence of the defendants was chiefly directed, was that, owing to the way their outside flexible tire was made—being made partly of cloth cut on the cross—it was not held at all, or to any substantial extent, in the groove by the pressure of the inflated tube forcing its edges against the sides of the groove substantially as described in the plaintiffs' specification. The evidence on this point was considerable and complicated. At the conclusion, if I had been bound to decide at once, I should have decided against the point. But I felt some doubt, and in hopes of having that doubt removed, I suggested that an independent expert should be appointed to examine into the matter and report to me. The parties consented to this, and agreed in selecting Mr. James Swinburne as the expert. That gentleman has acted and reported, and most carefully and ably he appears to me to have done his work. Any doubt I had has been entirely dispelled by his report, and it is clear to me that the defendants' tire cannot be distinguished from the plaintiffs' on the ground I am now considering. Another point taken by the defendants is this. In the body of the specification the patentee describes his inside tube as made of cloth and india-rubber. The defendants' inside tube is made of india-rubber only. It is said that cloth was essential to the plaintiffs, for otherwise their inside tube would be too elastic to blow out the outside tire—at any rate, would do so if the sides or edges of the outside tire were not sufficiently thickened. And the argument is put very ingeniously thus:—"If the plaintiffs' specification be construed so as to include an inside tube made wholly of india-rubber, then it is bad, because the patentee has not shown in that case how to avoid the blowing off of the outside tire which would ensue, and which would make the tire useless." But, ingenious as all this is, it does not appear to me sound. The patentee has pointed out by his invention—specification—a perfectly good way of carrying his invention into practice. The invention worked in the way stated in the body of his specification, with an inside tube made of cloth and india-rubber, works perfectly well, and no one practically could feel any difficulty in carrying it out. I do not think he was bound to point out, what would be obvious to any sensible person, that the less cloth you had, and the more elastic therefore the inside tube became, the more necessity there would be for increasing the grip by thickening the sides of the outside tire or exaggerating the dovetailing of the groove. Clearly, to my mind, the patent is not bad on any such ground. But take it that, so far as the patentee is concerned, he has indicated by the reference to the cotton that he does not contemplate his inside tube being too elastic, or being made wholly without cotton. And then suppose a man subsequently finding that by much increasing the grip referred to in the patent he can, without risk of blowing out the outside tire, make the inside tube more elastic than the patentee thought, and wholly drop the cotton, would this enable him with impunity, and without being considered an infringer, to take and use the whole of the patentee's invention, so long as he employed the increased grip and the more elastic inside tube? I think not. He would still be taking and using the essence of the invention—of that which was patented—and would be an infringer, though his particular tire might be an improvement on that precisely indicated by the patentee in the body of his specification. The next point taken by the defendants is that their outside tire is essentially a complete tube, and not an arched tire like the plaintiffs'. But I am satisfied that the defendants' outside tire is not a complete tube, but is in all substantial respects, though enlarged in size, the same as plaintiffs' arched tire, and acts in exactly the same way, and has the same advantages as to speedy removal and otherwise as the plaintiffs' tire. Reference was made to paragraph eleven of Mr. Swinburne's report and the experiment there mentioned as tending to support the view that the defendants' outside tire acted as a complete tube. But this suggestion is made on a misunderstanding of Mr. Swinburne's experiment. The strips which he put on were put, not across the tube at right angles to the plane of the wheel, but lengthways. Mr. Swinburne himself, who was present in court, corroborated this. Lastly, the defendants try to make out that their tire is held in the groove by a different kind of action from that by which the plaintiffs' is held. The defendants say that the plaintiffs' tire is held in exclusively by frictional action, and that in the defendants' case there is no friction, but on the evidence and reports as a whole, and from my own observation and judgment, I come to the conclusion that this contention of the defendants is not supported in fact. No doubt there is more direct frictional action in the plaintiffs' case, especially in the example where there is no thickening of the sides or edges of the outside tire. But



Figs. A

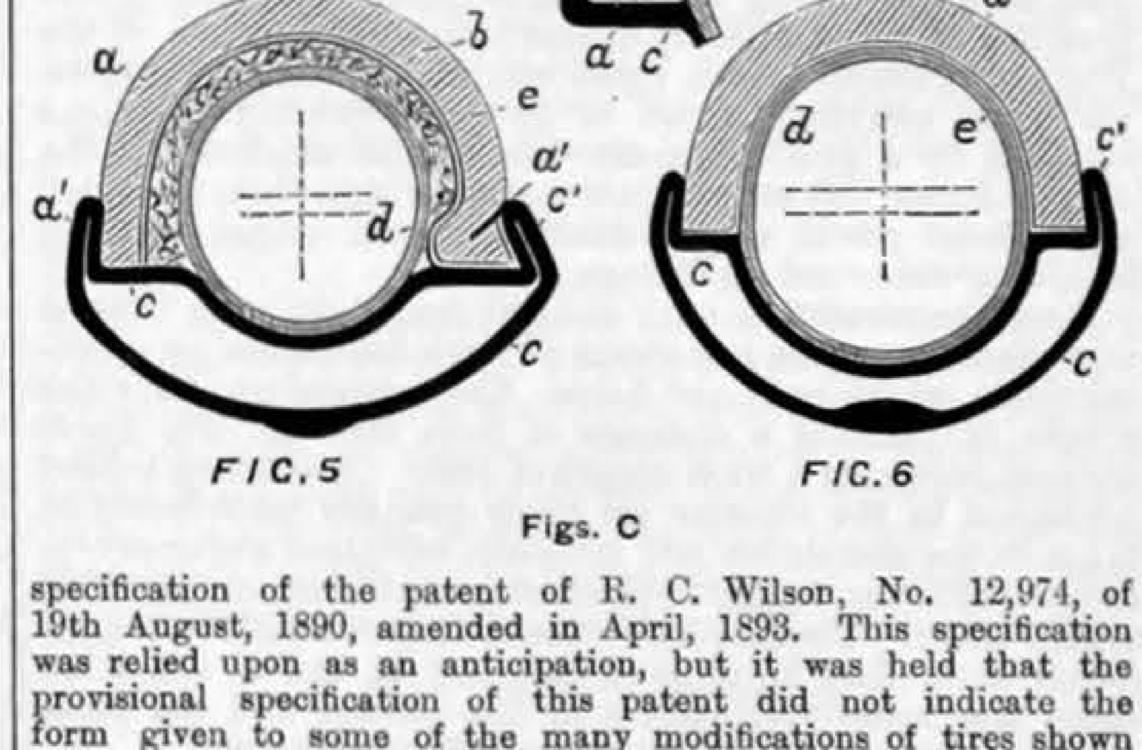
it is not all frictional pressure even in the last example. You cannot have friction without pressure, and pressure of an elastic material against an edge or anything in the nature of an edge tends to thicken the adjacent parts of that material. Nor is the defendants' action wholly free from friction. The truth, I think, is that the difference between the two is only one of degree arising from the fact that the defendants have, as I before mentioned, increased the size of the outside flexible tire and the thickening of its edges and exaggerated the dovetailing of the metal-grooved tire. In both cases the tire is kept on by the difficulty caused in trying to pull a broad thing through a narrower opening. The plaintiffs, therefore, are entitled to the relief they claim. His Lordship



Figs. B

accordingly gave the plaintiffs an injunction, an account—instead of damages—and costs, and ordered delivery up of the infringing articles. He certified that the validity of the patent came into question, but he stayed the injunction and the effect of the rest of his judgment to enable the plaintiffs to appeal, on the condition that their notice of appeal should be given within a fortnight.

In the engravings given herewith, Fig. A shows Bartlett's first tire as described in the specification of patent No. 16,348, 1890. In this the tire consists of a flat band of rubber, with central canvas, sprung into a rim, the flanges of which form a wide V groove. This forms a cushion tire, and upon it Bartlett founded the Clincher pneumatic tire shown by Fig. B, taken from the specification of No. 16,783, of 1890; the dates of the two patents are 14th October and 21st October, 1890. Fig. C is from the



Figs. C

specification of the patent of R. C. Wilson, No. 12,974, of 19th August, 1890, amended in April, 1893. This specification was relied upon as an anticipation, but it was held that the provisional specification of this patent did not indicate the form given to some of the many modifications of tires shown in the drawings of the final, and the Clincher pneumatic tire had become widely known through extensive use between the dates of Wilson's provisional and his final specifications. The patent under which the defendants manufactured tires was taken out on the 8th December, 1890, No. 19,990, and was amended in July, 1893. The specification describes numerous forms of pneumatic tires with outer rings, having projecting edges or beads which take into the metal rim of the wheel, these flanges of these metal rims being bent inwards to fit these beads, which gave a tire which in section is something like the letter Ω, and therefore only an exaggeration of thickened edge tire shown by Bartlett.

THE Eighth International Congress of Hygiene and Demography is to be held in Buda Pest this year, from the 1st to the 8th September. A British committee has been formed, of which Sir Douglas Galton is the chairman, to further the interests in this country of the Congress, about which any information can be obtained from the hon. secretary, Dr. Paul F. Moline, 42, Walton-street, Chelsea.

RAILWAY MATTERS.

THE Severn and Wye Valley Railway—Acquisition—Bill has been passed, and so also the Monmouth Electric Lighting Bill.

THE Great Western Railway claim against the Swansea Harbour Trust, which was originally £31,650, has been at length settled. Mr. Garrard, the arbitrator's, award was £14,250, and at the last monthly meeting of the Trust this was adopted and passed.

THE Board of Trade have made an Order under Subsection 6 of Section 33 of the Railway and Canal Traffic Act, 1888, prescribing the manner in which notice shall be given by a canal company of any intended increase of its published tolls, rates, or charges.

MR. WILLIAM HOBSON, who has been over forty-four years with the North-Eastern Railway Company and its predecessor, the old Stockton and Darlington, for the last thirteen years as assistant goods and mineral manager for the Darlington section, has resigned his position, being desirous of retiring into private life.

AT the sale by auction of the undertaking of the West Metropolitan Tramways Company on Wednesday last, the auctioneer, Mr. Bousfield, stated that the lines were offered subject to the clause of the Act of Parliament under which they were created and worked. The power of purchase arose in fourteen years from 1889. Not a single bid was made for the property.

AN American contemporary describes the King electric railway system, with underground conduit, which is being tried on the Tenleytown railway at Washington, D.C. Two ploughs on the car force back the flexible cover of the slot, which consists of hinged iron plates with a continuous strip of water-proof rubber belting underneath. The cost is estimated at £2000 to £2400 per mile.

THE Boston and Maine Railroad Co. is making a new station at Lowell, Mass., wedge shaped in plan, between converging tracks. The following particulars give an idea of the proportions adopted in such buildings:—The waiting room is 55ft. by 66ft.; smoking room, 15ft. by 22ft.; women's room, 18ft. by 25ft.; dining room, 18ft. by 24ft.; express room, 22ft. by 36ft., and baggage room, 42ft. by 28ft. The two latter rooms form a separate building, but under the same roof which covers the platforms.

LORD TRAYNER, Sir Frederick Peel, and Viscount Cobham will hold a Court in Edinburgh on the 27th inst., to decide differences which have arisen between the colliery owners in the counties of Fife, Lanark, Linlithgow, Stirling, and Clackmannan, and the Caledonian and North British Railway companies as to the allowance to be made where the colliery owners and not the railway companies provide trucks for the coal traffic. The hearing of the cases is expected to last some days.

MESSRS. W. JESSOP AND SONS, Brightside Works, have delivered at Liverpool, per Midland Railway, two propeller shaft brackets, weighing each fifteen tons. The brackets, being very large, overhung both sets of rails, and thus blocking both lines, they had to be sent on Sunday. They are for one of the powerful first-class cruisers now being built by the Spanish Government. Two other sets of propeller shaft brackets are being constructed at the Brightside Works for the Spanish Admiralty.

THE Birmingham and Henley-in-Arden Railway, having been inspected by Major Yorke, R.E., for the Board of Trade, and passed, was opened for public traffic on Wednesday, 6th inst. The company is to be congratulated on having completed the line, and are much indebted to Mr. Beverley Griffin, Assoc. M. Inst. C.E., to whose care the works were intrusted, and now so satisfactorily ended. The line is worked by the Great Western Railway Company, whose main line it joins thirteen miles from Birmingham.

IN order to comply with Standing Orders of the House of Commons, the Port Talbot Company has withdrawn from its Bill, as passed by the House of Commons, all powers to enter into working agreements with the Great Western and South Wales Mineral Railway Companies. The effect of this is, that the Rhondda and Swansea Bay Railway Company has become the only one allied with the Port Talbot Company, and in the event of the Bill becoming law this fact will pleasurably commend itself to the shareholders of the latter.

THE Philadelphia and Pennsylvania Railroad Company is changing the gauge of such parts of its track as require it from 4ft. 9in. to 4ft. 8½in. The standard gauge on the Pennsylvania Railroad for passenger tracks is 4ft. 8½in., but for freight tracks it is 4ft. 9in. It is the purpose to make the gauge uniformly 4ft. 8½in. when the wheel gauge is definitely and accurately settled. On the lines west of Pittsburgh some of the divisions having light curvature are being relaid to 4ft. 8½in. gauge whenever new steel is put down, it being the intention to make that old gauge standard. Where the curvature is heavy the 4ft. 9in. gauge is retained.

ANOTHER new cable tramway system is, we understand, likely to be brought forward at an early date. Mr. Sturgeon, whose name is well known in connection with compressed air apparatus, is associated with Mr. Davies in a new arrangement with which is used a shallow cable conduit, and in which the vertical carrying wheels are not employed. A well-known firm in Yorkshire is at present engaged with the object of developing the system, particularly in connection with its use in a large Yorkshire town wherein an electrical system has been under trial. The new system includes also a new form of gripper, one of the objects of which is to reduce the suddenness with which the strain is put upon the cable.

AT a meeting of the Engineering and Allied Trades Section of the London Chamber of Commerce, Sir Edward H. Carbutt, Bart., in the chair, to consider a report which had been prepared by one of the members, Mr. Wm. Shalford, M. Inst. C.E., as to what recommendations should be made to the Secretary of State for India with a view to such concessions being granted to private capitalists as would encourage investments in Indian Railways, Lieut.-General Sir Andrew Clarke, G.C.M.G., C.B., C.I.E., and Mr. Duff Bruce, C.E., brought various suggestions before the meeting, and, after a long discussion, recommendations to the Council of the Chamber were agreed upon, the general opinion being that the rebate of 10 per cent. offered by the Government was not a just division of the interchanged traffic, and would not attract capital to Indian railway enterprise.

THE mule train line from Vera Cruz to Jalapa has been removed, it being unable to exist in competition with the Interoceanic Railway. The Tehuantepac Railway from Contracoalcas to Sulina Cruz is 200 miles long, of which there are thirty miles unfinished. It is expected that the line will be completed by September next. This line across the Isthmus of Tehuantepec will afford a shorter route to many parts of the world to goods in transit, and will eventually divert a considerable amount of freight from other routes, but it cannot expect to compete effectively unless it is provided with sufficiently good ports at either terminus. According to a recent report of the British Consul at Vera Cruz, Contracoalcas on the Gulf side can easily be converted into a commodious port with all the requirements necessary for a large amount of shipping, but Sulina Cruz, on the Pacific, is only an open roadstead exposed to the constant heavy swell that will greatly impede the shipment of goods, and it does not seem practicable to make of this place a sufficiently convenient port for the purposes required, and to be able to compete with Panama.

NOTES AND MEMORANDA.

COMPRESSED hay for paving is reported to be under trial by the Amies Pavement Co., of Philadelphia. Under heavy pressure in a Dederick hay press, the dry grass is pressed into cubes, and then cut into paving blocks of convenient size. After being soaked in a drying oil it is claimed that the blocks become indestructible.

GOLD of considerable purity is found throughout nearly the whole of Lower Burma, especially in the beds of the rivers in Tenasserim. Specimens have been found of quality equal to average Australian gold. Gold occurs also in certain districts of Upper Burma. The native method of obtaining gold is almost universally the washing of auriferous sands from the beds of rivers.

THE automatic signals from the Westminster clock were received at the Greenwich Observatory regularly throughout the year ending May 10th, 1894, except on fourteen days when the signal failed. The error of the clock was under 0·5 sec. on 24 per cent. of the days of observation, under 1·0 sec. on 41 per cent., under 2·0 sec. on 79 per cent., under 3·0 sec. on 94 per cent., under 4·0 sec. on 98 per cent., and exceeded 4.0 sec. on five days.

IT has been stated that the 16-candle light hours which can be obtained for one penny by different systems of light are as follows, in London:—With gas, using Welsbach burners, 22·2 hours; incandescent electric, driven by gas engine and Dowson gas, 10·6 hours; duplex oil lamp, 8·6 hours; good petroleum lamp, 8 hours; gas, with Argand burner, 6·4 hours; with fish-tail burner, 4·7 hours; and with incandescent lamps on town mains, Mr. Head at a meeting of the Society of Engineers, gave 2·2 hours.

THOSE who are acquainted with the speed log which Admiral Fleuriais, of the French Navy, brought out in 1878, will be interested to hear that he has substituted for the telephone—the sound of which was not sufficiently distinct for accurate observation—an electric bell, which rings on the completion of every twenty-four revolutions of the vane spindle. The speed of the ship is thus obtained from the length of the interval between two consecutive strikes of the bell.

THE French are a curious people. Exactly a hundred years ago, they executed Lavoisier, their greatest scientist, with all ignominy on the guillotine, and at the same time confiscating all his apparatus. Now there is on foot a national reparation scheme taking the shape of a Salle Lavoisier in the Vaucansen Gallery where this apparatus is on exhibition, notably, that with which he made his studies on fermentation, and also what is most important in the history of chemical research, the apparatus with which he proved that water is a combination of oxygen and hydrogen.

THERE are in all twenty-two transformer stations in the City of London, whose situations are as follows, viz.:—Bartholomew Close, Crosby-square, Coleman-street, Falcon-square, Farringdon-street, Finsbury Circus, Fetter-lane, Lime-street-square, Milk-street, New-square (Minories), Red Cross-street, Rood-lane, Salisbury-square, St. Andrew's-hill, St. James's-place, (Duke-street), Watling-street, and Warwick-square; Copthall-avenue, St. Benetfink Churchyard (at the rear of the Royal Exchange), Queen Victoria-street (St. Nicholas Churchyard), Nicholas-lane (in churchyard), and Pancras-lane.

COMMANDER L. K. BELL, R.N., has contrived a range-finder which is to be adopted in H.M. fleet for station-keeping purposes. It admits of greater rapidity of calculation than the old method of taking a sextant angle, usually from the fighting top, a method which is not only slow but unsafe in action. Seeing, therefore, that the new instrument can be used with accuracy from the conning tower, a double advantage is gained. The distances are calculated on a scale attached to a graduated prism, the only necessary datum being the height of the enemy's mast, which is in most cases obtainable from the Naval Intelligence books; if not, it ought to be.

THE extent of land returned in 1893 as under all forms of crops, bare, fallow, or grass, in Great Britain appears as 32,644,000 acres. The arable land of Great Britain declined by 176,000 acres, while the surface returned as permanent pasture is greater by 134,000 acres. The decline of the arable area of Great Britain commenced twenty-one years ago, in 1872, when prices of corn were much above the present level, and the reduction was attributed in that and the following year to the increasing cost of agricultural labour and the attraction of the high prices of meat and dairy produce then prevailing. Since that period, with two insignificant exceptions, the record of each successive season has shown less arable land. Compared with 1873, the arable area of 1893 is rather more than 2,000,000 acres smaller, or about an acre less in every nine. The surface under corn crops in Great Britain has never again been so large as it was in 1869, when 9,758,000 acres were thus accounted for. Comparing the present corn area with that of 1873, the decline is 1,800,000 acres. Wheat now covers little more than half the surface it occupied in Great Britain in 1871-5, and beans much less than half.

AT a meeting of the Manchester Geological Society on Tuesday, Professor Boyd Dawkins, F.R.S., read a paper in which he described an important discovery of a range of salt-bearing marls—in the Isle of Man, as the result of borings which had been carried out with the object of proving the existence of coal measures, which, however, had not been found. He said it was an open question how far the marls of the Isle of Man were continuous under the sea eastwards to Barrow and Fleetwood and to the North-west in the direction of Carrickfergus. The sequence of the marls in the islands was exactly that of the lake district, and the geology of the one was to be read by the light of the other. They might also conclude from the identity of structure between the areas of Barrow and Black Combe on the one hand, and that of the North of Ireland on the other, that the coal measures of Whitehaven did not range so far south as the Isle of Man. If they did occur, the only spot where they could be proved was in the extreme north of the island. The discovery of the salt marls, however, was very important, and would probably result in the establishment of a salt industry in the island.

IN an article on the "Niagara Falls Power Station," *Nature* says the patent for Professor Forbes' construction of dynamo—which is being built—has been just allowed by the United States Patent-office. One object to be attained was to have a fixed armature, so that the armature might be wound so as to give a very high E.M.F. without being subjected to the enormous centrifugal forces of the revolving part. Another object was to attain a maximum fly-wheel effect with a minimum weight. The revolving parts of the turbine and dynamo, and the vertical shaft connecting them, are all supported hydraulically by means of a piston in the turbine. The supporting power of this piston limited the weight of the revolving part of the dynamo to 80,000 lb. The governor of the turbine demanded—to fulfil the required conditions of regulation—a momentum equal to 1,100,000,000 lb., moving at the rate of 1ft. per second. Both of these objects are attained by Professor Forbes' construction, which consists in making the armature fixed and ring-shaped with a space inside for getting at the bearings, and in making the fields of a bell-shape, the poles being on the inside of a nickel-steel ring, which is supported by the top piece or cover, which in its turn is rigidly fixed to the vertical axis. This novel construction gives all the fly-wheel effect required, without making the weight too great. Every design which had been made previously required the addition of a fly-wheel costing at least £800 or £1000. The construction for which Professor Forbes' patent has now been granted has also the great merit that the magnetic pull between the armature and the fields tends to diminish the breaking strain of centrifugal force on the revolving part.

MISCELLANEA.

THE total length of London sewers constructed during the year ending April 30th, 1894, was 1285ft.

A CORRESPONDENT writes to us inquiring for some more profitable means of disposal of large quantities of tobacco, tea, cocoa, and other tins—than the dust-bin. Perhaps some of our correspondents can help him.

A NEW concert pavilion on the Royal Pier at Southampton was opened last week. The hall is 85ft. in length, 73ft. in width, and about 46ft. in height from the floor to the top of the cupola, and provides seats for 970 persons.

A "NEW" propeller, we read, has been designed by a Mr. N. Cain, of Detroit. It is precisely similar in principle, and apparently the same in form as that by Francis Pettitt Smith, 1836-1839. The novelty, therefore, in the design is scarcely obvious.

THE American torpedo boat Ericsson was launched at Dubuque, Ia., on May 12th. She is built of steel, and is 150ft. long, 15½ft. beam, 10½ft. deep, and 120 tons displacement. There are two sets of quadruple expansion engines, driving twin screws at 420 revolutions per minute. They are expected to develope 2000-horse power. She carries three tubes, and four one-pounder Q.F. guns.

THE Russian Government have recently concluded a contract with Messrs. Yarrow and Co., of Poplar, to construct a torpedo boat destroyer 180ft. in length, having the guaranteed speed, during a run of three hours' duration, carrying a load of 30 tons, of 29 knots, this being two knots in excess of the speeds hoped for in the forty-two destroyers lately ordered by the British Admiralty.

WE have received notice of a new work by M. Sebillot, and edited by J. Rothschild, 13, Rue des Saints Pères, Paris, entitled, "Folklore on Public Works and Mining." Every country is dealt with as regards its beliefs, legends, customs, rites, &c. Concerning the ways, bridges, railroads, embankments, canals, waterpower, ports, lighthouses, mines, and miners, since the most distant times, over Europe, Asia, and America.

THE hopper dredger, Hugh Andrews, recently launched by Messrs. Fleming and Ferguson, Paisley, for the Warkworth Harbour Commissioners, has just completed a series of dredging and speed trials. When dredging in very hard material, we are informed, she raised easily 350 tons per hour, and on measured mile with her full load on board she attained a speed of over seven knots per hour, fulfilling the guarantees on all points.

THE construction of the Ramasamudrum Reservoir, Kolar Division, was sanctioned, says the *Indian Engineer*, as storage at this place will fill seven tanks and supplement the supply to four anicuts, yielding a revenue of Rs. 5000 and odd, and eventually bring some 1500 additional acres under cultivation. The progress has been reported as good, the bund on the left bank being brought up to R. L. 85·00, and that on the right upto the temporary weir, and the outlay up to date Rs. 51,824.

WE read in a Scotch paper that a fifteen years' test of Gardner's timber-preserving process has shown most satisfactory results. "In 1879 the pine timber used in the extension of the West Quay at Greenock was subjected to Gardner's No. 2 process. In 1881 that used at the new frontage to the Custom House Quay was also subjected to the same process. In both cases the timber has stood remarkably well. Within the last month special examination was made of the above quays, and the timber found to be perfectly sound."

THE Manchester Corporation have appointed Mr. T. de Courcy Meade, M. Inst. C.E., engineer and surveyor to the Hornsey Local Board, as city surveyor of Manchester at a salary of £1000 a year. The *British Architect* says:—The committee no doubt would have been better pleased to recommend a local man for the appointment than a Londoner, but they wisely made local preferences give way for broader considerations. Local knowledge is undoubtedly a good recommendation for a borough engineer, but it is after all a very subsidiary one compared with the all-important one of general professional ability and wide experience.

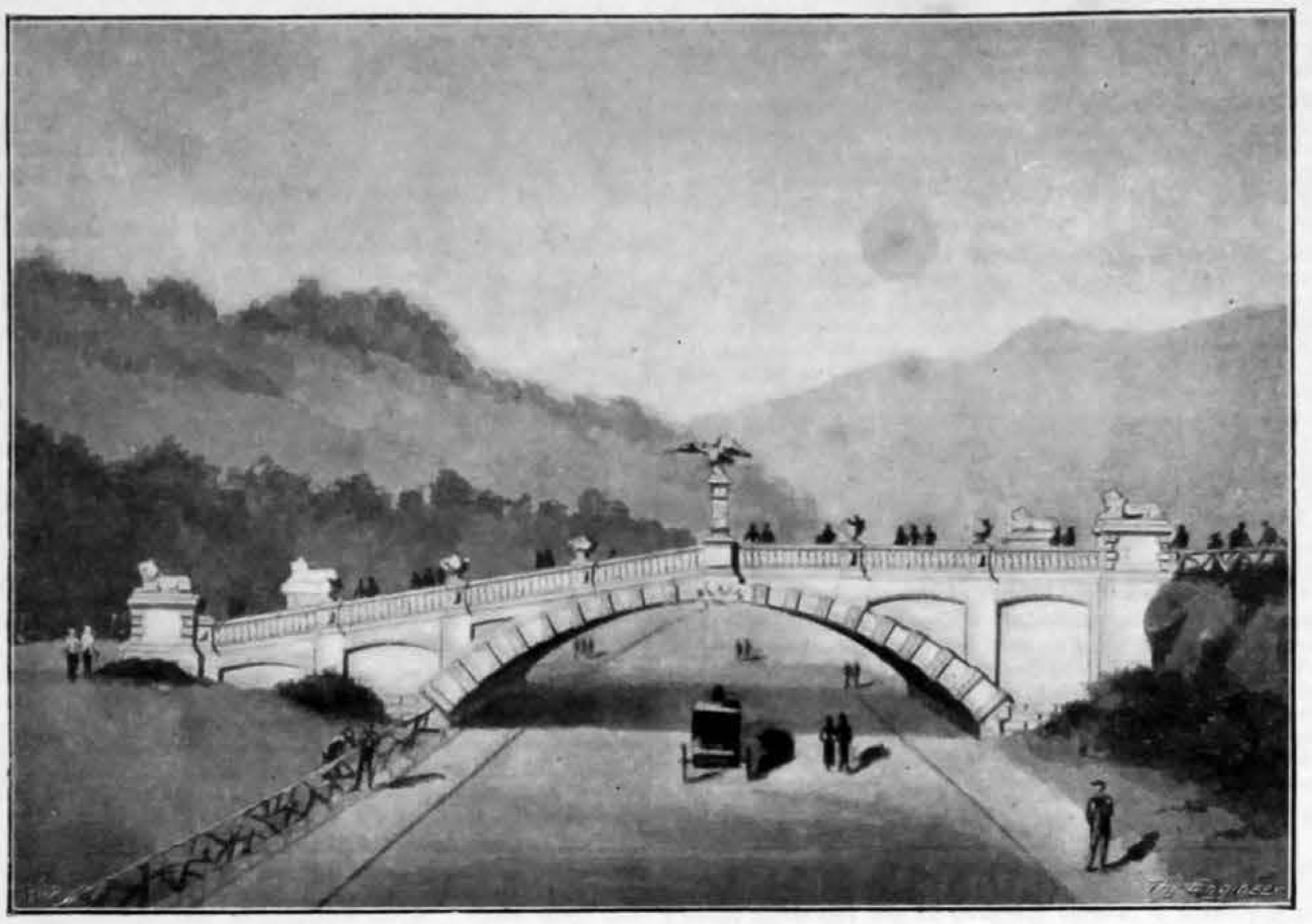
THE casting of the large hour bell for the tower of the new municipal buildings, Croydon, which are being erected in Katherine-street at a cost of £100,000, was successfully carried out last week. The clock which strikes it will have four faces, each 10ft. 6in. in diameter. It will chime the Westminster quarters and strike the hours, the aggregate weight of the five bells being 93 cwt. Four of these have already been cast, and the bell which was cast last week weighs 36 cwt. The greater part of the metal used did duty for eleven years in the shape of a bell on the Eddystone Lighthouse. A syren being now employed on the lighthouse, the two bells, each weighing two tons, were returned to Croydon, Messrs. Gillett and Johnson buying them from the Trinity House authorities.

IN his report to the City Commissioners of Sewers, Mr. D. J. Ross, the engineer to the Commissioners, refers to the refuse destructor apparatus at Lett's Wharf, which has been in constant operation both day and night throughout the year ending 30th April last, with the exception of a stoppage of 19½ days for repairs and cleaning flues. The number of loads destroyed was 25,157, which produced a residuum of 4970 loads of ashes or clinkers, more or less hard, but valueless, and for the removal of which the Commissioners had to pay. Mr. S. Elliot, who has had permission to fit up, at his own expense, his patent annihilator apparatus, for dealing with the fumes from the chimney, has been engaged since March last year in erecting his machinery, which is now nearly complete, and he hopes shortly to have the same in operation.

THE delays that are being experienced in carrying out the naval programme of 1891 are giving rise to a great deal of dissatisfaction in France. By now there ought to have been twenty-nine new vessels either completed or on the stocks, but of this number two battleships and eight cruisers have not yet been begun. The deficit will be still more considerable next year, for the list of constructions just drawn up for 1895 take little account of the torpedo-boats, gun-boats, and other light vessels, which brings up the deficit to fifty-two units. These proposed new constructions for 1895 comprise a first-class battleship, two cruisers, a vessel for coast defence, a sea-going torpedo boat, and two first-class torpedo boats, making seven vessels in all. The ten ships already in arrear cannot now be put on the stocks until after 1895. These delays are explained by the fact that the arsenals cannot undertake more work than is now being done, but against this it is pointed out that the vessels in arrear were to have been constructed in private shipyards, and these are far from being fully employed.

THE Middlesbrough Corporation had a grand "field day" on Tuesday on the question of the tenders for a gasholder which they intend to have erected, and which is to contain 2¼ million cubic feet of gas. The Whessoe Foundry Company, Darlington, offered to construct this with ordinary guide framing carried to the top of second lift for £15,368, and Messrs. Ashmore, Benson, Pease, and Co., of Stockton, offered to erect a rope-guided gasometer on a principle patented by one of the firm, and which had been tried at various places and given great satisfaction. Their tender was £14,401. They were willing to inflate the holder with air and thoroughly test it next spring and summer, and then if it failed to give satisfaction, to put up standards on the terms agreed upon. The Gas Committee of the Corporation last month paid a visit to Tyne Dock, and examined a gasholder which is erected on Messrs. Ashmore, Benson, Pease, and Co.'s principle, and is working satisfactorily. After a long discussion the Corporation decided to accept the tender of the Stockton firm. The holder is to be 189ft. in diameter and 120ft high.

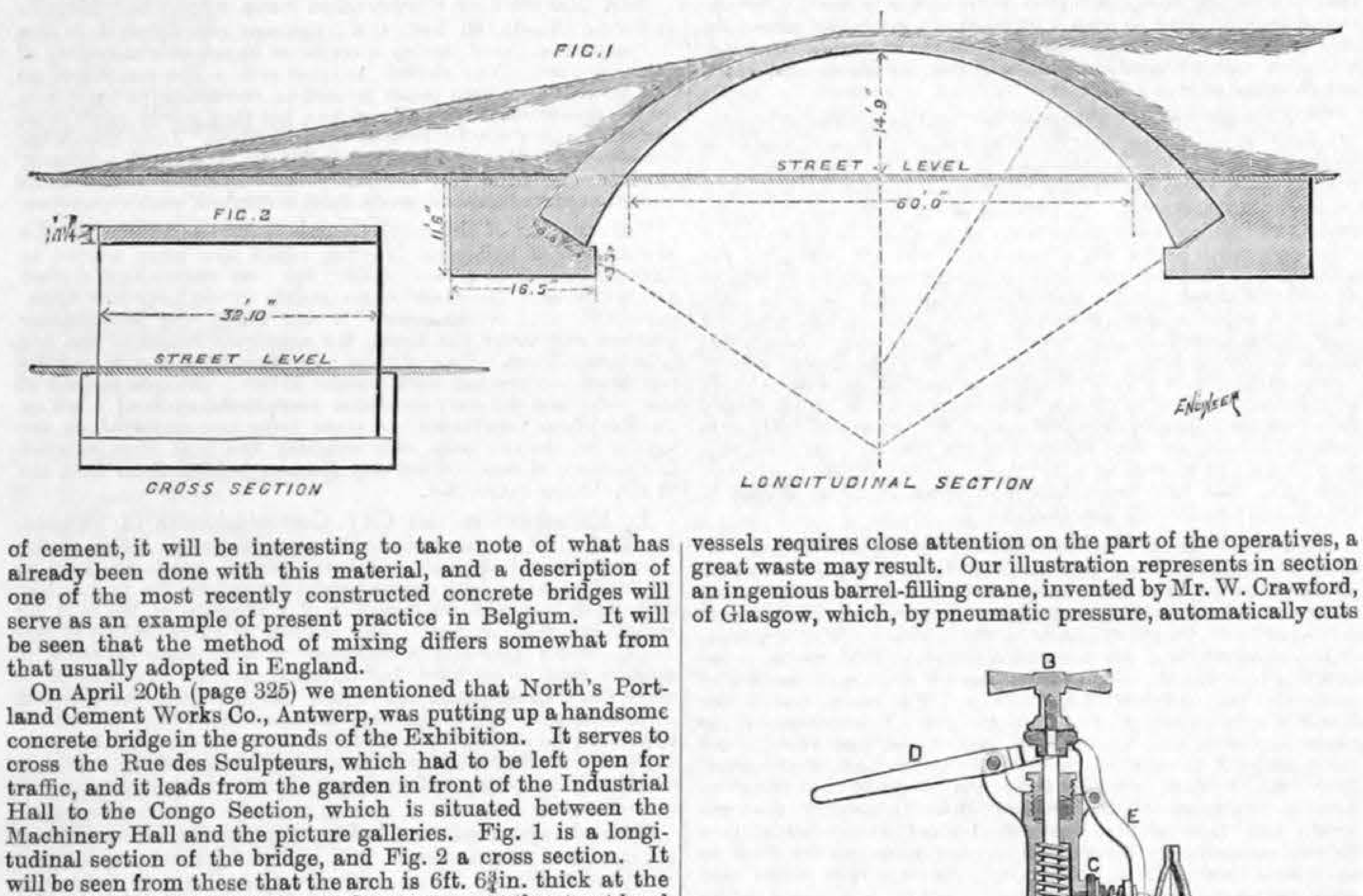
CONCRETE BRIDGE, ANTWERP EXHIBITION



CONCRETE BRIDGE AT THE ANTWERP EXHIBITION.

The use of concrete as a substitute for masonry has made a good deal of progress during the last few years. Thirty years ago it was almost confined to foundations, engineers who used it for retaining walls were thought venturesome, and there were few who considered it a suitable material for the construction of arches.

Though concrete bridges are now no longer a novelty, there seems to be great difference of opinion as to the most suitable proportions of cement, sand, and stone; in fact, it cannot be said that there is any rule in the matter, beyond the "rule of thumb;" we can only be guided by the experience of others. But as it seems evident that concrete will be employed for arches of much greater span than any which have yet been made, whilst none can assert that we have reached the point below which it would be impossible to reduce the proportion of cement, it will be interesting to take note of what has already been done with this material, and a description of one of the most recently constructed concrete bridges will serve as an example of present practice in Belgium. It will be seen that the method of mixing differs somewhat from that usually adopted in England.



CROSS SECTION

LONGITUDINAL SECTION

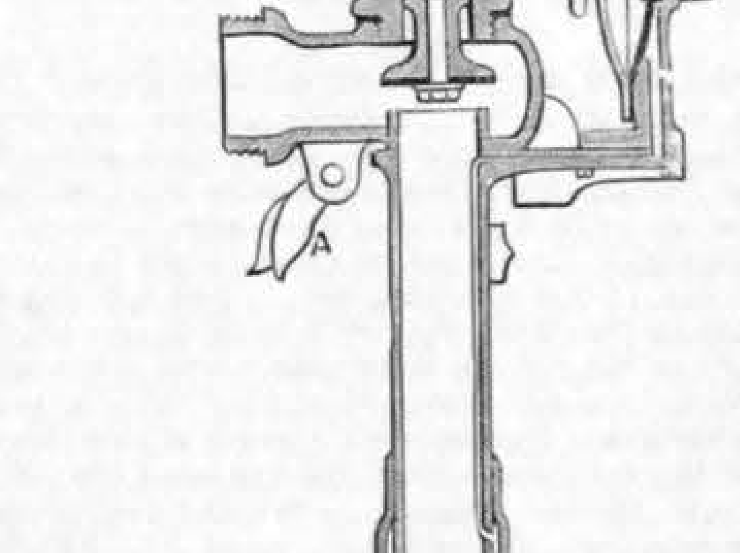
On April 20th (page 325) we mentioned that North's Portland Cement Works Co., Antwerp, was putting up a handsome concrete bridge in the grounds of the Exhibition. It serves to cross the Rue des Sculpteurs, which had to be left open for traffic, and it leads from the garden in front of the Industrial Hall to the Congo Section, which is situated between the Machinery Hall and the picture galleries. Fig. 1 is a longitudinal section of the bridge, and Fig. 2 a cross section. It will be seen from these that the arch is 6ft. 6⅝in. thick at the springing, and only 1ft. 7⅝in. at the crown. At the street level it is 4ft. thick. The height of the under side of the arch above the roadway is 14ft. 9in., and the inside width at this level 60ft. The width of the bridge is 32ft. 10in., and the total length 131ft. 3in.

The ground at the abutments was excavated to a depth of 11ft., and in doing this a wall about 3ft. thick was discovered, crossing the line of the bridge obliquely. This wall was demolished to within 3ft. above the seat of the foundation, and the rest of the ground was found to be tolerably firm sand, slightly argillaceous. The abutments are 16ft. 5in. wide, and the concrete was rammed down in successive horizontal layers, each 6in. thick.

The mixture for the concrete in the abutments was not the same as in that for the arch; but in both cases a mortar was first made, and subsequently mixed with the stone. For the abutments, this mortar consisted of one of cement to four of sand, whilst for the arch one of cement to two of sand was used. In each case 10 per cent. of water was added, to work the materials up into a rather dry mortar. Forty-five parts of this mortar were then mixed with a hundred parts of crushed porphyry. It will thus be seen that in the abutment there is only part of cement to fifteen of sand and stone, whilst for the arches the proportion is 1 to 8¾. For the centreing five wooden trusses were used, placed 6ft. 7in. apart, and covered with ¾in. planks. The construction of the arch was commenced on December 18th, 1893, and was finished on the 23rd of the same month. A week later a severe frost set in, the thermometer falling to 10deg. Centigrade below zero—14 deg. Fah. On January 23rd the centreing was removed, and though careful observations were made, no settlement could be detected. To avoid the infiltration of rain, the extrados of the arch and the tops of the abutments have been coated with a mortar consisting of equal parts of cement and sand. The general appearance of the bridge is very satisfactory.

CRAWFORD'S AUTOMATIC BARREL FILLING CRANE.

The proper filling of barrels in breweries and distilleries has always been an operation demanding considerable care and labour. More recently the development in the industry of importing oil in bulk has greatly increased the number of comparatively small vessels requiring to be charged with more or less exactitude; and as ordinarily performed the filling of such vessels requires close attention on the part of the operatives, a great waste may result. Our illustration represents in section an ingenious barrel-filling crane, invented by Mr. W. Crawford, of Glasgow, which, by pneumatic pressure, automatically cuts

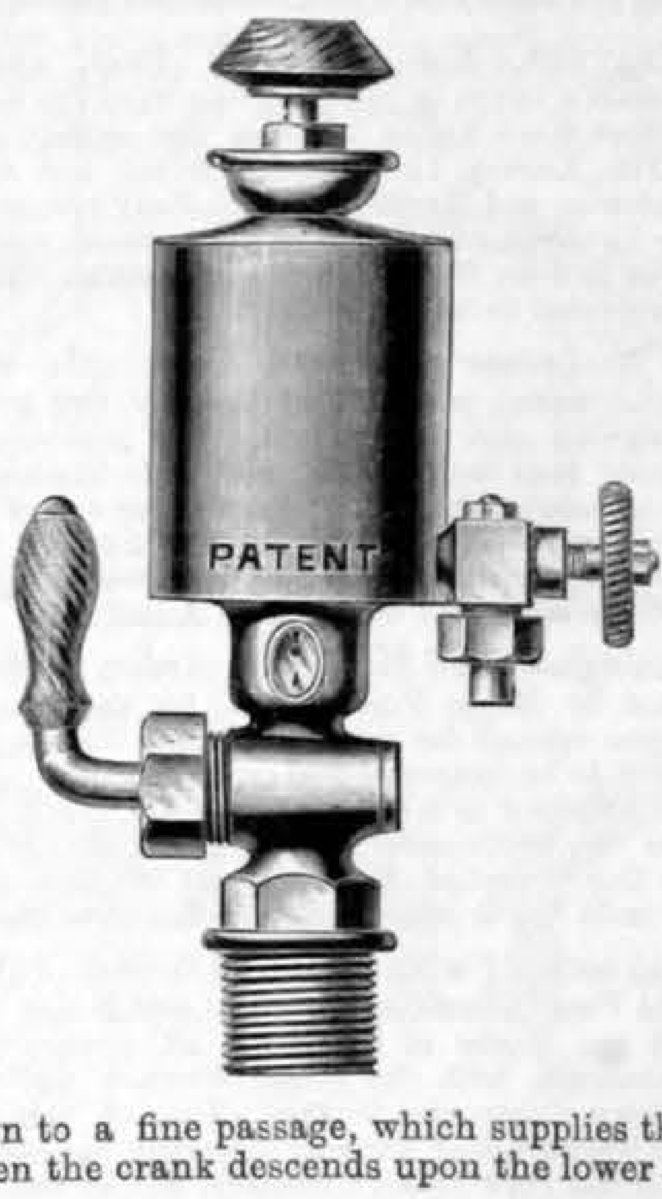


AUTOMATIC BARREL FILLING CRANE

off the supply of liquid when the vessel is sufficiently full. The apparatus is very simple, and the mechanism will be readily understood from the drawing. The top of the filler pipe for insertion into the barrels is faced to fit a disc valve, which when closed is held down by a long spiral spring. The lower end of the same pipe has an outside casing several inches in length, fixed so as to form an annular space between the pipe and the casing as shown. This space communicates by means of a small tube with a metal vessel above containing a leather diaphragm attached to a rod operating the trigger lever E. This lever is pressed outwards and against the leather diaphragm by a small spring, the tension of which may be adjusted with the greatest nicety by the milled nut C. When the appliance is to be used the hose conveying the liquid is attached to the spigot, seen to the left of the figure, and the filler pipe inserted into the barrel till the grip points A rest on the edge of the bunghole. The disc valve is then opened by pulling up the handle B, or depressing the lever D till the trigger lever E comes into operation to hold up the valve. The liquid then rushes into the barrel, and as it rises round the filler pipe it increases the pressure of the air imprisoned in the annular space surrounding the lower part of the pipe. The pressure is communicated to the leather diaphragm operating the trigger lever E, and when the increased pressure on the diaphragm overcomes the resistance of the spring at C, the lever is moved inwards. The handle B is thus released, the disc valve closed, and the flow of liquid instantly arrested. The spring C can be adjusted so that barrels may be automatically filled, either bung full, or to any lesser desired amount; and after a barrel has been charged, negligence on part of attendants can cause no waste. The apparatus, which is manufactured by Crawford's Patent Automatic Barrel-Filling Crane Company, Glasgow, has, we are informed, already been adopted by some of the largest brewers and oil firms with very satisfactory results.

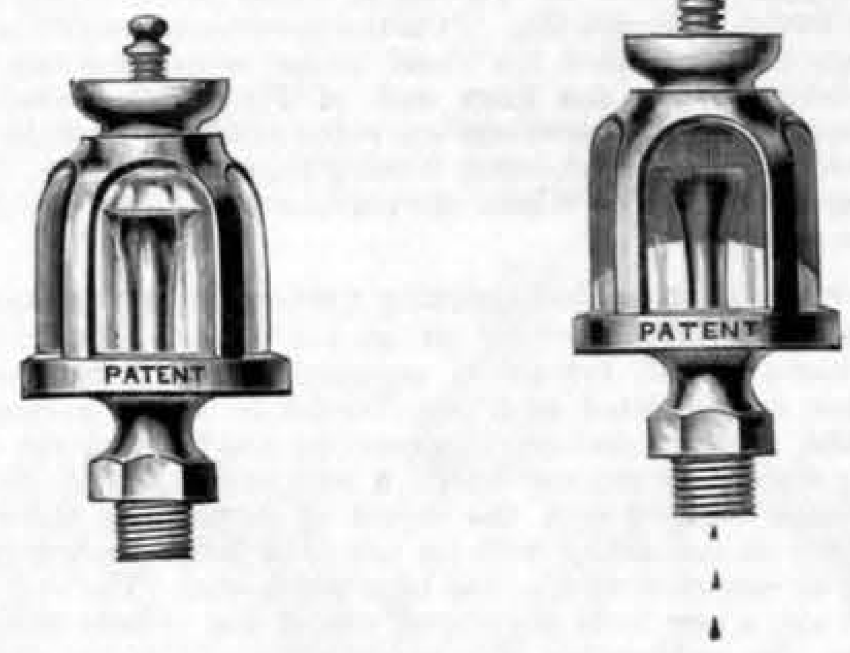
MITTON'S CENTRIFUGAL AUTOMATIC CRANK PIN OILER.

This is being introduced by Messrs. Hunt and Mitton, Oozells-street, Birmingham. The principle involved is very simple. The centrifugal force of the crank is utilised to operate on the loose fluid in the chamber of the cup, or by its upward stroke. It drives the oil to the top of the concave top, from which it is guided into a bell-mouthed orifice,



tapered down to a fine passage, which supplies the oil to the bearing when the crank descends upon the lower half of the revolution.

The same firm are also making the lubricator illustrated. It has been invented to meet the demand for a compact single-connection lubricator with the advantage of a visible feed.



The cock is below the glass, so that the connection may be broken at once without the necessity of disconnecting the lubricator, and new glass may be added whilst in position, affixed from inside the cup. Steam is condensed in the cup by independent supply, and displaces the oil which passes down the oil pipe to the cylinder until all the oil is exhausted, when the water is drawn off and the cup re-charged. Regulation is made by the plug being opened or closed as required.

Iron and Steel Institute: Brussels Meeting.—As already announced, the autumn meeting of the Iron and Steel Institute will be held in Brussels, and will commence on Monday, August 20th. The arrangements are being organised by a local reception committee, of which Mr. Gillon, president of the Society of Liége, is the chairman; Mr. Briart, president of the Society of Engineers of Hainaut, the vice-chairman; and Mr. E. Coppée, of Brussels, and Professor A. Habets, of Liége, the honorary secretaries. The following is an outline draft of the provisional programme at present proposed:—Monday, August 20th—Arrival in Brussels. Reception in the evening by the local committee. Tuesday, August 21st—The morning will be devoted to the reading and discussion of papers, and the afternoon to visiting the Antwerp International Exhibition. Wednesday, August 22nd—The morning will be devoted to the reading and discussion of papers, and the afternoon to visiting places of interest in Brussels. Thursday, August 23rd—The members will leave Brussels by special train to visit the Mariemont Collieries and the Couillet Steelworks at Charleroi, returning to Brussels in the evening. Friday August 24th—The members will leave Brussels by special train to visit the works of the Cockerill Company at Seraing, and the Angleur Steelworks at Liége, returning to Brussels in the evening. A detailed programme will be issued when the local arrangements are further advanced.

TURNBULL'S STEAM TRAPS.

THE accompanying illustrations almost explain themselves. I is the inlet, O the outlet, C the chamber, F V the float vessel, V the valve, S the regulating screw, A V the air valve, S P the sludge plug, or may be a small blow-through cock; the latter is recommended. The traps are direct-acting, and are of the simplest possible construction. As the total weight of the float vessel is carried by the spring—which is made of the special metal, and which is in all ordinary situations practically non-corrosive—it follows that the total displacement of the float vessel is available to open the valve against the steam pressure, and consequently when the valve opens it gives a full and free discharge, the great value of which will

FIG. I

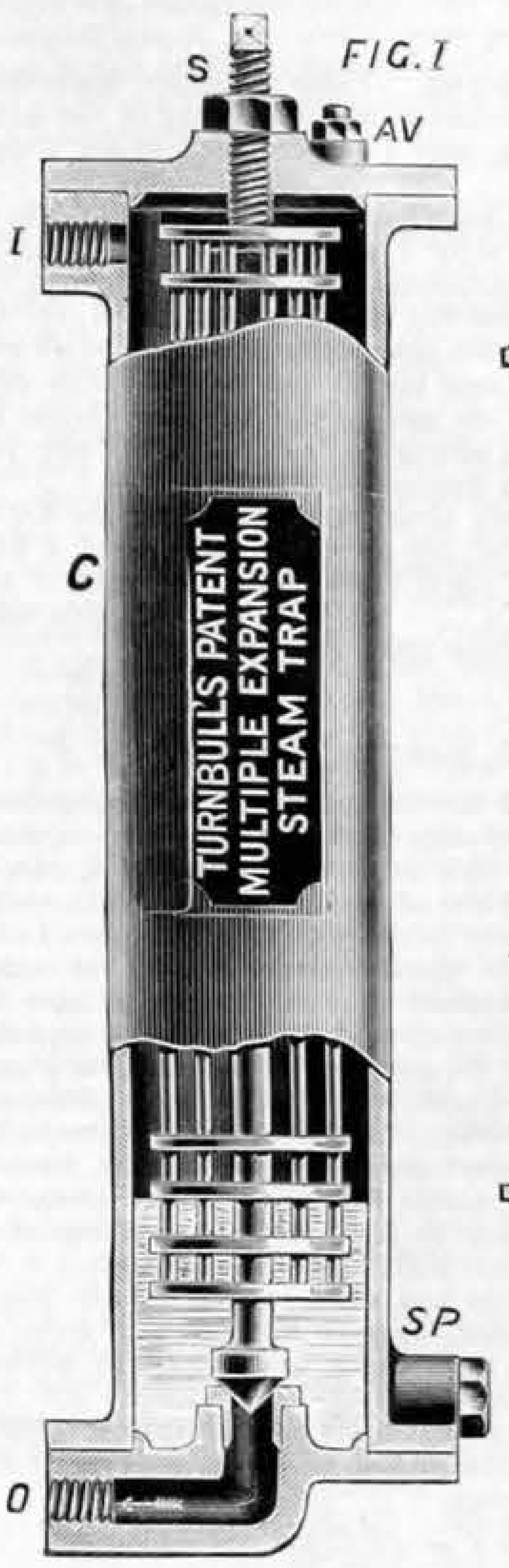
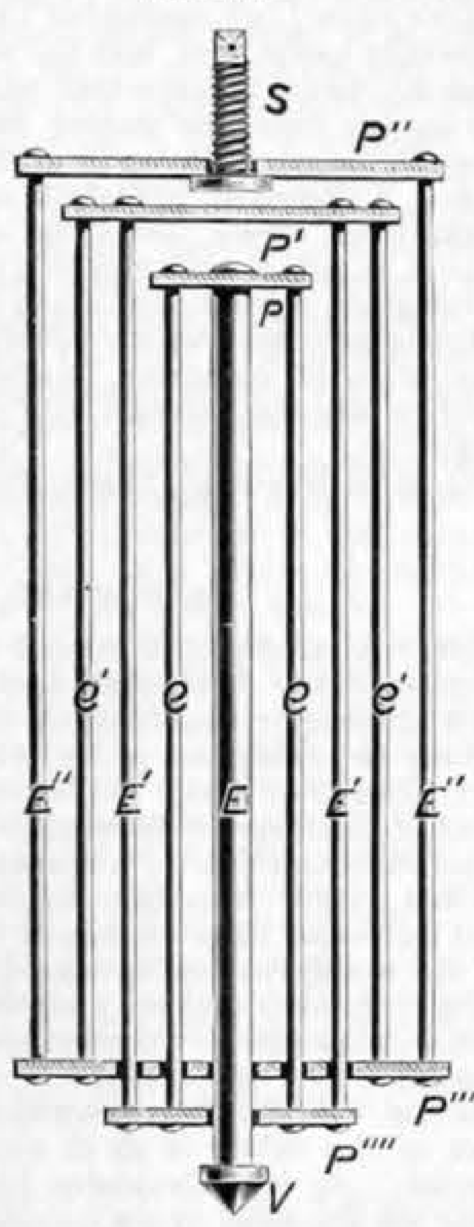


FIG. 3



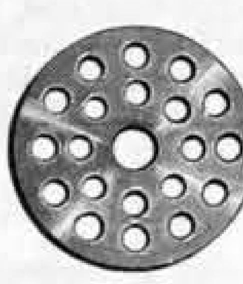
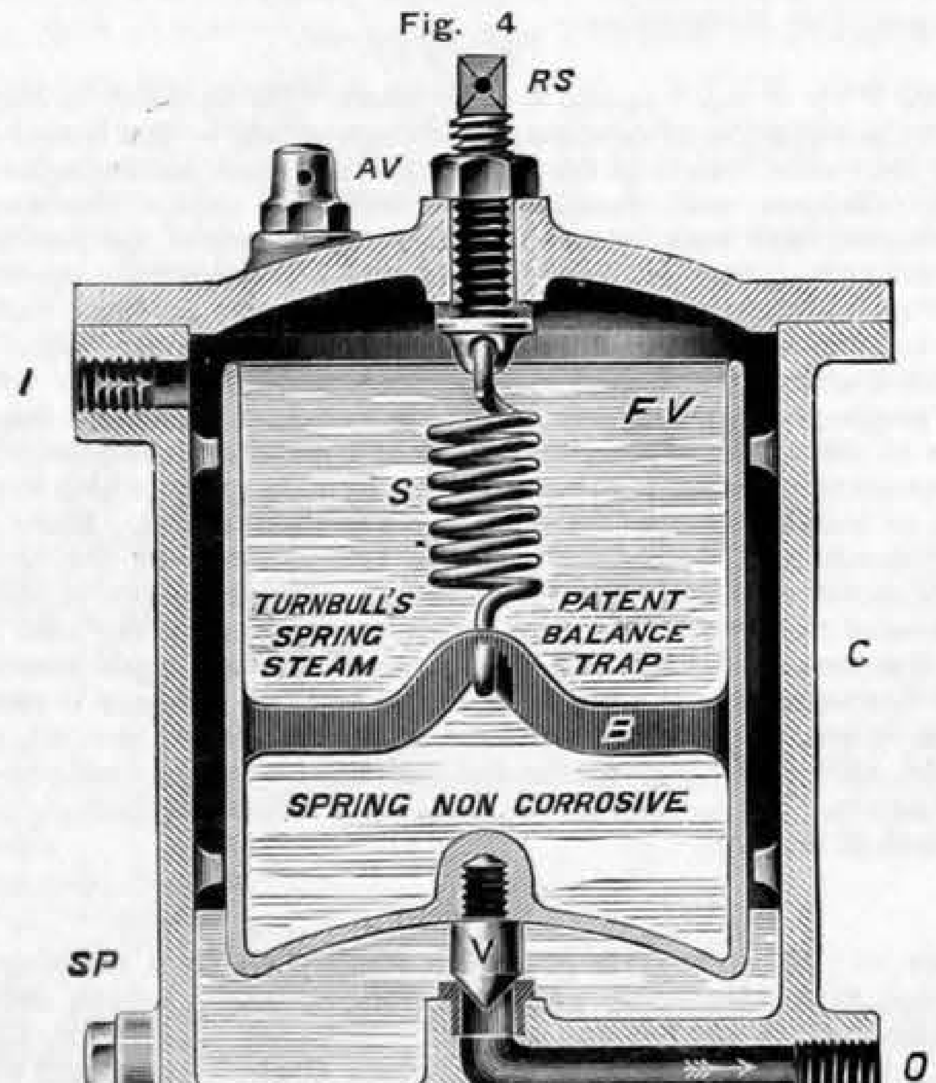


FIG. 2

be fully understood in prolonging the durability of the bearing surfaces. In one form, Fig. 4, the spring is in suspension, the valve being at the bottom, while in another the spring is in compression, and the valve at the top of a central pipe. The multiple trap, Figs. 1, 2, and 3, is constructed like a gridiron pendulum.

The expansion arrangement, which at first sight may appear puzzling to some, is really of a very simple nature, and consists of a series of rods connected by plates and suspended loosely, and so that it cannot be screwed down or jammed in any way, and therefore is not liable to be strained—this

Fig. 4



being a defect common to many other expansion traps—by the regulating screw S, and so that the valve which is formed on the bottom end of the centre rod is just touching the seat when there is very little water in the trap. The rods are arranged in the area of a circle in pairs diametrically—half the number of pairs E, E', E'', being of a metal having a large coefficient of expansion, while the other half *e*, *e'*, *e''*, are of a metal having a small coefficient of expansion, and are so arranged by being fixed to or passing loosely through the plates P, P', P'', P''', &c., as in Fig. 3, that the aggregate difference of expansion due to the number of pairs employed causes the arrangement to shorten or lengthen, and thereby causes the valve to open or shut as water or steam may be in the trap.

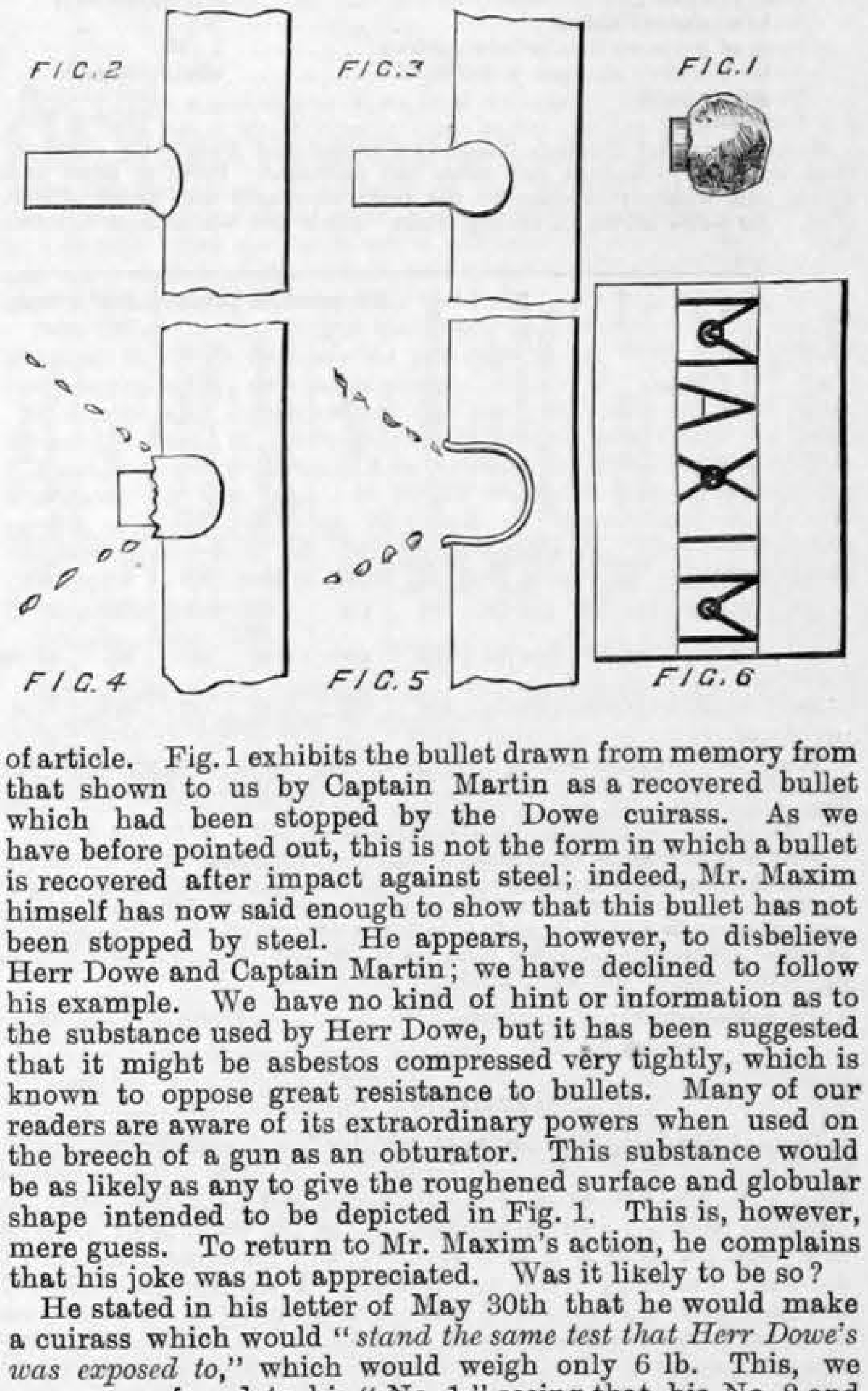
NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet Engineers: Cornelius Pitt, to the Hibernia, Charles E. Stewart, to the Vivid, both additional; W. H. Burner, to the Collingwood, and W. H. T. Bills, to the Victory, additional. Acting Chief Engineer: J. W. Agnew, to the Cordelia. Staff Engineer: J. H. Adams, to the Howe. Engineer: Mark Blakeman, to the Æolus.

MAXIM'S CUIRASS COMPETITION.

IN the daily papers of Saturday, June 9th, Mr. Maxim announced that he had received an immense number of letters from parties who either had a cuirass to sell, or who wanted a cuirass tested, and that he had arranged with the Royal Aquarium authorities that all shields, cuirasses, or armour-plate that may be brought before them should be tested by a skilful engineer, who on that Saturday night proposed to deliver a lecture on the question, viewed from a scientific standpoint, and who would then try numerous experiments, showing the resistance of various bodies to the passage of a bullet, the disruptive force of the bullets, and so forth. The original cuirass made by Mr. Maxim would also be tested, and Herr Dowe or any one else was invited to compete. "Should Herr Dowe produce a cuirass on this occasion," wrote Mr. Maxim, "which will beat mine—weight for weight, and area for area—it should be tested by electricity after the manner suggested by the public press, and if it contains no metallic armour-plate or plates, I am to pay over to Herr Dowe the sum of £100. There will be several other competing cuirasses present, and I offer £10 reward to any one who will bring any kind of armour-plate, not steel, which will show higher resistance—weight for weight, and area for area—than the resistance of the plate of the cuirass which was tested at Erith. All cuirasses will be tested with the English service rifle and ammunition."

Accordingly, at about half-past seven a large audience assembled in the theatre at the west end of the Aquarium to witness an exhibition which, to do it justice, certainly possessed features of scientific interest, but to which attached the boisterous tone imparted by a body of people who have paid for their seats, and have thus acquired a right to express their views, more especially when they are appealed to almost as umpires or judges. Under these circumstances Mr. Maxim did well in appearing in person, and also in drawing on to the stage Admiral Saumarez as umpire, whose ponderous manner was a capital foil to the brilliant personality of Mr. Maxim himself. The surroundings were exactly those which suit an English audience who want fair play, who want interest and fun, but who are swayed by any popular clap-trap to an extent which prevents serious competition being easily carried out. Suggestions and questions from time to time were shouted out from specialists or would-be specialists, and endorsed with cheers or other sounds. We will run through the chief proceedings briefly, and then deal with the features of scientific interest. Mr. Maxim came forward, and after a short explanation of the behaviour of bullets, which we reserve for the end, he made a humorous speech, in which he said that he should try no more jokes in this country, unless, he added in explanation, "This is a joke." He stated that his object throughout had simply been to show that English steel might be made to beat anything that Herr Dowe or any German or other foreigner brought forward that was not steel, and though conceivable, that it would be very difficult to beat it with any foreign steel. That, however good German steel might be, he noticed that if the Germans wanted such a thing as a propeller shaft for a big armour-clad, they came to England for it. The word English was introduced very frequently in contrast to the word German, apparently bidding for cheers and enlisting English prejudice on the side of the Maxim shield. A man feeling for sympathy and support from an audience may do this almost unconsciously; but here it was very marked, and was of course undesirable. The first Maxim Erith cuirass, sold to the Aquarium, was then suspended and fired at. The second cuirass was also exhibited, now leather covered, like the first. This, Mr. Maxim said, was the competing cuirass. He proposed to cut open the first one—"No. 1" as we may term it—and exhibit the inside. After firing at the No. 1 cuirass, he passed it to be felt by any of the audience near. It obviously had not been perforated by any bullet. At this moment a Mr. Loris, a professed rifle shot, asked leave to fire at the first cuirass, and met with such warm support from the audience that Mr. Maxim had to stay his knife before going further. Then he explained that his first cuirass was not in truth plated all over, but merely in the central strip, the portion covered by the word Maxim, as shown in Fig. 6, and he requested that the shot might be only aimed there. This Mr. Loris appeared to consider was not in the bargain, and he fired at the right-hand bottom part, perforating the cuirass, and afterwards he fired, rather unwillingly and on pressure from the audience, at the centre. Mr. Maxim then cut open the first cuirass, showing the centre plating, leather, &c. It contained, he said, 3¼ lb. of steel only. He then said that his second cuirass was of ¼in. steel, and weighed 10 lb. to the square foot. This allowed a certain margin of safety; the service bullet could be stopped, if all went well, with a slightly thinner shield. He placed up also a ⅜in. plate of ordinary steel, and received from Mr. Lowe, who was present, the remains of the package of cordite service ammunition, from which he had fired several rounds at the Dowe cuirass, Mr. Maxim fired them either at the ordinary steel plate or at his own cuirass, just as might be desired. The former let all the bullets pass through, the latter stopped them. He then opened his cuirass, and drew out a steel plate with a turned-up margin. The latter was made thin to show the violence of the particles of lead flying laterally along the face of the plate, which had cut it through, and had there been no further lateral protection would have proved dangerous to persons near. After this followed delay and waste of time, the cuirass, at the request of the audience, being put against a block to prevent swinging, and fired at. Mr. Lowe requested that he might try some steel-coated bullets against the Maxim cuirass, which was naturally objected to. A new Maxim shield, No. 3, was brought out and fired at, successfully resisting the bullets. Then Mr. Maxim was pressed to show the same confidence in his cuirass that was displayed by Herr Dowe in his—that is, to put it on and let it be fired at when on his person. He replied that he had anticipated such a request, and had raised the question at home, but that Mrs. Maxim had charged him on no account to do so; consequently he was unable to accede to this request. Then it was asked was there no one present who would show the same confidence in the English steel that the Germans had exhibited in the Dowe cuirass. In reply, a little sallow boy of perhaps ten or eleven years of age proudly stepped forward and squeaked out that he knew nothing of Maxim or Dowe, but that he was an Englishman, and would stand fire in the cuirass. This gallant little yellow man, we regret to say, was greeted with laughter, rather than the applause he fairly earned. No one eventually stood fire in the cuirass. Then followed an exhibition of the behaviour of bullets entering other metals. Zinc, 1in. thick, stopped the bullet, setting the end up flat. A copper plate, 3in. thick, had a sort of pocket blown in it, in which remained a thin coating of nickel and lead. Then a shield brought forward by a Mr. Neate was tested, which successfully resisted the bullets, but which weighed 14 lb.; a lighter one was pierced. A third light shield was also pierced.

We may now pass to the scientific standpoint, as Mr. Maxim calls it. He early in the evening explained the action of the bullet by diagrams, which we roughly reproduce in Figs. 1, 2, 3, and 4, which show the successive conditions of a lead bullet striking a steel plate. It will be seen that the head is spreading out in Figs. 2 and 3. In Fig. 4 the head is shown flying off at the edges, and in 5 the final state is shown with the cavity fully enlarged, the nickel casing forced out as a lining, and nearly all the lead thrown off. Mr. Maxim described the behaviour of the lead at this high velocity as being exactly that of water driven into a substance of suitable body. With the illustrations referred to this was very good in its way, but there is nothing very new to specialists. We believe that very hard-faced steel plates have been made by other manufacturers only $\frac{2}{10}$ths thick which have actually resisted the service bullet, but which, although thinner than the Maxim shield, were probably of no better quality, as we may grant him a little more thickness for the larger factor of safety which he probably had, and indeed claimed. Mr. Maxim has, in fact, exhibited an excellent steel shield, such as it is probable would be very difficult to beat. He has done this, but no more and no less. Such a shield may possess advantages over the one exhibited by Herr Dowe, but we do not believe that it is the same kind



of article. Fig. 1 exhibits the bullet drawn from memory from that shown to us by Captain Martin as a recovered bullet which had been stopped by the Dowe cuirass. As we have before pointed out, this is not the form in which a bullet is recovered after impact against steel; indeed, Mr. Maxim himself has now said enough to show that this bullet has not been stopped by steel. He appears, however, to disbelieve Herr Dowe and Captain Martin; we have declined to follow his example. We have no kind of hint or information as to the substance used by Herr Dowe, but it has been suggested that it might be asbestos compressed very tightly, which is known to oppose great resistance to bullets. Many of our readers are aware of its extraordinary powers when used on the breech of a gun as an obturator. This substance would be as likely as any to give the roughened surface and globular shape intended to be depicted in Fig. 1. This is, however, mere guess. To return to Mr. Maxim's action, he complains that his joke was not appreciated. Was it likely to be so?

He stated in his letter of May 30th that he would make a cuirass which would "*stand the same test that Herr Dowe's was exposed to*," which would weigh only 6 lb. This, we presume, referred to his "No. 1," seeing that his No. 2 and No. 3 weighed 10 lb. to the square foot. It must be presumed that *this*, then, and not either of the others, was the one that he invited Mr. Lowe to fire at when he authorised him "to see that the experiments were conducted in exactly the same manner." Yet it was this cuirass that he nevertheless refused to allow anyone to fire at at Erith, and which it turns out now only contained a strip of steel down the centre. Had he been so sure that the Dowe cuirass had only received blows on the central part thus protected, and that he allowed Mr. Lowe exactly to repeat the same attack, he would have been in a sort of way justified. As it was, he put himself out of court. Next as to cuirass No. 2 and No. 3. These, he says, weigh 10 lb. to the square foot. Now, Herr Dowe's, being 12in. by 16in., has an area of 224 square inches, and would, at 10 lb. per square foot, weigh 15⅝ lb., so that it is lighter than Maxim's. Mr. Maxim's offer to compete sounds, however, fair. Herr Dowe could not complain of the electric test as to steel, as it would reveal nothing, but only test the truth of what Herr Dowe has already told us. Nevertheless, Mr. Maxim's letters and action had not been such as to encourage a man to venture his secret into the Aquarium with its boisterous if well-intentioned audience. Herr Dowe's cuirass is his only child, Mr. Maxim has more like 200 children; the former would naturally be careful. We confess to reading all that Mr. Maxim writes now with special care as to its meaning. We will give, for example, the second invitation, that to all competing cuirasses. Probably many readers thought that any of the steel cuirasses competing last Saturday were open to receive the £10 offered if they beat Mr. Maxim's cuirass. As we now read it this was not so. The invitation says "*not steel*" plainly enough. Probably even the wretched steel plate which was perforated every time was as good as any metal plate not made of steel, and so even this would have held the field. Mr. Maxim may fairly plead that this is plain enough, but surely a true Englishman would consider it right to remind the competitor that he was not open to the prize before his shield was fired at. This was not done. Altogether we would conclude by the remark that Mr. Maxim has done himself harm rather than good by the Maxim cuirass. His powers of invention are splendid, it is a pity to have made his name famous by anything so much less to be admired.

THE JUNIOR ENGINEERING SOCIETY.—On the 5th inst. the locomotive works of the London and South-Western Railway, at Nine Elms, were visited. Mr. William Adams, superintendent, was present to receive the members, and made adequate arrangements for their guidance through the numerous departments of the extensive works. The thanks of the party for the facilities enjoyed were conveyed by Mr. P. J. Waldram, chairman of the Society.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

WATER-TUBE BOILERS.

SIR,—Referring to your leading article in last week's issue on "Boiler Efficiency," permit me to refer you to the enclosed cutting from Messrs. Conrad Knap and Co.'s catalogue of their well-known "Root" water-tube steam boilers, giving particulars of tests made at the cement works of Messrs. Brooks, Shoolbridge, and Co., Grays, Essex. I having already on a former occasion ascertained to my satisfaction that the said testing was carried out in the most careful and trustworthy manner, and that the steam was perfectly dry.

You will notice that the average evaporation over 77 hours is 4·12 lb. of water per square foot of heating surface, 10·2 lb. of water being evaporated per lb. of coal, from feed of 110 deg. under 120 lb. steam pressure, no allowance being made for clinker, &c. The length of the tubes in this boiler is only about 8ft., and this accounts for the greater efficiency of the heating surface as compared with the boilers you refer to in your article, it being a well-known fact that water-tube boilers with short tubes evaporate considerably more water per square foot of surface than boilers having long tubes. This important consideration is, however, frequently overlooked by buyers of boilers, who are commonly anxious only to get as much heating surface as possible for their money; and boilers with long tubes are obviously much cheaper to manufacture per square foot of heating surface than those with short tubes:—

Evaporative Tests.

Total tube surface of boiler	985 square feet
Grate surface of boiler	30¾ " "
Ratio of grate surface to tube surface	1 : 32
Water contents at mean water-level	about 820 galls.
Steam room at " "	" 106 cubic ft
Feed-water	" 110 deg. Fah.

Water measured through Kennedy's meter and frequently checked. Coal weighed. Clinkers and ashes not deducted. Fires in same condition and water-level same at the commencement and finish of each trial. No water blown off during trials. Each test continuous. Steam dry.

Duration of trial. (continuous.)	Water evaporated. Total during trial from 110 deg. Fah.	Coal burnt. Total during trial. Welsh steam coal.	Water evaporated per lb. of coal, from 110 deg. Fah.	Working pressure.	Evaporation per hr.			Coal burnt per hour.	
					Total.	Per square foot of tube surface.	Per square foot of grate surface.	Total.	Per square foot of grate.
Hours	Gallons.	Gross lbs.	Gross lbs.	lb. per sq. in.	Galls.	lbs.	lbs.	lbs	lbs.
42	16,922	†15,770	‡10·73	120	403	4·09	131	375	12·2
6	2,584	†2,407	‡10·74	120	431	4·37	140	401	13·04
29	11,187	†11,070	‡10·1	120	385	3·91	125	382	12·4

Work very irregular during this trial. The boiler evaporated during this trial about 600 gallons per hour for several hours, owing to stoppage of another boiler—remainder easy work.

† Weight of clinkers and ashes not deducted.

‡ No addition made on account of clinkers and ashes.

Sundry stoppages of engine during each trial for the purpose of connecting or disconnecting machinery, and the dampers and doors in consequence had to be regulated to stop boiler making steam. The quantity of water evaporated per hour does, therefore, not represent as much as the boiler actually did when steaming full.

50, Lombard-street, London, June 7th. ROBERT PORTER.

ENGINEERING AS A PROFESSION.

SIR,—I have read the letter of "Pater" on the above subject in your issue of May 25th, and would like to offer a few remarks from a student's point of view, and to this end I will give what has occurred from my own experience. Some ten years ago I entered as a pupil the office of a civil engineer, and for about two years I did—as I find many others do—nothing. I was rudely awakened at this time to the fact that I must earn my living in the profession to which I was attaching myself, or take to some other. Looking round to see what I could do to improve and work up any natural abilities, I began to study at a technical school the various stages of mathematics, mechanics, drawing, &c., success attending these efforts; and for a higher theoretical education I joined and passed through the three years' course of engineering at one of our prominent engineering colleges, under a professor who is himself a M.I.C.E. Also, during these three years I studied for the engineering degree to be obtained at the Royal University of Ireland. Of all the pupils at the engineering laboratory, there were about three or four of us who can now be said to be earning our livings; most of the others have had to enter afresh, at the average age of twenty or twenty-one, as pupils in some engineering establishment. In cases twelve months have been taken off for their training in the laboratory.

Last year, when at Dublin, several graduates accosted me with the question of whether I could obtain for them an appointment in England? Many a three years' civil engineer's apprentice would smile at their weak efforts of draughtsmanship—and, by the way, the drawings executed in the engineering colleges are poor specimens of the work that has to be done in an engineer's office. They are rarely as intricate, and the dimensions are just as often not figured; and again the example set to them from a professor's brain is, as a rule, but a feeble sample of an incident from actual experience.

One of the candidates last year who had never in his life given any attention to engineering, and had gone in for acquiring the degree from mere study, laughingly told me that he did not know the difference between a theodolite and a level, and had never had either the one or the other in his hands, was actually called for honours and got them. It is a little satisfactory to learn that he has taken up the calling of a "bacon factor." Here arises the question of "what is the value of a B.E. degree as a qualification for a man calling himself an engineer?"

The conclusions I draw are much the same as those of "Pater" as to technical instruction alone, but if the course is taken simultaneously with the apprenticeship the student is the gainer, as he learns in the classes what he would never obtain in the office, and *vice versâ*. To conclude, and follow these conclusions to a practical example. Four years ago I obtained my first appointment away from home, and eighteen months have passed since I accepted a berth which carries with it the charge of the design and construction of a scheme costing £80,000, and these without canvassing or influence being exerted. STUD. INST. C.E.

June 9th.

SIR,—In your recent article on "Engineering as a Profession," you expressed a desire that the subject should be discussed; the dogmatism which we find written in your correspondence columns can hardly be said to come under the heading of discussion. "Denarius" shows most convincingly that technical education is wasted upon those who deal in scrap iron and the like, but the question is by no means exhausted in his exposition.

Let us first ask ourselves whether there is need of technical instruction. I find the answer to that question very plainly suggested by the following considerations. How am I to know the properties of materials used in engineering work? How shall I determine the stresses in structures to enable me to arrange my material most economically? How can I design a valve gear correctly without expensive models? Why, in the choice of gearing, is its mechanical efficiency so little regarded? Why are so many air compressors inefficient? How are the stresses in structures affected by the elasticity of the materials used? These are queries which must at some time present themselves to the young engineer, though it is obvious from the work turned out by many firms that their eyes are blinded to these important considerations by the glare of their own self-satisfaction.

Let us consider how we may attack these problems. We may procure abundant literature and educate ourselves by close application, but a book knowledge is not by any means sufficient to supply the want felt. Now I believe that it is to supply this long felt want that technical education has become systematised. At present there are two broadly distinct methods of teaching. Firstly, there are institutions where students are taught to handle machine tools and to acquire some knowledge of fitting, verbal instruction being given in lectures intended to supply practical and theoretical knowledge. Secondly, there are a few institutions where they do not profess to teach the arts of fitting and turning, but devote their energies entirely to testing and experimental work, with its theoretical and practical application, lectures being given to direct the experimental work.

Both these systems are largely supported, showing that there is perhaps some need of both. But the opinion is fast growing that the latter system is best suited to fit men for the ever increasing demand upon the enterprise of the engineer. It is of course essential that shop training should be gone through before availing oneself of this latter method. Having experienced the effects of both systems, I feel very strongly in favour of the latter.

"Denarius" says there is no more science in machinery than in "blankets or tea." This is no doubt true in his case. But let me ask who is best fitted to make the long and costly experiments he speaks of—is it the man who is trained to make accurate observations and to conduct experiments successfully, or one whose only knowledge of the subject is the price per ton of the material? Your correspondent also says, "the oil engine has emanated from men who have had no scientific training. One of the best is the invention of a medical man." I was not aware that the medical profession is so devoid of the first principles of science—whether applied to engineering or not. This quotation speaks volumes for the cause of technical education, it being capable of the most obvious paraphrasing, namely, that engineers have not the necessary scientific knowledge to assist in the development of their own profession.

It cannot be denied that in the struggle to attain a high position in the engineering world, many are over-educated for the work they do, but the burden of responsibility must not be placed with those engaged in the great and responsible work of supplying to young men that knowledge which they may or may not ultimately require. The latter is entirely beyond the region of prediction.

In conclusion let me but say that whilst the systems of technical education are not without the possibility of improvement, I nevertheless hope that this letter will be read as an emphatic protest against its abolishment. I further wish to urge that special attention be paid to the different methods of the various technical institutions in order to choose that most suited to the ultimate requirements. F. G.

Leeds, June 9th.

SIR,—Is not your correspondent "Pater," in your last week's issue, trying to make technical colleges responsible for an evil for which nothing less than the whole social system can be held responsible?

At the present time there are a certain number of "jobs" existing in the world. There are a certain number of men and women candidates for these jobs. The number of men and women largely exceeds the number of jobs. I write in every-day language. Whatever the future may bring us in the way of remedies, it cannot be denied that at the present moment what I have said is the case.

I am aware that all this is commonplace to a degree. My point is this. If technical colleges were to tout for pupils even to the extent that manufacturing engineers tout for customers, things would not be a halfpenny worth the worse. As a matter of fact I cannot see that technical colleges do tout; but let that go. If one profession become very much more overcrowded than another, the public will hear of it soon, and with no uncertain sound. There are newspapers and magazines published in this year, 1894, and though their news is a little shaky at times, in general we get to know glaring facts. The ratio $\frac{\text{Number of candidates}}{\text{Number of jobs}}$ is well above unity in all professions, and it varies by jumps in any one profession from time to time; so does the speed of an engine with an ancient sort of governor. But just as the engine does not stop outright or reach excessive speed, by reason of its governor, so will this ratio be prevented from becoming much larger in one profession than another by public outcry—this too even in our profession, and spite of possible skyscraping advertisements of technical colleges. Indeed, so far as this goes, touting is only likely to draw attention the sooner to overcrowding instead of dragging in fresh victims.

I can only agree with "Pater" that many men try to be engineers who are not made of the right stuff. But to my certain knowledge technical colleges do a good deal of sifting in this line, and in a way much less expensive of time and money than a pupilage in the shops. To be sure, many men get beyond college and are then stranded, but this in the main is due to over-population. No improvements in details of training can alter it.

"Pater" surely does not mean us to understand that in his mind there is an idea of apprenticeship *versus* technical college as a training for an engineer. The engineer, at any rate of the future, must have knowledge which can only be gained in the shops, and also knowledge which can most easily be gained at a technical college.

What is wanted is that engineers should work hand in hand with technical colleges, instead of affecting to despise them. We might then get much better arrangements, both for sifting men and training them, than we have at present. You, Sir, have suggested this in your admirable leader this week.

Nevertheless if all systems of training were perfect, the ratio $\frac{\text{Number of candidates}}{\text{Number of jobs}}$ the world over would not be altered.

There is one idea which, if generally given up, might help matters a little—that it is *infra dig.* to get a living by handicraft work. There are many men born in a position which makes them think this, but who have not brains enough to do brain work. Let them give up this idea as to working with the hands. Many have done so, but too many have not. I am aware of the unpleasantness in companionship, and so on, which now goes with such a course. But facing the difficulty boldly is the only way of removing it.

Members of our profession may thank "Pater" if he prevents his one man from becoming an engineer. All other professions will not thank him unless he contrives to get his man buried in some unknown manner. I will trespass on your space no further.

Bristol, June 6th. SON.

SIR,—As one of the ingenuous youths mentioned by your correspondent "Denarius," I should like to express my opinions on the above subject. First of all, with regard to a theoretical training, it is obvious that a man cannot ever hope to be an engineer unless he understands the why and the wherefore of the various parts of the machine he has to deal with. Where is he to obtain this very necessary knowledge? Certainly not in the shops. Again, everyone knows that the modern engine has undergone a process of evolution, and is a case of survival of the fittest, as "Denarius" mentions in his letter published in your issue of the 8th inst., but it must have emanated from something. Drawing a simile from "Denarius," there is a missing link. Every kind of mechanism had an origin, this being supplied by the theoretical engineer in the first instance.

To specialise somewhat, take the case of an engine working with saturated steam. Anybody with a knowledge of thermodynamics is aware that there is a certain maximum theoretical efficiency possible.

Now the actual efficiency is far less than this, but it cannot be sensibly increased by any alteration in the construction of the machine or boiler, else it would have been done years ago by the practical man. The theorist now comes in and says, "Superheat your steam," and the efficiency of the engine is at once increased. Further, may I ask, "Is the refrigerator entirely due to the practical man?" I think not. Without some knowledge of the physical and chemical properties of the various agents used, one of the greatest boons to civilisation would never have been invented.

In conclusion, my argument is this:—All machines of a class differ only in their practical construction, and have been perfected as far as the ruling conditions will allow. Any improvement which can, therefore, come only from the theorist is of commercial value. Hence a theoretical training is of commercial value.

7, Eastcombe Villas, Blackheath, S.E. CECIL LIGHTFOOT.

SIR,—I have read with interest "Pater's" letter and others which have appeared in your columns, and being one of the unfortunate youths under discussion, may I be permitted to ask a question.

Ever since I can remember I have had a weakness for engineering especially locomotive, and the older I have grown the stronger has been my desire to learn that particular branch. I have been trying for two years the leading railway and contract shops up and down the country, and yet I cannot get in; there seems to be no work to do. I know the hardships one has to put up with, the dirty work, long hours, but these do not in the slightest damp my ardour, in fact it only makes it stronger. I would go to any part of the globe if need be to learn locomotive engineering.

While your readers are talking about the welfare of the future generation of engineers, would one of them kindly put a little practice into the question, and see if every youth is made of soft stuff? E. R. BRIGGS.

89, Belle Vue-road, Leeds, June 12th.

CARNOT AND MODERN HEAT.

SIR,—As nearly all who read the letters in your correspondence columns either frankly acknowledge that they do not understand mathematics, or merely think they do, but do not, I took care to put my two criticisms of Mr. Alexander's communication in such a form that they would be clearly intelligible to all who are in the habit of thinking for themselves, whether they do or do not understand mathematics. I am surprised that my criticisms have not elicited a reply from Mr. Alexander, and certainly fully expected that he would have explained the meaning of the symbols M and N, and would have endeavoured to show the falsity of my criticisms, since he himself evidently considers that the relations between the scales of the two air thermometers and the absolute scale, form an important part of the thermodynamic fabric. If my criticisms are just and well founded, according to Mr. Alexander an important part of the fabric of *fin de siècle* thermodynamics must fall to the ground. As Mr. Alexander has not done so, I must ask you to allow me the small space necessary to give the *coup de grace* to his analytical investigations, in a form easily understood by all who are interested in the discussion.

Mr. Alexander states that, by Regnault's experiments, it appears that N is constant. The formula quoted therefore reduces to the form

$$\mathrm{J}\left(\frac{d\,\mathrm{M}}{dt}\right)^{v} = \left(\frac{d\,p}{dt}\right)_{v}$$

There are only two possible values of M which can satisfy this equation, viz., $\mathrm{M} = \frac{p}{\mathrm{J}}$ or $\mathrm{M} = \frac{p + \text{const.}}{\mathrm{J}}$, where the constant must represent a pressure, since we can only add a pressure to a pressure. We may therefore put const. $= p_o$. If we put either of these values in the equation

$$\mathrm{J\,M} - p = \mathrm{V}_1, \quad . \; . \; . \; . \; . \; . \; . \quad \mathrm{A}.$$

we shall get $\mathrm{V}_1 = 0$ or $= p_o$. In either case the equation A reduces to the form

$$0 = \mathrm{O}.$$

If we substitute either of these values in the equation of relation alleged by Mr. Alexander to exist between J, M, p, and τ, viz.,

$$\mathrm{J\,M} = \tau\left(\frac{d\,p}{d\,\tau}\right)_{v} \quad . \; . \; . \; . \; . \; . \quad \mathrm{B}.$$

We get after integration—

$$\mathrm{P} = \mathrm{A}\,\tau,$$

where $\mathrm{P} = p$ or $= p + p_0$ and A is constant. This equation is identical with the equation of relation, which, according to the law of Boyle and Marriotte, exists in the case of perfect gases between the absolute pressures and temperatures indicated by a thermometer graduated with equal intervals when the volume of the perfect gas remains constant. If, therefore, equation B were true, the conclusion at which Mr. Alexander has arrived would be true, viz., that $t - t_o = \tau - \tau_o$. Equation B is, however, not true. Mr. Alexander has simply assumed it to be true, and has failed to advance one single argument in support of his statement that the temperature on the absolute scale differs from that of the constant volume or constant pressure air thermometer by a quantity which is either zero or has the same value at all parts of these scales. Since equal increments and decrements of the temperature on the absolute scale correspond with equal increments and decrements of the heat possessed by the air, Mr. Alexander has to prove in the case of the air thermometer that when the volume is constant equal increments and decrements in the pressure, and when the pressure is constant equal increments and decrements of the volume of the air, correspond with equal increments and decrements of the heat possessed by the air. WILLIAM DONALDSON.

June 11th.

ENTROPY.

SIR,—"When heat is given by conduction to a working substance, that substance, after the influx, must be in a different condition from what it was before." Thus has written Dr. Lodge; and I think your correspondent, "Otto Cycle," would not object, nor would be troubled in his slumbers, if he made the admission that whenever heat, by conduction or otherwise, entered or left a working substance, this substance would then be in a different condition from its antecedent state. Furthermore, this difference, conventionally, might be named *a difference of entropy*. And, if any purpose was served thereby, sufficient to overrule a not unjustifiable repugnance against violation of Sir Isaac Newton's "first rule of reasoning in philosophy," viz., "We are to admit no more causes of natural phenomena than such as are both true and necessary for their explanation"—I quote from memory—then "no one would be a penny the worse!" I, in a published paper, have characterised the usual explanations on *entropy*, as unnecessary and improper mystifications of a simple matter, the results of which have been that we have entropy written about as if it were a definite objective existence, instead of its real meaning—the quantitative superficial phenomenon of the definite entity, heat.

The equation $\phi_1 - \phi_2 = \int_1^2 \frac{d\,\mathrm{Q}}{\mathrm{T}}$, or otherwise, when the members are very small, $d\,\phi = \int_1^2 \frac{d\,\mathrm{Q}}{\mathrm{T}}$, signifies: the variation of entropy is equal to the sum of the variations of the involved quantities of heat, each being divided by the absolute temperatures of the associated matter, as influenced by those quantities of heat. Now, variations of the heat, whether influx or efflux, are causes; to be measured by the product of two conjoint phenomena, as their effect. First, the quantity of matter with which the heat is associated. Secondly, by the *intensity* of the temperature effect which the heat induces in that matter; which, in turn, is defined as its absolute temperature, and, also, involves a quality of the matter defined as its specific heat. The absolute temperature being denoted by T, the ratio $\frac{d\,Q}{T} = \frac{\text{quantity} \times \text{intensity}}{\text{intensity}}$ = quantity simply. That is to say, the quantitative factor of the variation of heat d Q, on eliminating the complexity arising from the conjoint intensity factor. Hence, when integrating this function over a Carnot cycle (in which the working substance, after receiving a quantity of heat, finally returns to its initial state), the heat given back and the work done, evaluated according to the thermal equivalent, together are *precisely* equal to the heat furnished to the working substance; and necessarily, we have $\int d\,\phi = \int_1^2 \frac{d\,Q}{T} = 0$. This has been a not unimportant contribution to the common fund of this science. Only, the mistake has been, the having had it advanced as a reversal and condemnation of the even more important work of preceding investigators, while an air of novelty and fictitious personal claims, most improperly, have been sought to be affixed to it, by insisting on a ludicrously mistaken notion, to the effect that prior to certain mathematical processes, asserted to be cognate thereto, the doctrine had been that heat could do work without suffering any diminution of its quantity. Such statements, when not stigmatised as entirely dishonest and false, at best were highly ungenerous and misleading. It having been an axiom with capable thinkers that, whenever work was done, we must have had a quantity of heat proportional to the work done, disappearing as heat; and having now to be accounted for in mechanical effects produced. Now, effects due to an imponderable cause, have to be considered from two points of view: as to their quantity, and also as to the co-ordinate intensity. That is to say, not singly, but as a product, for the one factor can merge into and take the form of the other; the conjoint product, alone, can give the equivalent of the vanished heat. In point of fact, the mechanical effects are but modes or manners of existence of heat. Professor Tait very properly writes:—"Heat, though not material, has an objective existence in as complete a sense as matter has." Doubtless, it is the present fashion to speak and write about heat as a "form of energy," which is merely introducing, under a new name, the old *tertium quid*, in physics known as caloric, and in chemistry as phlogiston. Energy, as a conventional name, may be useful; conservation of energy is but one way of saying that heat is an indestructible entity, invariable in quantity, but capable of existing in various shapes, of which temperature of matter and sensible movements of matter, to us, are the most direct and obvious phenomena.

From this thermo-dynamical point of view, many difficult and intricate mechanical problems become much simplified. I have long pointed out how directly it enables us to arrive at the true law of the relation of power and speed in steam vessels. I would again refer to the investigations, really pertinent to and introductory to the discussion of this matter, published in THE ENGINEER about twelve months ago. Take, for example, the fifth set of trials upon H.M.S.S. Iris, for which this relation was shown to be: $E = D^{\frac{3}{5}}\ V\ 10^{(V - 10\cdot91)\cdot0662}$.

This vessel, with the displacement D = 3724 tons, was propelled at the respective speeds, V = 17·98, 16·10, and 12·63 knots. If so, the corresponding powers, in indicated horses, ought to be as follows:—

Test speeds, V	=	17·98	16·10	12·63
Subtract, X	=	10·91	10·91	10·91
Then, (V − X)	=	7·07	5·19	1·72
∴ (V − X) ·0662	=	·4680	·3435	·1138
Add, log. V	=	1·2548	1·2068	1·1014
„ $\frac{3}{5}$ log. 3724	=	2·1425	2·1425	2·1425
Sum, or log. E	=	3·8653	3·6928	3·3577
∴ E	=	7334	4930	2279

Exactly, as given by trial data!

The rationale of this very simple calculation is, the quantity factor $D^{\frac{3}{5}}$ V, into the intensity factor $10^{(V - 10\cdot91)\cdot0662}$, is, necessarily, the measure of the heat, which, in this vessel, must have disappeared from the steam, in developing the indicated horse-power E. In a hydro-dynamical point of view, we may equally state the matter thus: a volume of water, proportional to the product $D^{\frac{3}{5}}$ V, is driven astern, past the vessel—through the *Poncelet paroi* or imaginary pipe—by a pressure proportional to the factor $10^{(V - 10\cdot91)\cdot0662}$, the power thus expended is necessarily proportional to the product $E = D^{\frac{3}{5}}\ V\ 10^{(V - 10\cdot91)\cdot0662}$, and we may again transform this to a still more mechanical, but equivalent shape, by writing it in the form: $E = 26\cdot30\ V\ 10^{\cdot0662\,V}$: where the factor 26·30 means: the measure, in indicated horses, of the initial torque of the screw shafts, when the vessel first begins to move; this torque being made up of a force, the product of Morin's constant, or the mean diagram steam pressure upon the pistons, under which they first begin to move; into the piston travel, corresponding to the revolutions—whole or fractional—of the shaft, when the vessel just begins to move; in this case of the Iris V[th], amounting to 26·3 indicated horse-power. The test as follows:—

V	=	17·98	16·10	12·63
Then ·0662 V	=	1·1903	1·0658	·8361
Add log. V	=	1·2548	1·2068	1·1014
Add log. 26·30	=	1·4202	1·4202	1·4202
Sum, or log. E	=	3·8653	3·6928	3·3577
∴ E	=	7334	4930	2279

Exactly the same as by the former calculation, and as shown by the trial data. Having thus given an example of theory and its application, I will not intrude further on your space at present.

ROBERT MANSEL.

Glasgow, June 4th.

TRANSATLANTIC RIVALRY.

SIR,—The commercial depression that exists within our borders at the present time is due neither to reckless speculation, strikes, mono-metallism, nor any other single cause, but to all of these and many more besides. In some measure it is the result of increasing competition from without. Powerful rivals in lines of manufacture, which in former times were almost exclusively our own, have risen up, and not only have they established themselves firmly side by side with us in export trade, but they have even rounded on us, and now pour into our home markets numerous articles cheaper, if not better, than we can make for ourselves. Some few things, indeed, we still supply to our neighbours without fear of competition, and of these we may mention warships in particular.

Within the past few weeks, however, our enterprising kinsmen of the United States have asked H.M. Government for designs, in order that they may tender for the construction of warships for the British Navy; and so, we may presume, the decadence of the Briton in matters navicular has also begun.

If we are not on the downward grade ourselves, it must be that our American cousins are very much in the ascendant, and are actually outstripping us in the race of commerce. It may therefore be interesting, and perhaps instructive, to consider this matter a little in detail.

First of all, what American firm is it that offers to build battle-ships for us? And how and by what means has it risen to this exalted position? We have to look to Philadelphia, Pa., and to the firm of Cramp and Co., of that city, to learn.

It is not, certainly, because the yard itself belonging to this firm occupies an exceptional situation for shipbuilding that it comes so suddenly into fame. It stands on the swampy banks of the Delaware, about seventy miles by water from the sea, and with an approach to the deeper parts of the river, made and maintained only by dredging. Nor has it coal and iron mines at its gates, to reduce to a minimum the cost of transit. On the contrary, all the material for construction has to be brought to it from Pittsburg, many miles away. Neither are wages there lower than in Great Britain, to enable them to compete successfully against us. Indeed, wages are much higher.

A visit to the works will show nothing remarkable in the way of a shipyard, and though the largest in the United States, it is yet smaller than many British. In its equipment, too, as a yard, it hardly comes up to some of them, or to its own engine and boiler-shop departments, which, it must be admitted, are well supplied with good machinery. The newest machines are introduced whenever an opportunity presents, but many of these are made in the old country. The visitor, as he looks around the yard, will be surprised to find, however, that attempts have been made to obliterate the names of the English makers wherever it can be done cunningly and without disfigurement, the jealousy of the "Britisher" which exists being perfectly puerile. Nothing of the nature of labour-saving appliances can be seen which are not well known and used on this side of the Atlantic. A floating crane may be pointed out, but its advantages over the fixed cranes generally in use are very questionable.

The offices, too, of commanding elevation, near the entrance gates are stuffy within, both from the lowness of the ceilings and the overcrowding which exists in them. Nothing in all this, therefore, calls for special notice or imitation.

Mr. Charles Cramp, the manager of the whole concern, is dubbed president; and under him is a numerous staff. Strangely then, as one passes along, do the dialects of Englishmen and Scotsmen fall upon the ear from the lips of the chief draughtsmen bending over their boards, in their much-extolled American drawing-office. On inquiry it will be found that these men, who are doing the principal work of the place, are, five-sixths of them, British and Swedish. No doubt there are many young citizens of the United States in addition, but these, it will be observed, are mere tracers. And the best workmen in the yard besides are British and German.

It is difficult to conceive that this United States firm could then, under such conditions, build a war vessel for us, either as well or at as low a cost, as we could build for ourselves; and from a purely business point of view, it is incomprehensible why they should essay to do it. Merely to study the very latest designs of battle-ships and cruisers evolved from the British Admiralty, would be only waste of time to the naval architects who have designed the Columbia, the "gem of the ocean and the sweeper of seas." Still there are rumours afloat about grave defects existing in the machinery of both the Columbia and New York, but, let us hope, without foundation, else these ocean greyhounds will be found wanting in time of need. Should such defects have really been discovered, though, there will be time to remedy them in the two war vessels now being built; and possibly any little hints of recent British practice might be welcome at such a juncture.

The desire to build ships for us, with the object simply of ministering to the national vain-glory, and to give the newspaper people of the United States an opportunity to vaporise, could hardly, I should think, be worth the cost. Yet this business has so many large capitalists interested in it, and has friendly relations of more than superficial character with such powerful bodies as the Pennsylvania Railroad Company, the International Line of steamers, and the Carnegie firm, that it might do many things with impunity which would be deemed foolish on the part of a weaker combination.

It must be rather galling, however, to the heads of the firm, who have been the objects of such lavish praise, to be forced to confess that the skilled work of their yards and offices is done chiefly by men who are aliens; and it may be the bracing effects of this bitter cup that is inducing them now to replace as far as they can by their own people, those of their instructors who still refuse to become naturalised. No promotion may be looked for among the strangers until the papers renouncing king and country have been signed. But to their credit be it said, there is a strong feeling of patriotism binding together these little bands of Britons and Swedes away from home; and those among them who have lapsed are well described as "whitewashed" only.

With these facts before us, the fear of any serious competition in warship building from the United States will be set at rest. The builders on the banks of the Delaware have hardly yet completed their apprenticeship at the hands of the smart foreigners, who have tried to push their fortunes among them. These soon learn that, with the cost of living so high, little more is to be saved from their earnings over there than at home; and it takes a good deal to make up for the expatriation.

Our own shipbuilders may well feel regret, when they contemplate the fact of so many highly-trained engineers from this side of the ocean seeking employment in the United States, and helping to establish a rival trade there; and it would be unjust to these, at this point, not to say a word on their behalf. In many cases they are men of education, who have adopted the profession of engineering for the love of it; and after having mastered all details of their craft, and worked and waited on for years without advancement, receiving wages the while upon which they could hardly subsist, naturally break away and try to better themselves. During the conflict that has been raging between "capital and labour," whilst the workman has had his share of the profits increased, the draughtsman's has been at a standstill. This, as a matter of injustice, can only result in disaster in the end; and of the many indirect ways that punishment may come, that which is here described is one of them.

A BRITON.

June 12th

THE BOARD OF TRADE UNIT OF ELECTRICITY.

SIR,—The B.T.U. of electrical supply is 1000 watt-hours—that is, the ampères, the volts, and the time, in hours, multiplied together equals 1000. For instance, the following would be equal to 1 B.T.U.:—10 ampères at 100 volts for 1 hour, or 40 ampères at 100 volts for ¼ hour. But the number of ampères flowing through any installation is not constant, because of lamps being turned off and on, therefore it is best to multiply the quantity—coulombs—of electricity supplied by the pressure at which it is supplied, for 1 B.T.U. equals 3,600,000 coulomb volts. Electrical power is measured in watts, and a watt is that power which will do 1 joule of work per second. Electrical quantity is measured in coulombs, and 1 coulomb is 1 ampère flowing for 1 second.

Ampère does not denote the quantity but the rate at which electricity is flowing round the circuit. "Town Councillor" says, Is a kilowatt a time quantity? No; it simply denotes 1000 watts, whether working for 1 second or 1 hour, and is generally used to denote the power of machines. For instance, a machine giving 10 ampères at 100 volts would be termed a 1 kilowatt machine, and a machine of this power would have to work for 1 hour to deliver 1 B.T.U.

"Town Councillor" says, how long will a machine giving 40 ampères at 2000 volts take to give 80 units? Now this machine is giving out 80,000 watts—for 2000 × 40 = 80,000—therefore it will take this machine 1 hour to deliver 80 units—for 1 B.T.U. equals 1000 watt-hours. He also says that to him it seems that the B.T.U. is really 3,600,000 watts. Well, this is really so, but when the watts are multiplied by the time in seconds in which they have been flowing, they are not spoken of as watts, but as coulomb-volts, and are a measure of the quantity supplied; or, in other words, "Town Councillor" would have 1·34-horse power working for 1 hour for 1 B.T.U.

A LEARNER.

East Croydon, June 11th.

SIR,—The difficulty expressed by your correspondent, "Town Councillor," is by no means an uncommon one. It is also quite possible that the electrical engineers he has consulted have been at a loss to explain the apparent anomaly, because one gets so into the habit of using contractions that in the course of time the shortened form of an expression is used to express a certain definite idea, while the steps that led to the shortening pass entirely from one's memory. "Town Councillor's" difficulty, however, admits of a simple explanation.

A Board of Trade unit is the product of a rate of doing work into a period of time. It is a kilowatt hour, not a kilowatt.

"Town Councillor's" dynamo, which gives 40 ampères at 2000 volts, is doing work at the rate of 80 kilowatts. At the expiration of one second $\frac{80 \times 1}{3600}$ or $\frac{1}{45}$ of a Board of Trade unit will have been delivered.

The dynamo therefore must give 40 ampères at 2000 volts for 45 seconds before delivering one Board of Trade unit. Perhaps an analogy involving more familiar quantities may best show where his argument is wrong. His question is equivalent to the following:—"Suppose I have a locomotive running at 40ft. per second—equivalent of ampères—against the resistance of the atmosphere, axle friction of the train, &c., equal to, say, 2000 lb. — the equivalent of volts. That means 40 × 2000 = 80,000 foot-pounds per second—the equivalent of watts. Now I want to know how long will that train take to do 80 units—one unit being represented by the amount of work done during an hour by the locomotive when working at a velocity of 1000ft. per second against a resistance of 1 lb.—the equivalent of the Board of Trade unit, namely, 1000 ampères, flowing at a pressure of one volt. Clearly the time occupied will be:—

$$\frac{1\ (\text{ft. per sec.}) \times 1000\ (\text{pounds}) \times 3600\ (\text{secs.})}{80{,}000}$$

$$\text{or}\ \frac{3{,}600{,}000}{80{,}000}$$

or 45 secs.

ED. C. DE SECUNDO.

Victoria Mansions, 28, Victoria-street, London, S.W., June 8th.

SIR,—With reference to the query raised by "Town Councillor" in your last issue, the following may be of service. A watt is the power developed in a circuit when one ampère flows through it, and when the difference of pressure at the terminals of the circuit is one volt; or stated in another way, a watt is the power developed in a circuit when one coulomb of electricity flows per second past any cross section of the circuit, and when the difference of pressure at the terminals of the circuit is one volt.

Now it can be shown that the power thus electrically developed is equal to ·7375 foot-pounds per second, or 44·25 foot-pounds per minute, or $\frac{1}{746}$ of a horse-power.

If the current continues for one hour we have one watt-hour. Hence the Board of Trade unit of 1000 watts hour may be taken to mean the power developed in a circuit by 1000 watts, and this continued for one hour. If 80,000 watts are being carried by a circuit, then in one hour 80 Board of Trade units have been utilised, and this, at 6d. per unit, equals £2. The horse-power developed is 107·2 H.P., and the cost would be nearly 4½d. per horse-power per hour.

W. H. TOZER.

London, June 11th.

SIR,—Formidable indeed is the mountain that "Town Councillor" has managed to construct from such a simple molehill as the B.T.U. of electricity. Unfortunately your correspondent has gone wrong from the very beginning. He says, quite rightly, that the "volt" stands for "pressure," but the "ampère" does not by any means stand for quantity, it is the poor "disused" (?) coulomb, which stands for quantity, and is an ampère × 1 second. The ampère is the unit of strength of current, and is quite independent of time.

The idea "Town Councillor" has that the ampère is a latter-day name for "coulomb" is quite wrong, as the most elementary of text-books would inform him. Again, the B.T.U. is 1000 watt hours—a very different thing from 1000 watts—*i.e.*, any number of watts × any number of hours that will make 1000.

Grasping this, then, it is easy to calculate how long "Town Councillor's" dynamo will take to supply 80 B.T.U.'s.; its maximum output is 80 kilowatts, therefore, at full load for 1 hour, it will have given 80,000 watts × 1 hour = 80,000 watt hours = 80 B.T.U.'s. So the machine at full load will take 1 hour to supply 80 units.

The Turret, West Heath, Hampstead, N.W.

H. S. WEST.

June 11th.

SIR,—I am not surprised that "Town Councillor" is puzzled. I can endorse what he has said as to the ignorance of electrical engineers as to the occult meaning of the unit. Its legal meaning is no puzzle. The difficulty arises in the fact that the Board of Trade unit does not represent a thing but an action. The word coulomb was intended to represent the "current" that could be passed by an impulse of one volt through a resistance of one ohm in a second of time. The ampère originally represented "current" without regard to time. I have put the word current into quotation marks, because it is the *crux* of the whole question. Nobody on earth knows what current is. We only know what it is not. It is not quantity. There is no such thing as a quantity of electricity. There is a letter Q used to stand for it in equations; but that is another story. The word quantity is used vaguely, and the ampère is very commonly regarded as a measure of quantity. But any and every electrician knows that this is wrong. If "Town Councillor" will turn again to MacFarlane, he will see on page 271 why the use of the word coulomb was given up. At the International Congress of Electricians held in Paris in 1881, the ampère was made to mean a coulomb per second; after that there was no further use in practice for the word coulomb, which has been dead and buried in practice this dozen years.

The word "quantity" in electricity has a special arbitrary significance. It means dyne per P c G s by (cm. radius)² per cm. arc. It would take up too much space to explain what this means, and is unnecessary, as "Town Councillor" has MacFarlane's "Physical Arithmetic."

The Board of Trade unit is a strictly conventional affair. The moment electricians have decided on the meaning of the word "current," it will become rational. As I have said, it is an attempt to measure an action lasting for a given period of time.

To all intents and purposes the watt is a power unit, involving the second. Deprived of the second, it has no more meaning than 33,000 has if deprived of the minute. The nearest analogy to the Board of Trade unit is to say that 1·34-horse power exerted for one hour is a unit—that is to say, just 216,000 times the work done in one second.

"Town Councillor" is quite right when he supposes that his dynamo would earn £2 per hour at 6d. per unit.

Westminster, June 12th.

CHARGE MAN.

A VOLUNTEER FLEET.

SIR,—I was interested in the account of a new ship for the Russian Volunteer Fleet, but where does England come in? We have our Volunteers, but they are restricted to the land. Why should we not possess a Volunteer fleet as well? I feel sure that if a scheme were put forward, it would meet with a national response. We are a seafaring nation, and it is acknowledged that we want more seamen for our Navy. What better auxiliary can we have than a Volunteer fleet in time of need?

Greenwich, June 11th.

J. C. MERRYWEATHER.

(*For continuation of Letters see page* 529)

THE INSTITUTION OF NAVAL ARCHITECTS.—The summer meeting will be held this year at Southampton, beginning on Tuesday, July 24th. An excellent programme is being arranged, particulars o which will be made public at an early date.

THE ENLARGEMENT OF LIVERPOOL-STREET STATION

(For description see page 515)

"The Engineer" Swain Eng

PUBLISHER'S NOTICE.

*** *With this week's number is issued as a Supplement a Two-page Engraving of a Four-coupled Bogie Tank Engine, London and South-Western Railway. Every copy as issued by the Publisher includes a copy of the Supplement, and subscribers are requested to notify the fact should they not receive it. Price 6d.*

CONTENTS.

THE ENGINEER, June 15th, 1894.

TO CORRESPONDENTS.

Registered Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

*** *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 penny postage stamp, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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

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

H. H. (Longsight).—*It does not.*

L. E. B.—*We shall probably illustrate the engine.*

BALTIC.—*The "directorate" of the Russian Volunteer Fleet absolutely refuse details of armament. She is supposed to be a merchant vessel, so that she may be able to run through the Dardanelles into the Black Sea, no armed ship being allowed by the Paris Treaty. She therefore flies the merchant flag of Russia,* i.e., *in time of peace. Undoubtedly she is intended to prey on British ships if there should be a war, hence her interest.*

WATER ANALYSIS.

(*To the Editor of The Engineer.*)

SIR,—I beg to refer your correspondent "Analysis" to page 3071 in Spon's "Dictionary of Engineering," vol. iii.. Purification of Water, &c.

Sunderland, June 9th. H. T. W.

RENDERING.

(*To the Editor of The Engineer.*)

SIR,—May I beg any reader to answer the following questions:—(1) If in engineering works I specify "rendering"—cement—what process does the term imply? (2) Does the term "rendering" signify the same with architects as with engineers? W. C.

Victoria-street, Manchester, June 12th.

MEETINGS NEXT WEEK.

JUNIOR ENGINEERING SOCIETY.—Saturday, June 16th, at 4 p.m. Visit to the Wembley Park Tower Works. Train leaves Baker-street at 3.28 p.m. for Wembley Park Station.

ROYAL METEOROLOGICAL SOCIETY.—Wednesday, June 20th, at 8 p.m. Papers: "Fogs Reported with Strong Winds during the Fifteen Years 1876-90 in the British Isles," by Robert H. Scott, M.A., F.R.S.: "Some Characteristic Features of Gales and Strong Winds," by Richard H. Curtis, F.R. Met. Soc.

THE ENGINEER.

JUNE 15, 1894.

WATER-TUBE LOCOMOTIVE BOILERS.

IN the pages of an American technical magazine for June, we find a suggestive article by Mr. David L. Barnes on the present and future locomotive. It is mainly devoted to a consideration of the conditions limiting the power of the locomotive. Mr. Barnes holds that the maximum has been very nearly, if not quite, reached in the United States. He argues that the area of fire-grate and the quantity of coal that can be burned per square foot per hour determines the power of the boiler, and this it is which ultimately fixes the power of the engine. Now in the United States they have got grates 10ft. long, which is as much as any man can possibly fire, and they put on these grates coal at the rate of 200 lb. per foot per hour. Further than this, he thinks, and we are sure, it is impossible to go on a 4ft. 8½in. gauge. In this country Mr. Barnes admits that 80 lb. is nearly the maximum rate of combustion per foot of grate. But then the conditions of traffic do not demand so much power as seems to be needed in the United States. We have repeatedly directed attention to the fact that in United States railway practice the power required to do a given amount of work appears to be considerably greater than suffices for the same work in this country, but no satisfactory explanation of the fact has ever been made public. One theory is, that the wheels of American locomotives are too small for high speeds, and it is at high speeds that the discrepancy between English and American practice is most apparent. Let the cause, however, be what it may, it seems that there is still a possible margin in England, and that were it desirable it would be practicable to construct a locomotive more powerful than anything yet built for a British road. Yet it may be admitted without hesitation that to do this we should have to follow in certain respects in the footsteps of American engineers, and augment the area of our grates by carrying them very high and spreading them out laterally over the frames. This is not a policy to be commended. We fancy, however, that in the height of the tourist season most drivers find that they have little or nothing in hand, and that it is only by a fortuitous concatenation of circumstances that they are able to keep time. The limit of locomotive power may have been reached in the United States. It has not been reached in this country, but we have got rather close to it; so close that it is worth while to consider how the limit may be extended.

We take it for granted that all our readers will agree with us that the true measure of locomotive engine power is the boiler. Various devices have been adopted to augment this. Thus, for example, the whole barrel has been filled with tubes, and one or two subsidiary barrels provided to hold the steam. We illustrated a locomotive of the kind in our impression for March 4th, 1892. The Fairlie double-bogie double-boiler type need only be named to recall the memory of a more or less successful experiment. But there is reason to believe that after all and notwithstanding all that has been done and proposed, we are very far from having reached the limit of steam generating power for railway work. Mr. Barnes greatly insists on the need for keeping down weight. "The limit of increase of dimensions must be governed by the maximum single grate that can be properly fired. The weight per wheel of passenger locomotives is already near the limit that is safe on present track and bridges. The steel bridges now built are practically permanent, and the best road beds about as stable as it is economical to make them. Some passenger locomotives have now all the boiler power that can be given them without passing the limit of weight, and it is probable, therefore, that in future the steam passenger locomotive will not be changed much, although the weight and power may be increased a little." Mr. Barnes maintains that excessive speeds are picturesque but not practical, and that what is needed is high average speeds; but he does not add, as he ought, that it is in maintaining them that the greatest power is needed. It is possible, we think, that the solution of the whole problem will be found in the adoption of an entirely different type of boiler; in other words, in a radical change in the method of generating steam.

It is not to be disputed that the locomotive boiler is an admirable steam generator. It is more. It lends itself perfectly to being carried about on wheels. In every way it is suitable to its intended purpose. If the gauge of railways happened to be 7ft., or even 6ft., it would be unnecessary to suggest a serious change in form; but with the gauge what it is, it must be admitted that in the United States the limit of power has been reached, although considerable sacrifices have been made, and that in this country the limit has also been reached, unless we, too, are prepared to make sacrifices. If these points are conceded, then it will be granted, without much trouble, we think, that a proposal for a radical change in locomotive boilers is worth a hearing. Now a considerable advantage over the existing type would be possessed by a boiler which, not less economical than the existing boiler, would weigh a great deal less, and permit the use of a larger grate. To us it appears that no insurmountable obstacle lies in the way of designing a water-tube boiler which would comply with the necessary conditions. Practice with torpedo boats has proved that a very great saving in weight can be effected by substituting the water-tube for the locomotive type. Again, a much larger grate area than is now admissible could be had, especially if outside cylinders and outside valve gear were adopted, in which there is of course nothing experimental, since these things are the rule rather than the exception on the Continent. Again, every locomotive superintendent knows that his boilers give him more trouble, and cost more for repairs, than anything else. It is more than probable that a suitable locomotive tubulous boiler would give better results, costing less for repairs and up-keep. Ostensibly the best type for the purpose is that of Yarrow or Thornycroft; that is to say, an express boiler with small tubes. We are met, however, by the difficulty that such boilers are worked with distilled water, and that they cannot be worked with anything else. But again, engineers never know what they can do till they try. There are, of course, two reasons why ordinary water cannot be used. One is that it causes priming; but it is well known that locomotives can get on with an absurdly small steam space without priming, mainly, it would appear, because the jolting of the engine seems to shake the steam out of the water, and something analogous might very well take place with a tubulous boiler. The second objection to ordinary water is that the tubes would quickly become furred up. Even this, however, might be got over, and a special construction of boiler is possible. Indeed, we have seen a design for a launch boiler in which every tube can be cleaned inside with a steel scraper or wire brush, almost as easily and quickly as the flues of the normal locomotive boiler can be swept. A compound engine might be used with a boiler pressure of 200 lb., which would give the compound system a fair chance; and lastly, there is no reason why a locomotive with a water-tube boiler should prove unsightly, or, indeed, present any remarkable departure from the existing form. The advantage gained would be that, without augmenting weight, it would be possible to increase boiler power by about 50 per cent. For extreme speeds a wheel 9ft. in diameter would be found most suitable, because of the reduction of the number of reciprocations of the piston. But, indeed, any draughtsman who possesses ingenuity and a competent knowledge of locomotive engineering, will have little difficulty in designing either a very fast or a very powerful locomotive, by abandoning the existing type of generator.

We do not at all forget that water-tube boilers have long since been proposed and tried in America for locomotives. But the failures of thirty or forty years ago in this direction do not establish a warning precedent for us. The water-tube boiler of 1894 is a very different affair from its predecessors. It has gone far to turn the locomotive type of boiler out of torpedo boats, and it is by no means impossible that it may yet play a very important part on our railways.

THE CRISIS IN THE GAS SUPPLY.

MR. FIELD'S "Analysis" of Gas Accounts for 1893 has just been issued, and confirms our recent remarks as to a decline in the consumption of gas in the metropolis, as well as in some other parts of the kingdom. It may happen that the extent of the backward movement will not be maintained in the present year, nor in the future generally. If so, the extraordinary retrogression in 1893 may be the more confidently attributed in some degree to the unusually fine weather. But the competition of the electric light is such that the statistics of the gas companies, especially in London, must be expected to reveal the existence of some check from this quarter on the progress of the older style of illumination. Gas companies may still prosper, and we anticipate that they will, but they will have to share the field with the new comer. Much is being done for gas by improved modes of burning, and this of itself reduces the rate of consumption, while conciliating the consumer. Subject to the rivalry of electricity and also of oil, the gas companies will be placed under the necessity of giving as cheap a supply as possible. On this point they have no small advantage at the present time, as against electricity, and if they are wise they will do their utmost to maintain it.

Looking into Mr. Field's figures, we find he acknowledges a decrease of 3·63 per cent. in the sale of gas in the metropolis last year, as compared with 1892. The Gas Light and Coke Company exhibits the largest decline, its falling-off in the quantity of gas sold being 4·57 per cent. The Commercial Company shows a decline of 4·04 per cent., and the South Metropolitan ·78 per cent. In 1892 the Gas Light and Coke Company showed a decline of ·60 per cent., and the Commercial Company ·72 per cent. But in that year the South Metropolitan had an increased sale of gas by as much as 2·58 per cent. The general result was that the consumption of gas in London in 1892 showed a fractional increase of ·13 per cent. The figures for 1893 are especially striking, and show that the sale of gas in London last year was thrown back very nearly to the point it had reached in 1890, and decidedly below that for 1891. A falling-off in the sale of gas to the extent of 972 millions of cubic feet in two years is not a matter to be lightly spoken of. In 1892 the net gas rental of the three London companies was £3,969,000. In 1893 it was less by £171,000. Among the suburban gas companies—twelve in number—there was on the whole last year a decrease of ·82 per cent. in the sale of gas. Five out of the twelve show a decreased sale, ranging from ·70 at Tottenham to 3·62 per cent. in the district of the Crystal Palace Company. Brentford has a decline of 3·01 per cent., West Kent 2·34 per cent., and Richmond 1·44 per cent. The maximum increase is at Mitcham, where it is as much as 6·64 per cent. Hornsey has an increase of 4·02 per cent., while in three instances the increase is below 1 per cent.

Proceeding to deal with the provinces, Mr. Field gives statistics respecting eight English Corporations supplying gas. Taken collectively, these show an increase of 1·37 per cent. in the sale. Three have suffered a decrease, amounting to 1·84 per cent. at Birmingham, 2·70 at Leicester, and as much as 9·75 per cent. at Oldham. But in this last case the falling off—or the greatness of it—is attributed to the cotton strike. Ten provincial companies in England are specified, among whom there is on the whole a decrease of 1·10 per cent. in the sale of gas. The falling-off is 11·66 per cent. at Preston, 5·64 at Sheffield, 3·66 at Bristol, 1·69 at Bath, 1·24 at Derby, and ·15 at Brighton. There is an increase of 3·35 per cent. at Plymouth, 3·22 at Newcastle, and 3·03 at Portsea, while the increase at Liverpool is only ·07 per cent. In Scotland, the Glasgow

Corporation had an increased sale of 4·80 per cent., while in Ireland the Dublin Corporation had a decrease of 2·49 per cent. Taking the whole range of the statistics relative to the consumption of gas in 1893, it may be said that the year's record is decidedly unique, as showing so many instances—and some on a large scale—in which the sale of gas has actually fallen off. It is quite possible that 1894 will compare favourably with 1893, but we feel assured that the future history of the gas supply will differ in degree from the past, by a reduced rate of progress, though we are not predicting any disaster to the companies. They have resources at their command which, if rightly developed will render their position secure. But there are indications of a crisis which the directors and managers of gas undertakings cannot afford to disregard. Mr. Field is doing good service to the gas interest by pourtraying from year to year, with such admirable clearness and fulness of detail, the mass of facts lying latent in the periodical accounts of the companies and corporations. On this occasion we have only dealt with one feature of the "Analysis," but in former articles we have gone somewhat at length into the elaborate and instructive statistics contained in the annual volume, concerning which we may say that it improves from year to year.

THE PACIFIC TELEGRAPH SCHEME.

In a few days we may expect to hear something definite as to the long-projected Pacific submarine cable project. A long correspondence which has been taking place between Sir Charles Tupper and Sir John Pender on the matter may be said to have brought forward some of the facts that had been almost forgotten. There is the twofold aspect of the question—commercial and strategic—and both have their interest for engineers. The project is a vast one, the estimate for a single cable laid being £1,800,000, whilst the recommendation of the Wellington Conference was that the rate should be 3s. per word, which Sir John Pender contends would leave only 1s. 6d. per word for the Pacific cable, after the payment for the land lines and the other cables had been deducted. Whether the Governments of the United Kingdom and of the Colonies would subsidise a cable so laid sufficiently to give it the needful revenue to pay its cost, interest on construction, and that heavy depreciation or renewal fund which cable companies must accumulate, remains to be seen. But there is very little doubt that the growth of traffic over the cables that are laid—a growth that is perhaps not very marked in periods of depression like the present, but is shown over longer comparisons—will in the end very probably lead to the construction of an alternative cable to Australia, though it does not follow that it will be one that will be able to adopt the word rate that has been suggested. The Australian telegraph traffic is now efficiently conducted, and that cheaply, on the basis of government guarantees against any loss through the lowering of the traffic rate. As there is recovery from the deep depression that overtook the Colonies a year or two ago, it may be expected that there will be a more marked increase in both the volume and the value of the traffic, and that will stimulate the companies and the projectors to increase the facilities for transmission. It remains to be seen what the Governments will offer to those who may project the Pacific cable to enable them to transform that project into a fact in the future, for it is evident that it will need years to accomplish. In the meantime, it is noticeable that the great companies which now do the service are enlarging the area that they serve, and are adding new feeders to the great lines, so that it may be fairly said that there is a prospect of remuneration for those who were the adventurers in days when cables were less certain modes of investment and more difficult to lay than now.

THE SITUATION IN THE COAL FIELD.

We are again threatened with a crisis in the coal trade. A statement has been going the round of the press that the coalowners intend to bring before the Conciliation Board a request for a reduction of 10 per cent. in wages. This statement is not quite correct. In the first place, the Federation of Owners has not been called together, the president of that body, Mr. A. M. Chambers, being still on the Continent. But there is every reason to believe that the Board, on its meeting, will be called upon to consider this question. An application has been made from the coalowners' side of the Board "to vary the rate of wages," but no amount has been named. The president of the Miners' Federation, Mr. Pickard, objects to a demand which does not specifically state its amount. He thinks the coalowners ought to say how much they want. The coalowners reply that they had enough of that last year. One of the largest coalowners in South Yorkshire, and himself a member of the Coalowners' Federation, puts it in this way:—"We first asked one amount and then another, and the public thought we did not know our own minds. 20 per cent. were due on the figures, but we offered later to take 15 per cent. Now the miners' leaders want to put a demand for 10 per cent. in our mouths, because they know the figures will justify more than that. We shall not ask for 10 per cent.; we shall ask the Board and Lord Shand to fix the amount to which we are entitled." This is understood to represent the situation from the coalowners' point of view. In other districts the coalowners say that a 20 per cent. reduction is necessary, and there is a general impression that the Miners' Federation would agree to a 10 per cent. reduction if the owners would make that the minimum wage. But this is the one point to which the owners steadfastly object. The steam coal trade continues in a brisk condition, and the contracts which have now been concluded, both for locomotive and gas coal, have been in advance of the prices obtained last year. Whether this advance is sufficient to compensate for the higher rate of wages is another point. House coal is in better demand in spite of the varied weather, but stocks are steadily accumulating. One colliery is reported to have a stock in hand exceeding 30,000 tons.

THE TAXATION OF MACHINERY.

Machinery users up and down the country will hear with great surprise of a new practice in the rating of movable machinery for local purposes. It is asserted on the authority of the Machinery Users' Association that many of the attacks which of late have been made by local rating authorities upon manufacturers are due to a system under which a certain class of valuers specially canvass for employment by instigating the reassessment of works and other properties, and by offering to secure an increase in the assessments in return for a commission on the increased valuation. This is a system so iniquitous that at first sight it might seem to be almost incredible. We have, however, taken pains to ascertain the correctness of the matter, and, without entering into details, we may say that our inquiries at first hand leave no manner of doubt that the allegations are all too well founded. Steam users and engineers have heard recently of various ways of assessing machinery which constitute a severe injustice on the manufacturing industries. But here is a state of things which amounts to a positive inducement to private valuers, for the sake of personal gain, to inflate values and to harass and annoy machinery users almost beyond endurance. No wonder that Sir William Houldsworth, M.P., should wax eloquent at the recent meeting of the Machinery Users' Association in denunciation of such a practice. If some remedy cannot be found for this abuse the proprietors of manufacturing establishments will have an additional and powerful cause of complaint. Already the action of union authorities on this rating question is sufficiently difficult to bear with equanimity. If, however, secret espionage is to be encouraged it will not be without its effect even on the demand for machine plant in this country. The matter is one with which the every-day business interests of the engineering and machinery trades are closely bound up, and machinery users should receive every assistance in their resistance to this new impost from manufacturing engineers themselves.

THE ENGINEERING TRADES AND SHORT HOURS.

"One swallow does not make a summer," is a truism which we would just now carefully impress upon some employer members of the engineering trades who are disposed to view too seriously the action of those engineering firms in the country who have conceded the forty-eight hours week. The recent conversion of the additional Manchester engineering concerns to the example set by Messrs. Mather and Platt, following upon the adoption of the new system by one of the leading agricultural engineering producers in Bedford, and by certain of the Sheffield and Birmingham engineering houses, may at first sight lend encouragement to the idea that the eight-hours question is settled. It should, however, be pointed out that these instances are merely drops in the bucket, compared with the overwhelming sea of employer engineers, both private and joint-stock, who continue to resist the new departure. The examples quoted are rather to be regarded in the light of individual experiments than as establishing any settled dictum that the forty-eight hours week can be adopted in the engineering trades without increasing the cost of production. The views which are here and there being expressed on the progress of the eight-hours movement need that this should be specifically borne in mind. Special circumstances of different works, too, or their particular class of manufactures, may lend sufficient warrant for the trial of the new venture by single firms. But the main body of employers continue convinced that the adoption of the eight-hours day would only mean a repetition of the well-remembered effect of the introduction of the nine-hours system, and that there would be a further curtailment of productive capacity, alike by machinery and hands, together with a necessary rise in dead charges.

LITERATURE.

Sewage Disposal in the United States. New York: D. Van Nostrand and Co. London: Sampson, Low, and Co. 1894.

This large volume is the joint production of Mr. G. W. Rafter—acting under instructions from Messrs. D. Van Nostrand and Co.—and M. N. Baker, associate editor of the *American Engineering News*. They were engaged independently of each other, having in view the production of a manual on "Sewage Disposal in the United States." They ultimately combined the information they had collected, which they state was compiled for the use of American engineers. A perusal of the work, however, enables us to say that it will be read with advantage by all engineers, chemists, and biologists, who are interested either in the prevention of river pollution, or in the questions of water supply and sewage disposal, which are practically inseparable subjects. The authors modestly state that "the amount of original matter in the book is relatively small," but we consider they deserve thanks for collecting and sifting so much useful information out of the mass of available data, and of published expert opinion.

The first part of the book is devoted to the consideration of water-borne communicable diseases, infectious diseases of animals, and river pollution occasioned thereby, and also that caused by manufacturing refuse.

The legal aspects of the question are touched upon at some length, and the decisions in cases that have been tried in the States are quoted. Data are given as to the relation between the water consumption of various American cities and the disposal of sewage, both present and prospective. The advantages and disadvantages of separate and combined systems of sewerage are investigated, and much information is given as to the practice in America, which is in accord with that elsewhere, as all are agreed that it is better to avoid the great variations in volume of sewage which occur where the whole rainfall is admitted to the sewerage system, causing difficulties of an engineering and sanitary nature, both in the sewers and at the outfall.

To all who are engaged in dealing with the question of water supply or sewage disposal the importance of a full knowledge of what is known as nitrification will be recognised, and the authors make full and free use of the original experiments and researches which are recorded in the reports of the State Board of Health of Massachusetts. These contain information of the greatest value, and afford ample materials for reference, as is the case also with experiments carried out in this country by Warington, Frankland, and others, which are referred to appropriately. The available data from these sources are summarised in a concise way, and show clearly that filtration is not a mechanical straining and chemical oxidation, but is a biological process, and must be viewed in that light by those who have to deal with the problem of sewage disposal. From a sanitary point of view the purification of sewage by filtration through land is now known to be a process by which the organic matter contained in it, and which in certain conditions becomes dangerous to health, are converted into their harmless inorganic constituents. The knowledge of this enables a clear line to be drawn between the methods for the disposal of sewage upon land for agricultural purposes—having in view commercial results—and the large number of cases where the first consideration is the absolute destruction of harmful matters. The failure to recognise this broad distinction leads to the frequent conflicts that arise, and this book contains much that will assist to prevent such conflicts.

The bearing of climatic conditions and temperature are considered as being important features in connection with the disposal of sewage on land. Some useful practical experiments and observations are recorded, and the conclusions arrived at are that where the mean temperature of the air in the coldest winter months is not lower than 20 deg. or 25 deg. Fah., and that of the sewage distributed is not lower than 50 deg., purification by broad irrigation might probably be effected without serious interruption from the frost. Below the before-mentioned mean temperature purification by broad irrigation will be probably considerably interrupted by frost, the purifying action of filters by the nitrifying organism being greatly influenced by temperature. The data given may be usefully studied by those who rely upon land for the purification of sewage.

Tables are given of the composition of sewage, and of the values of commercial fertilisers, determined by observations made at the New York State Agricultural Experiment Station, with a view to indicate the theoretical value of the nitrogen, phosphates, and potash of sewage, in relation to the composition of the various soils used for sewage disposal. Mr. Hazen—the chemist in charge at the Lawrence Experiment Station—made a series of observations with various chemical precipitants, the results being tabulated afford valuable records for reference. The effect of the aëration of the effluent water is referred to, and the conclusions arrived at by Messrs. Dupré and Dibden in this country are confirmed by the investigations of Messrs. Hine and Brown in America. These show that the oxidation of organic matter in water is not "hastened by vigorous agitation with air or by air under pressure," although the presence of oxygen is important in order to secure the purifying operation of the nitrifying microbes before referred to. The same opinion was given by the late Dr. Angus Smith in a report to the Local Government Board in 1882 in these words: "In all cases putrefaction is delayed by aëration. The oxygen recovers itself in the aërated specimens better than in the non-aërated. Nitrates are formed more readily in the aërated than in the non-aërated specimens."

The cost of distributing sewage on land, and the arrangements of carriers for effecting this, are described, and numerous practical illustrations are given. Reference is made to the experiences which have been gained by the fruit growers in California, where sewage has been applied in connection with fruit culture. Much information is given as to the agricultural results obtained from various sewage farms in the shape of crops, cattle fattening, dairy produce, &c. Where heavy green crops exceed the demand for them at the time of their production, silos are recommended, in which the excess can be stored. Many examples are given of chemical precipitation works, sewage farms, and land filters, that have been carried out in the United States, and the detailed illustrations afford a mass of practical information of much value.

The authors state "that the book is now other than relatively complete is not pretended; it is merely put forth as representing the best effort in this direction of which the joint authors are capable at this time." The success they have already attained should encourage them to pursue their labours in the same direction, as the volume before us contains much information of practical value.

LUXEMBURG WORK EXHIBITION.

In an article on the railways of Luxemburg, published in The Engineer of 18th March, 1892, the accompanying map showed the extensive iron ore deposits in the south-west of the country. This national wealth has given rise to an important iron industry; and, as the proportion of phosphorus in the ore is sufficient to require the Thomas-Gilchrist process, the quantity of basic pig is gradually increasing, being now made by all the twenty-three blast furnaces, while some important steelworks finish on the spot the production of five furnaces. Were the iron industry not predominant, there are half a dozen others which would be considered important in a little country which is no larger than an average English county. With the two-fold object of bringing before the public products manufactured in Luxemburg, making known her industrial resources, and opening up new markets on the one hand, and on the other introducing small motors, machine tools, and labour-saving appliances, the Government has organised an "Exposition du Travail" to be held in Luxemburg City, from the 20th of August to about the 20th September. While finished products are only admissible, so far as they have been to a considerable extent manufactured or perfected in the country, raw or semi-raw materials, motors, machine tools, and labour-saving appliances may be sent from any country. Technical instruction will be represented, and trade journals and catalogues, besides technical works, will be admitted to the reading-room. The charge for space is very moderate, and no customs dues will be charged. Steam, gas, water and electric current for the motors exhibited will be supplied at cost price; and power from the main shafting will be charged 1fr. 25c.—one shilling per quarter-horse power per day. As it is desired to make a special feature of improved methods and appliances for forging iron and working up zinc or tin-plate, special facilities and moderate terms will be accorded under this head. Application for space may be made, and further information obtained from M. J. P. Henrion, Conseiller du Gouvernement, Luxemburg.

THE CONVERSAZIONE OF THE ROYAL SOCIETY.

LAST Wednesday night, the second and last conversazione of the Royal Society was held at Burlington House, under the presidency of Lord Kelvin.

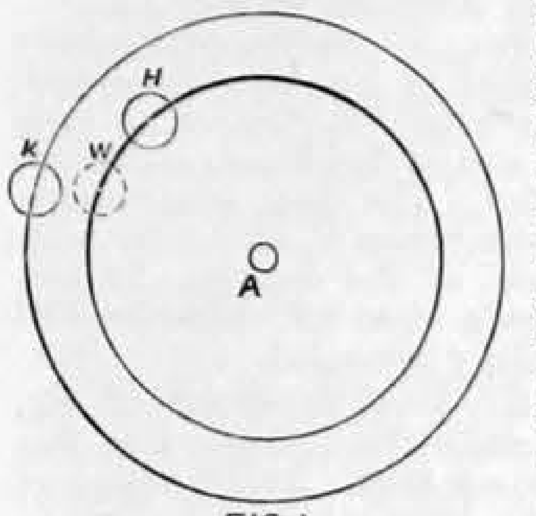


FIG. I.

Mr. Shelford Bidwell, F.R.S., brought under the notice of those present a new phenomenon in optics, which he had first made public at the previous meeting of the Royal Society. A disc of thin metal with a round hole in it was caused to turn in the optical lantern, and on the screen it threw the little disc H, which moved round in the larger circle represented in Fig. 1. H was of a green colour, because the rays were passed through a plate of green glass in front of the lantern. When caused to travel at a certain velocity, it was seen by the eyes of most persons to be followed in a larger circle by the ghost image K, which was of a violet colour; it seemed to describe the larger circle, because of the unsteadiness of the eye, and when the eye was firmly fixed on the centre A, the ghost image seemed to travel on the inner circle, as at W. It was not a case of complementary colours, otherwise K would have appeared to be red instead of violet. The more slowly H moves, the nearer to it is the ghost image K; the latter is always one-fifth of a second behind K. Mr. Bidwell thinks the effect to be almost entirely due to some action upon those nerve fibres in the retina which are sensitive to violet. He also exhibited a modified form of Charpentier's experiment, demonstrating the brief period of insensibility to luminous impressions which follows the impact of light upon the eye; Mr. Bidwell did it by strong transmitted light, instead of using Charpentier's opaque discs with sectors viewed by reflected light.

Mr. G. J. Snelus, F.R.S., described the Walrand-Legénisel process of steel manufacture as applied to steel castings. This process, he said, is a modification of the ordinary acid Bessemer process, the object being to make solid steel suitable for castings and so fluid that small converters down to 5 cwt. can be successfully used, thus enabling ordinary founders to make their own steel castings. The process consists in adding about 7 per cent. ferro-silicon, containing 10 per cent. silicon, to the metal in the converter at the end of the ordinary blow, then blowing again for about two minutes. The combustion of the added silicon produces so much heat that in two minutes the temperature of the steel is increased 250 deg. C., and the steel, therefore, is very much more fluid and sounder than ordinary steel. If pure materials are used it is equal to crucible steel. He also exhibited what he called "the triumph weldless chain," and added that this chain is made from best steel wire by a machine of American invention, one machine taking the wire from the coil, straightening it, and making the links and chain complete at the rate of from 100ft. to 300ft. per hour. The chain, he said, is twice as strong as a best welded chain of equal weight, and is suitable for all engineering purposes, especially for yachts, where lightness and strength are important, driving machinery, horse, cow, and dog chains, window sashes and picture hanging. It is made by the Weldless Chain Co., St. Helens, Lancashire.

Professor Elisha Gray exhibited what he has called the "telautograph," in which the principle of the pentagraph is applied to electric telegraphy. Four line wires are required for the instrument. The writer at one station uses a lead pencil, attached mechanically to the apparatus, and writing upon ordinary paper, transmits to the distant station a facsimile of his handwriting, at his ordinary writing speed. Sketches, sketch-portraits, diagrams, plans, trademarks, and the like, as well as the characters of hieroglyphic alphabets may also be transmitted. In the experiments with the apparatus, resistance equal to four miles of line wire was inserted between the two instruments, and when care is taken to keep the pencil always on the paper, it was stated that the sender could write at the rate of thirty or thirty-five words per minute, with successful transmission. It is a step-by-step system of signalling, and it was stated that a three or four watts current is sufficient to work through twelve or fifteen miles of line wire. The receiving instrument works with considerable force, as can be felt by holding the writing portion in the fingers. This telegraph should be of special interest to those illustrated newspapers which sometimes wish to send drawings, say from a seat of war, quickly. The instruments have but just arrived in England, and the representatives of Professor Gray are to be found at 16, St. Helen's-place, London.

Professor Oliver Lodge exhibited a sensitive detector of electric radiation and an emitter of the same. He said that electric charges suddenly imparted to a sphere or other conductor oscillate a few times before settling down in equilibrium, and these oscillations emit waves into the ether, which are in all respects light, except that they are not visible, being much too big. Hertz first experimentally proved their existence. To-day the detection of them is easy, and the most sensitive detector, he stated, is now exhibited in a compact and portable form. It consists of a minute battery galvanometer and a bad joint, all inclosed in a small cylinder 3in. by 2in. The rest of the instrument is a lamp and scale. Electric waves being generated in the neighbourhood, the resistance of the bad joint varies and the galvanometer is disturbed. With this receiver all ordinary optical experiments can be repeated, using the long electric waves instead of the ultra-microscopic waves of the same kind to which the eye responds.

Mr. J. Wimshurst exhibited models showing an improved method of communication between shore stations and lightships, or other like purposes. The method consists of arranging suitably wound coils of insulated wire A B upon the swivel pin K K—Fig. 2—of the moorings, the one coil being in communication with the shore station and the second coil in communication with the ship. Signals or sound are transmitted by induction, or by electro-magnetic induction.

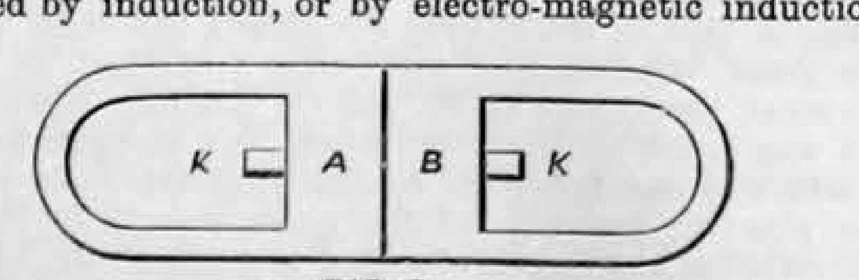
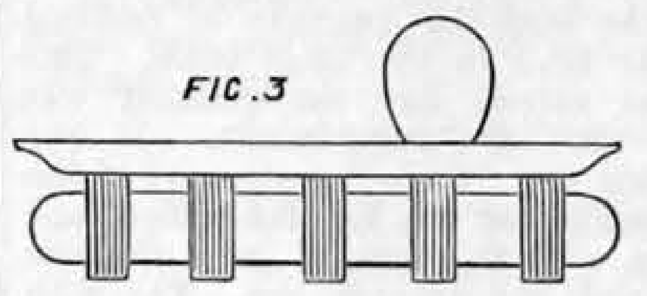


FIG. 2

This arrangement is more especially for telephonic communication. Mr. Wimshurst, however, stated that he lighted a lamp through it by induction.

Miss Edna Walter, B.Sc., and Mr. H. B. Bourne exhibited a projective goniometer. By means of this instrument, devised and constructed by the exhibitors, the projection of a crystal on a sphere is actually accomplished, realising in practice the fundamental assumption of the theory of crystallography; the instrument is thus of value in demonstrating the axioms of the science. If necessary, angular measurements can be made from the image, but these only attain an accuracy of about 40′ in 60 deg. = one per cent., which is inferior to that attained with a goniometer.

Professor Sylvanus P. Thompson, F.R.S., among other things, exhibited the revolution of a large copper egg, of an oval block of aluminium, and of a watch in a rotary magnetic field. Fig. 3 will give an idea of the arrangement, which consisted of a massive ring of soft iron, with coils of wire round it at intervals, through which coils an electrical current could be sent in a suitable manner. The egg lying down would begin to spin, and at last work itself upright, and spin on end.



The Postmaster-General exhibited a Wheatstone's automatic transmitter, running up to 600 words per minute, driven by Willmott's air motor. The air motor in this instrument dispenses with the 42 lb. weight which, when the instrument is running at 600 words per minute, requires rewinding by the operator every few seconds. The air motor being applied directly to the excentric axle dispenses with the whole of the train of wheelwork, the friction regulator, and complicated fly-wheel. The speed of the instrument is regulated by opening or contracting the nozzle regulating the supply of air. The power required is so small that the instrument can be driven at a moderate speed by simply blowing into it with the mouth. He also exhibited Professor Hughes' type printing telegraph, driven by Willmot's air motor. The air motor in this instrument takes the place of the 132 lb. weight previously used, and dispenses with the whole of the winding gear, and nearly all the train of wheelwork, the motor being applied directly to the printing shaft. The air motor is self-starting in any position, and will run continuously without any aid from the operator. When running by means of compressed air, the instrument is more steady than when driven by weight, due to the fact that there is less weight in the whole instrument.

Mr. Claude Vautin exhibited some white coherent lumps of metallic tungsten, a metal which has not been seen in such a state of aggregation before. He also exhibited specimens of metallic chromium, manganese, and iron, free from carbon, as well as fused alumina, obtained during reduction of the metallic samples. The specimens had been reduced from their oxides by means of metallic aluminium. The oxide of the metal to be reduced was intimately mixed with finely divided aluminium, and heated in magnesia-lined crucibles.

Professor Norman Lockyer exhibited some maps and plans which accompanied the report of the Egyptian Government on the Nile reservoirs. Sir David Salomons exhibited two new contact makers and breakers for induction coils. Professor C. V. Boys exhibited photographs of apparatus used by him in finding the Newtonian constant of gravitation. Lord Ross exhibited some original drawings of the Milky Way, made at the Birr Castle Observatory. Messrs. Thornycroft and Co. exhibited models of torpedo boats, and of their water-tube boiler. Mr. Charles Bradbury exhibited a new calculating machine. Mr. C. T. Snedder exhibited apparatus for heating pillows, pads, and such like things by electricity for hospital purposes. Mr. J. W. Swan exhibited gold leaves made by electrical deposition, quite transparent, and transmitting green light. Mr. W. Kurtz, of New York, exhibited photographic prints, in which the colours of nature were imitated by synthesis, by the process of Dr. H. W. Vogel, of Berlin.

GERMAN ELECTRICAL ENGINEERS IN CONFERENCE.

TWO years have just elapsed since the formation took place in Germany of the Union of Electrical Engineers of Germany—Verband der Elektrotechniker Deutschlands. The Union was constituted under the auspices of the principal and other firms engaged in the various branches of the electrical industry for the purpose of establishing a more intimate connection between German electrical engineers, and to promote the commercial and technical interests of the profession. It might, in fact, be likened to a combination of our own Institution of Electrical Engineers and the Electrical Trades Section of the London Chamber of Commerce. The Union held its first annual assembly in Cologne last year, when a very large gathering of the members took place. The not inconsiderable number of some eight hundred adherents to the Union were down on the books at that time. Various papers were read and discussed, and different commercial matters were considered; but the Union had hardly got into proper working order. It has taken another year to improve the position of the society, the president of which is the well-known Dr. Slaby. The mutual relations of the members required cementing together, the action of the adherents in regard to matters of general importance to the industry needed consolidation, and an official organ of the Union was considered to be essential in assisting the promotion of the members' interests. Several steps in advance have been made in the direction of attaining these objects. In the first place, a contract has been entered into under which the *Elektrotechnische Zeitschrift*—hitherto the organ of the Electrotechnical Society of Berlin—has now become the official journal of the Union. Mr. F. Uppenborn, who has so ably edited that journal during the past few years in conjunction with Mr. West, now retires, and becomes the electrical engineer to the city of Munich. In the second place, the Union required an efficient secretary, and probably no better man could be found for the position than Mr. Gisbert Kapp, whose agreement with the Union has now been finally ratified, a remuneration of £1000 per annum being guaranteed to him. Whilst sorry to lose Mr. Kapp from our midst, we at the same time tender him our congratulations and good wishes for his future success. In the position he has now taken up, Mr. Kapp will also act as co-editor with Mr. West, of the *Elektrotechnische Zeitschrift*. The decisions in these two cases were arrived at on the occasion of the second annual meeting of the Union held in Leipsic, on Friday and Saturday last, Mr. Kapp on his part expressing his thanks for the confidence shown in him, and assuring the members that he would not fail to do everything to promote the interests of the Union. Although in point of numbers the gathering in Leipsic was hardly as good as that in Cologne, yet the proceedings were of an important character. Two days previously the third assembly took place—in the same town—of the Free Union of Representatives of Electricity Works, a society dealing purely with the interests of the central electric light stations associated with the Free Union. It was probably in celebration of the assembly in the same week of the two Unions that the Electrical Exhibition held in the Crystal Palace was organised, where the many applications of electricity were demonstrated. Returning, however, to the proceedings of the Union of Electrical Engineers of Germany, it was stated the number of members was about the same as last year, namely, some eight hundred, and it was decided to alter the name of the Union to that of the Verband Deutscher Elektrotechniker—Union of German Electrical Engineers. After the general business of the meeting had been transacted, the consideration was commenced of a formidable list of papers. In treating of the scientific electro-chemistry of the present and the technical practice of the future, Dr. Ostwald expressed the opinion that an improvement in thermodynamic machines would only be possible by working at higher initial temperatures. A solution of the question, he remarked, might lie in the direction of gas engines, but the most important problem was to obtain cheap energy. Electro-chemistry would be the means of solving the problem, doubtless by means of some type of unknown galvanic battery. The Nissl telephone system was then described by Mr. Ross. It consists in the employment of a single wire leading to a telephone exchange for the use of several subscribers, clockwork mechanism and contacts bringing each individual subscriber into communication with the exchange once every minute. The method was also recently described before the Vienna Electrotechnical Society, but it is doubtful whether the system is of any practical value. Passing on from the question of lead safety fuses, which subject was dealt with by Mr. C. P. Feldmann, Mr. W. Lahmeyer discussed at some length the principle of rotary current plants and rectifiers, or, as they are termed down at Portsmouth, "motor commutators." The system described is identical with that employed for some time past in connection with the Bockenheim electricity works, and the transmission plant between Bozingen and Biel in Switzerland. A paper by Mr. G. Kapp was then presented, dealing with the historical development of electric lighting in England, and the projected electric railways in this country. Some investigations by Dr. G. Rössler and Dr. Wedding into the pressure and current curves of various types of alternators, and their influence upon the lighting power of alternating current arc lamps, were then made known. Among other papers read was one by Mr. Dolivo-Dobrowolsky, dealing with direct current machines for a three-wire system. This method consists in the employment of a single dynamo in conjunction with a compensating coil and compensating wire, fulfilling the same conditions as do two dynamos connected in series and using a third wire. As far as can be ascertained, this system has not been practically applied, although, in justice to it, it should be mentioned that it has only recently been devised. Various suggestions were made by members that committees should be appointed to deal with different questions affecting the industry, and the proceedings closed with the intimation that the next assembly of the Union would take place in Munich in 1896.

THE INCORPORATED ASSOCIATION OF MUNICIPAL AND COUNTY ENGINEERS.

THE following programme of the annual meeting to be held at 25, Great George-street, London, on Thursday, Friday, and Saturday, the 21st, 22nd, and 23rd June, 1894, has been issued:—

Thursday, 21st June.—10.30 a.m.: Council meeting. 11.45 a.m.: General meeting. Annual report. Presentation of premiums. General business, &c. Mr. Scoones—That the Articles of Association be amended by inserting in Article 25 the words "Eighteen—18—Ordinary Members," in lieu of "Twelve Ordinary Members." President's address. Paper and discussion—"Arrangements for Sterilising Cholera Dejecta, &c., adopted at Newcastle-on-Tyne," by W. G. Laws, Newcastle. 1 p.m.: Adjournment. 2 p.m.: Papers and discussions — "On some Experiments with Model Wheels and Road Coatings," by Thomas Codrington, London; "The Development of Sanitation in America," by Lt.-Col. Jones, London; "Irish County Surveyorships and the Grand Jury System of Ireland," by R. B. Sanders, King's County. 4.30 p.m.: Adjournment. 6.30 for 7: Annual dinner at the Holborn Restaurant—evening dress preferred—tickets 7s. 6d. each.

Friday, 22nd June.—10.30 a.m.: Papers and discussions—"Maintenance of Main Roads in Urban Districts," by J. E. Swindlehurst, Burton; "The Bradford Corporation Electricity Supply, with the results of four years working," by J. N. Shoolbred, London; "Electric Street Trams," by R. Hammond, London. 12.40 p.m.: Leave the Institution of Civil Engineers and proceed to Westminster Bridge station, and take tickets for Mansion House. Reception by the Lord Mayor. 1 p.m.: The Lord Mayor, the Right. Hon. George R. Tyler, will receive the members at the Mansion House. 1.40 p.m.: Leave the Mansion House by breaks, and proceed to visit the Limmer Asphalte Works, where on arrival the members will be received by the manager. After luncheon, a short paper will be read by Mr. Blake descriptive of the process of manufacture, which will be fully demonstrated and explained. 4 p.m.: Proceed to Nelson's Meat Stores, Blackfriars, where the members will be received by Sir Frederick Bramwell or Mr. Harris, who will accompany the party over the works and explain the process. Fare for breaks, 2s. 6d.

Saturday, 23rd June.—10 a.m: Members will embark on board the River Queen or other steamer, kindly provided by the president, Mr. A. M. Fowler, at the Temple Pier, and proceed up the river to Teddington, passing the new lock and foot-bridge at Richmond. Arriving at Teddington, an inspection will be made of the sewage works. Luncheon, 2s. 6d. each. Trains leave Teddington 1.7, 1.24, 2.6, 2.28, 3.7; arrive Waterloo 1.52, 2.8, 2.51, 3.15, 3.50. 2.30 p.m.: Leave Teddington for Molesey. Inspection of the Molesey Sewage Works. An opportunity will be afforded of visiting Hampton Court Palace and Grounds. Trains leave Hampton Court 3.35, 4.38, 5.20, 6.40; arrive Waterloo 4.18, 5.21, 6.2, 7.23.

THE NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—The annual excursion of this Society will be on July 19th. It is intended to visit the Consett Iron Company's works. A special train will leave the Central Station, Newcastle-on-Tyne.

IMPORTANT MINING ENTERPRISE IN CUMBERLAND.—On the 8th inst., many of the engineers, mine managers, and other gentlemen interested in the iron trade of the district, were present at the Winder mine of the Cleator Iron Ore Company, to witness the inauguration of the mine and the starting of the pumping machinery, which was done by Mrs. Ainsworth, wife of one of the proprietors. Owing to the fact that all the water for which provision has been made has not yet been met with, and that there is little standage, it was not deemed prudent to run the engine much above half speed. Considerable interest had been aroused in the district owing to the management having decided, contrary to local custom, to abolish stage pumping and to force the water to the surface in one direct lift. The pit which was sunk through rock, &c., under the direction of Mr. J. G. Howes, the company's mining engineer, is 820ft. deep, and has struck the ore at depths of 540ft., 696ft., and 820ft. The sinking, which has occupied three and a-half years, has been most successful, and everything at starting went without a hitch. The pumping machinery, which was supplied by Messrs. Hathorn, Davey and Co., of Leeds and London, consists of a compound condensing differential engine on the surface, with cylinders 34in. and 58in. diameter by 8ft. stroke, working two ram pumps 13in. diameter by 8ft. stroke, placed 820ft. below and forcing to the surface in one lift. After the start, Mr. Ainsworth, returning thanks for the toast of his health, expressed his opinion that the day of high royalties had passed. There was no reason why large quantities of iron should not be produced in the district, provided they sank deep, and had the best modern appliances for turning out a large quantity of ore, and if the royalty owner met them by reducing his royalty he would not be out of pocket, as the larger quantity which must be raised to make a deep sinking pay would bring him in the same annual sum.

SIX GERMAN STEAM BOILER EXPERIMENTS WITH THE SAME COAL (RUHR.)

By BRYAN DONKIN, M.I.C.E.

SUMMARY OF TRIALS.

(*Concluded from page* 510.)

(3) *Analysis of the hot gases.*—To test the more or less perfect combustion of the coal, and the corresponding loss of heat, it was necessary to determine the chemical constituents of the gases of combustion, the amount of draught and the temperature, as compared with that of the air admitted to the grate. Samples of the gases for analysis were taken at the damper end of the different boilers, and behind the fire bridge. The draught and temperature were measured at the chimney damper. Small tubes were introduced at these places, to draw off the gases and to admit thermometers. Various apparatus were used to determine the CO_2 and O, and the results formed a check upon each other. Samples were taken every fifteen minutes at the boiler end, while those obtained behind the bridge were drawn off continuously for two hours. These were enclosed in glass bottles of 1·3 gallons capacity. As the water was allowed to run from the bottles, they were filled with the gases, and no absorption of CO_2 was possible, because the water was previously saturated with the gases of combustion. From the percentage of CO_2 thus determined the quantities of air were calculated, which penetrated through the brickwork walls and grate, between the fire bridge and the end of the boiler, and through the walls of the flue. Thus the excess of air passing to the fire beyond the theoretical quantity necessary for combustion was ascertained. Taking the temperature of the hot gases at the end of the boiler at 572 deg. Fah., and their proportion of CO_2 at 12 per cent., the loss of heat in the chimney gases will be 26 per cent. of the total heating value of the coal. But if the CO_2 be taken at 7 per cent., with the same temperature the loss of heat will only be 8 per cent., and this appears the more correct estimate. The proportion of oxygen in the hot gases was determined by absorbing it in a strong alkaline solution of pyrogallic acid of potash in hydrate of potash.

Draught.—The draught was measured every quarter of an hour by a Siegert-Dürr apparatus. The temperatures of the hot gases were taken with mercury thermometers filled at the top with nitrogen, also by graphite and air pyrometers. The temperature of the air passing to the grate was determined once an hour with mercurial thermometers. These were also introduced into holes in the brickwork, to obtain the temperatures in different parts of the external brickwork surfaces.

The programme as laid down by the committee was generally carried out, except that the standard quantity of coal burnt, viz., 12·3 lb. to 14·3 lb. per hour per square foot of grate surface, was in some cases exceeded. Some of the exhibitors wished to obtain not only a high evaporating power, but also a high boiler efficiency; while a few of the boilers had to be forced, to generate sufficient steam for the engines at the Exhibition. The uniformity of the experiments was also affected somewhat by the different pressures of steam required, but this had little influence on the performance of the boilers.

With the first boiler the same coal was used for about two hours before the trial. The usual stoker acted throughout, and by desire of the owner 24·6 lb. coal were burnt per hour per square foot of grate surface. The same conditions were adhered to in the trial of the second boiler. There was some delay in beginning the test of boiler No. 3, which was consequently shorter than usual, and the products from the grate were not so fully determined. A marked peculiarity of the fourth experiment was that the quantity of residual products was much smaller than in the other trials. This was noticed, and on the second day the quantity was especially checked, but with the same result. It was supposed that when cleaning the "Cario" grate, part of the ashes and slack were pushed under the low fire-bridge, and could not be weighed; also with this type of grate the ash was lighter than usual, and the quantity less. The fifth experiment was not satisfactorily carried out until after several preliminary trials, but the sixth was as usual made on two consecutive days. The subsidiary experiments made on No. 1 boiler with Rinne's patent varied slightly from the usual method of proceeding, to test the value of this system. There appeared to be no smoke in the fire space.

The table of results gives the evaporation, efficiency, and losses of heat of the various boilers under trial, and also the efficiency of combustion, according to the percentage of CO_2 in the hot gases. This efficiency can also be determined from the proportion of CO_2 and O, but it was impossible to estimate exactly the loss of heat in the unburnt gases.

On the whole, boiler No. 1—Cornish—gave the best results. The highest thermal efficiency was attained, or percentage of water evaporated to heat received—about 73 per cent.—although this boiler was forced, and the quantity of coal burnt per hour per square foot of heating surface was from 43 per cent. to 85 per cent. higher than in any of the other boilers. It is true that the same efficiency was obtained with boiler No. 6, but the rate of evaporation per square foot of heating surface was about 44 per cent. lower. The high efficiency of boiler No. 1 is explained by the high initial temperature resulting from the perfect combustion, although the boiler was forced, the excess of air behind the fire-bridge being only ¼ per cent. Another contributing circumstance was that no air could enter the fire tube, as compared with water-tube boilers, and therefore the temperature of the hot gases in this flue was not affected. At the damper end of the boiler the excess of air was increased from ¼ per cent. to more than ½ per cent., owing to infiltrations of air through the brickwork. Nevertheless, the heat was well distributed, as shown by the final temperature, 600 deg. Fah. of the gases. The loss of heat to the chimney and all other losses were small, from 70 to 80 per cent. of the total heat being utilised to evaporate the water. The excellent combustion obtained was partly due to good stoking, but chiefly to the construction of the furnace, surrounded by air-tight walls. This is the principal advantage of internally-fired boilers. Boiler No. 2 gave the lowest efficiency, 62 per cent., but it ranks high among the water-tube boilers tested, because only 0·4 lb. coal per square foot of heating surface was burnt per hour. The cause of the low efficiency is shown by the analysis of the gases, proving that on their way from the fire-bridge to the damper they were diluted by the admission of considerable quantities of air. The excess of air penetrating to the fire behind the bridge was 0·6 per cent., or more than double that in boiler No. 1. The writer adds his opinion that the stoking in both boilers was equally good, but with external fires it is impossible to prevent air entering, not only through the bars of the grate and fire-doors, but also through the walls. Hence the excess of air, which increased threefold, to 1·7 per cent., at the damper end. This was accounted for by the large internal and external surfaces and porous brickwork. The same cause contributed to the increased loss of heat to the chimney. We must also notice that the thermal efficiency of this boiler is lower than that of No. 3, although the same quantity of coal per pound per square foot of grate surface was burnt in both cases, and the hot gases in No. 2 were carried off at a lower temperature. This shows that the thermal efficiency of a boiler should not be judged only by the low final temperature of the hot gases.

The thermal efficiency of boiler No. 3 was, as we have said, 8 per cent. higher than that of No. 2. Accordingly, we find that the hot gases were less diluted with air on their way from the fire-bridge to the end of the boiler, and hence their temperature was maintained. The final temperature, 595 deg. Fah., was higher, and the excess of air 0·6 per cent. at the fire-bridge, and 1·2 per cent. at the damper. In this case the soot doors, &c., were made tight with asbestos, and the joints of the brickwork carefully cemented.

In boiler No. 4 there was the greatest excess of air, 0·83 per cent. at the fire-bridge, while the minimum at this spot in the other boilers was 0·25 per cent. This is explained by the exceptional position of the furnace, which projects in front of the boiler, and is protected only by a wall from the external air, while in the other water-tube boilers the furnaces were inside the brickwork and under the tubes. More air may also have entered, as the "Cario" grate was fired mechanically, and therefore combustion could not be so carefully regulated as with hand stoking. The heat balance was not distributed in quite the same way as in the other boilers, because part of the products from the grate did not appear. The comparatively high thermal efficiency is partly due to the low coal consumption, 0·3 lb. per hour per square foot of heating surface, partly to the very small excess of air drawn in between the fire-bridge and the end of the boiler. Thus the distribution of heat was little affected, the final temperature of the gases being 603 deg. Fah. The percentage of dilution of the hot gases was less than in any other boiler, as the internal surfaces were not large, the boiler well covered, and the draught small.

Boiler No. 5: Here the combustion was imperfect, and there was a larger percentage of heat unaccounted for than in most of the others. To this the amount of draught, 0·46 in., possibly contributed, in the writer's opinion. The thermal efficiency, however, was not affected, because less heat escaped to the chimney. Both the initial and final temperatures of the gases were low, and the boiler was not forced, the consumption of coal per square foot of heating surface being relatively low. The excess of air at the end was only 0·94 per cent., being 34 cubic feet per pound of coal, as against 80 cubic feet in boiler No. 3. The brickwork was less porous than in other cases, and there were fewer cleaning doors.

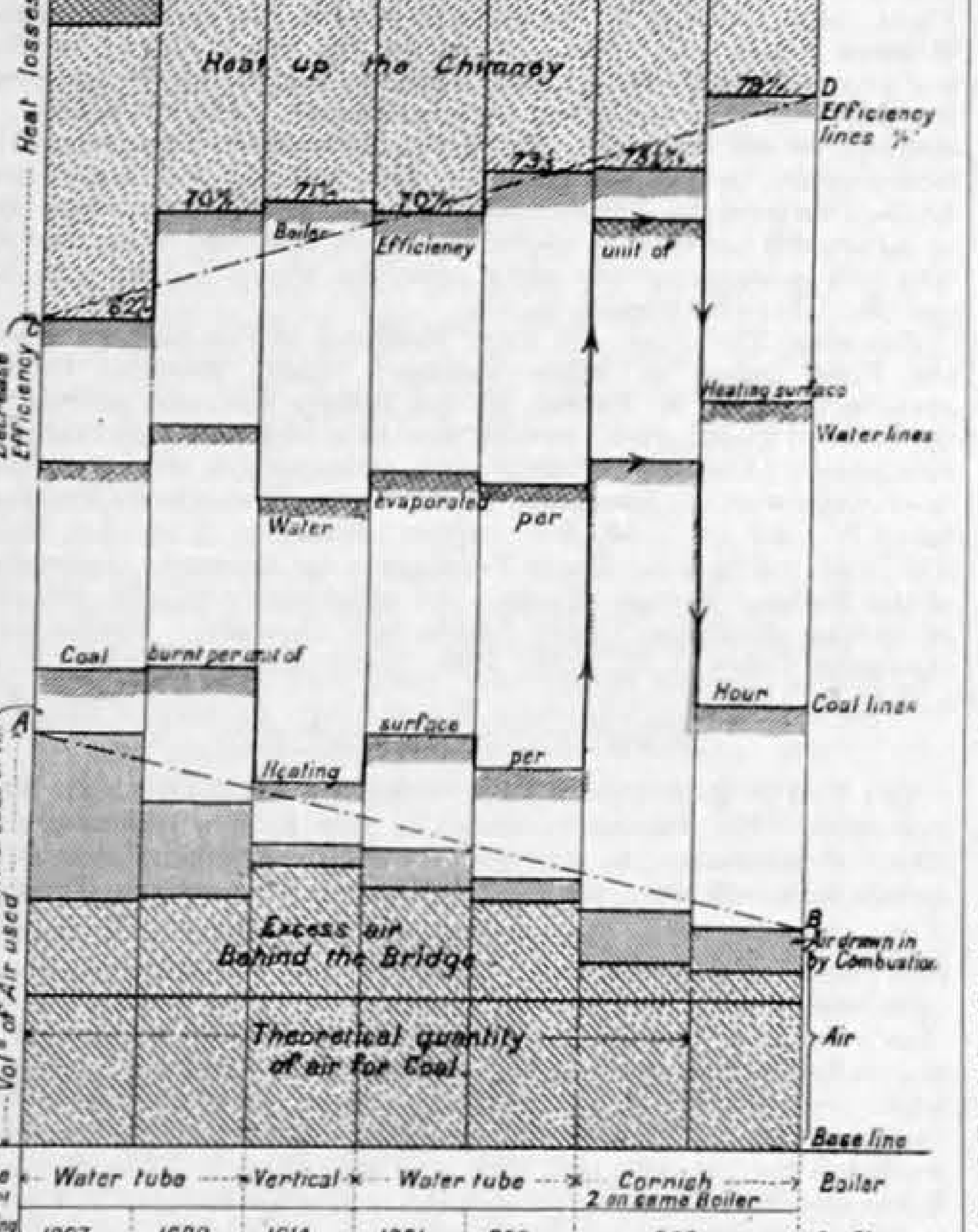
The thermal efficiency in boiler No. 6 was from 2 to 3 per cent. higher than in the other water-tube boilers. The following reasons are given for this:—The boiler was not forced, the coal consumption per pound per square foot of grate surface being very low; the excess of air, both behind the fire-bridge and at the damper end, was small; the heat balance, as shown in the table, was as good as in the Cornish boiler, and there was little loss of heat to the chimney. The small excess of air, 0·77 per cent., near the damper, was due to the non-porous nature of the brickwork and the low draught. The cleaning doors were also well jointed. The draught, consumption of coal, and quantity of air drawn in are less than in any other. Thus we see that with boilers set in brickwork it is important to work with a very low draught, that is, not to keep too great a thickness of coal on the grate. Combustion was rather imperfect, as shown by the small percentage of CO_2 and O; possibly, however, it was not completed at the place where the samples were taken. A difficulty was found in determining the exact spot where the pipe for drawing off the gases should be introduced. Nevertheless the results obtained are practically sufficient to determine the influence of the air drawn in upon the thermal efficiency of the boiler.

In the subsidiary experiment with boiler No. 1 and Rinne's improvements, the efficiency, 79 per cent., was higher than in

No. I.—*Table of Results of Experiments on Six Boilers with same Coal.*

Type of Boiler. (All trials 9 to 11 hours.)	Steam pressure above atmosphere.	Feed-water. Temperature.	Feed-water. Evaporated per hour per square foot of heating surface.	Feed-water. Evaporated per pound of coal.	Heating surfaces. Of boiler.	Heating surfaces. Grate surface of boiler.	Heating surfaces. Proportion of heating surface / grate	Quantity of coal. Burnt per hour per square foot of grate surface.	Quantity of coal. Burnt per hour per square foot of heating surface.	Ash and clinker. In proportion to coal burnt.	Ash and clinker. Percentage of carbon (combustible matter) in ash, &c.	Gases of combustion. Proportion of CO_2 and O. Behind the fire bridge. CO_2.	Behind the fire bridge. O.	At damper end of boiler. CO_2.	At damper end of boiler. O.	Temperature. Of the air for combustion.	Temperature. Of the hot gases at damper end of boiler (mercury therm.).	Draught in inches of water.	Temperature of external surfaces of brickwork of boiler. Front wall.	Side wall.	Back wall.	Top of boiler.
	lbs.	deg. F.	lbs.	lbs.	sq ft.	sq. ft.		lbs.	lbs.	P. cent.	P. cent	P. cent.	P. cent.	P. cent.	P. cent.	deg. F.	deg. F.	Inches.	deg. F.	deg. F.	deg. F.	deg. F.
I.—Cornish Boiler	120	64	5·09	8·62	645	15·5	41·7	24·6	0·59	8·03	41·41	14·81	2·71	11·48	6·82	80	589	·33	158	112	96	100
II.—Water-tube boiler	113	70	3·03	7·40	1307	25	52	21·3	0·41	5·92	38·65	11·80	5·75	6·57	12·38	89	475	·28	224	90	194	161
III.—Water-tube boiler	117	56·5	3·34	8 12	1688	33	51	20·9	0·41	6·59	28·74	11·70	6·40	8·48	10 23	83	593·5	·28	212	134·5	212	123
IV.—Vertical (three) water-tube boiler	105	64	2·72	8·48	1614	32·9	49	15·7	0·32	1·6	38·05	10·75	7·65	9·95	8·47	73	603	·25	—	131	—	166
V.—Water-tube boiler	141	59	2·98	8·34	1651	31 2	53	18·9	0·35	4·31	38·05	11·17	5 23	10·18	7·33	77	551	·46	176	127·5	113	158
VI.—Water-tube boiler	134	58	2·87	8·69	860	22·5	38	12 5	0·33	6·90	43·0	10·97	6·2	10·61	8·07	74	595	·18	129	—	—	—

Graphic representation of 6 Boiler tests with same coal.



No. II.—*Table of Results of Experiments, all with same Coal.*

Type of boiler.	Heat balance. Used. Heat utilised to evaporate water, or thermal efficiency.	Heat lost. In the grate products.	Heat lost. To the chimney.	Heat lost. Unaccounted for.	Quantities of air for combustion, per pound of coal, in different parts of the boiler flues. Theoretical quantity.	Behind the fire bridge. Excess over theoretical A.	Behind the fire bridge. Excess in percentage.	At damper end of the boiler. Excess over theoretical B.	At damper end of the boiler. Excess in percentage.	Difference B − A.
	P. cent.	P. cent	P. cent.	P. cent	Cub. ft.	Cub. ft.	Per cent.	Cub. ft.	Per cent.	Cub. ft.
I.—Cornish boiler	73·42	3·56	16·07	6·95	132·6	165·9	0·25	210·6	0·59	44·
II.—Water-tube boiler	62·0	2·40	21·96	13·64	134	215·3	0·61	360·9	1·69	145·6
III.—Water-tube boiler	69·91	2·03	22·62	5·44	132·1	218·8	0·65	299·7	1·27	80·9
IV.—Vertical triple water-tube boiler	70·95	0·60	20·82	7·63	134·8	237	0 83	263·6	0·96	26·6
V.—Water-tube boiler	69·97	1·70	17·71	10·62	135·6	229	0·69	263·2	0·94	34·2
VI.—Water-tube boiler	73·34	3·11	17·73	5·82	134·8	218·8	0·62	237·8	0·77	19·0
	←——100 per cent.——→									

any of the ordinary trials. However, it only exceeds that of No. 1 with the same boiler by 5·8 per cent., although the quantity of coal burnt was 35 per cent. less, and of steam generated 30 per cent. less. The heat lost was also less, and this was probably due to the effect of the Rinne brickwork, causing more perfect combustion. The percentage of CO_2 and O in the fire tube was also higher, the excess of air at the end was smaller, probably because the vacuum in the flues and the draught were less, the boiler being less forced. The heat balance and the thermal efficiency were both good; the final temperature of the hot gases was 48 deg. Fah. lower. The committee considered that the advantage of the Rinne brickwork consists less in the better utilisation of the coal than in the prevention of smoke and soot, and more complete combustion.

SUMMARY.

Although all these experiments do not furnish any general standard of efficiency, they afford suggestions for the construction and working of steam boilers. Comparing the thermal efficiency of the different boilers here tested with their excess of air at the damper end, it will be seen that when the one is a maximum the other is a minimum. In other words, the smaller the excess of air the higher the efficiency, and *vice versâ*. This fact has long been recognised by experts, but the influence exerted by the air leaking in through the walls, &c., upon the thermal efficiency, or rate of evaporation, has been systematically brought out in these interesting experiments. Bad stoking, bad coals, or defective grates are usually made answerable for the greater or less excess of air penetrating the boiler, as shown by the percentage of CO_2 in the hot gases. The injurious effects of cracks or porosity in the brickwork has not, perhaps, been sufficiently recognised, but trials 2 and 3 show that it must not be neglected. In boiler No. 2 there was double as much excess of air at the damper end as penetrated behind the fire bridge. If, therefore, much infiltration takes place, the fault must be attributed not only to the stoker and heating arrangements, but to the construction. The three last experiments prove that the bad effect of excess of air in the combustion space is compensated if little air is drawn into the flues. Hence the following conclusions may be drawn :—

Excess of air.—To obtain a high efficiency it is not only necessary to carry out combustion with the smallest excess of air, but also to prevent its entrance into the flues. In other words, not only must the temperature of combustion be as high as possible, but it must not be diminished by air thus drawn in. Of the different types of boilers, those with internal firing and tubes are in the same category, as regards infiltration of air, as those having air-tight combustion space and flues. On the other hand, their loss by radiation is greater, and they do not, as a rule, allow of stoking independent of the skill and care of the attendant, which is especially desirable with poor coal and large grate surfaces. The same remarks apply to boilers internally fired, with partly internal and partly external flues, where the internal flues form the greater part of the heating surface. The loss by radiation is about the same in all these three classes. Externally-fired boilers with flues set in the brickwork are most exposed to the injurious effect of infiltration of air. There is, however, less loss by radiation, and it is possible to regulate combustion over large surfaces of grate. If it is desired to increase the efficiency of the two last classes of boilers, the combustion space and the flues must be so made that a minimum of air can penetrate after combustion has begun, and this opens a wide field to engineers. The joints of the soot doors, &c., should be well made. Observations have also shown that less injury is done to the heating surfaces by the deposit of soot and ash, than by allowing air to penetrate by frequently opening the cleaning doors. If it is possible to render the flues and combustion spaces of externally-fired water-tube boilers air-tight, not only would a higher efficiency be attained, but a better evaporation of steam, and the boilers could perhaps be more forced than hitherto, without impairing their thermal results. These experiments show further that the amount of coal burnt and of steam generated per square foot of heating surface per hour are closely connected, and rise and fall together, without affecting the thermal efficiency. The quantity of steam produced in a boiler is a function of the quantity and heating value of the fuel used, while its efficiency is principally influenced by the excess of air in the gases. From the coal consumption we get the quantity, and from its thermal efficiency the cost of the steam generated. That the best way of economising coal is to have a good stoker is an erroneous idea. These experiments clearly prove the contrary, especially Nos. 2 and 3, where the efforts of the stoker were frustrated by the considerable admissions of air.

According to experiment No. 1, an excess of $\frac{1}{4}$ per cent. of air is sufficient to insure good combustion. More air, although it prevents loss by unburnt gases and soot, causes a greater loss of heat to the chimney, while at the same time, unless the layer of coal is kept thin, the stronger draught will produce a further excess of air by the porosity of the brickwork. But with air-tight flues the excess of air can be increased a little, without acting injuriously on the efficiency, if smokeless combustion be desired.

Priming.—The moisture in the steam, according to these results, is so small that the mean here given may be safely applied to all other boilers. We cannot deduce from them how the different boilers would work if they were still more forced; but we may conclude that it would be possible in all cases to draw off and separate the priming water from the steam.

Gases.—The great importance of analysing the hot gases, to show the chemical actions taking place, have been confirmed afresh by these tests. Light has been thrown upon a factor which, although it greatly influences the efficiency of boilers set in brickwork, has not been sufficiently recognised. More systematic and exact observations than it was possible to make on this occasion ought to be carried out, to determine whether the leakage of air through the brickwork can really be so considerable as these experiments appear to prove On page 528 is given a graphic representation of these boiler tests. Not only are the six trials given, but the seventh is added, made with Rinne's patent on boiler No. 1. Comparing the direction of the lines A B and C D, it will be noticed that with the increase in the quantities of air drawn into the flues in the various tests, there is a corresponding regular decrease in the boiler efficiencies.

The following is Dr. Bunte's chemical report :—

Chemical Analysis of one Sample of Coal used during the Trials.

Carbon..	81·84	91·96
Hydrogen	4·47	
Oxygen and nitrogen	4 35	
Sulphur	1·30	
Ash, &c., ...	4 73	
Water	3·31	
Total	100·00 per cent.	

The heating value of the coal reckoned from ordinary formulæ is 13,856 T.U. The percentage of coke in the coal, after it was dried in the air, was 79·30 per cent., or equal to :—

One Sample.	Fixed carbon	73 47	per cent.
	Volatile substances	20·23	,,
	Ash	5·83	,,
	Water	0 47	,,
		100 00	

Grate Products.

Moisture—or loss of dryness—at 230 deg. Fah.	0 41 to	0·63	per cent.
Incombustible substances—pure ash	70·57 to	52·30	,,
Combustible substances	29·02 to	47·07	,,
Total	100 00	100 00	,,

The writer of this abstract was present during some of the trials, and can confirm the care that was taken to insure accurate results.

LETTERS TO THE EDITOR.

(*Continued from page 523.*)

THE INDICATOR CARD OF THE OIL ENGINE.

SIR,—At the present time the progress made in oil engines establishes them as of paramount importance. It occurred to me that it would be of interest for the purposes of comparison if the indicator card of the oil engine was subjected to the same treatment as that of other prime-movers. This is the object of this letter. The indicator diagrams referred to were taken from a 12-horse power oil engine, the latest form of the "Priestman" type. In this particular form of oil engine, the oil is fed in the form of a spray cloud, mixed with a definite proportion of air, into a vaporiser or heater, this being kept hot by the products of the previous exhaust. This spray cloud of minutely fine oil particles floating in air, and heated to 260 deg. Fah. (approx.), is a highly explosive mixture, is drawn into the working cylinder, compressed, and exploded by electric ignition. The cycle used being the ordinary "Otto," *i.e.*, one explosion or impulse for every two revolutions of the crank shaft. Inasmuch as the diagram taken from explosive engines is of a very complicated form, great care should be exercised in choosing a suitable indicator and gear. A stiff spring and small inertia of moving parts is to be aimed at in the choice of indicators, otherwise three or four different diagrams may be taken, and then it is difficult to compute the indicated horse-power. The general form of diagram obtained is as shown in Fig. 1. The expansion part of the curve nearly always

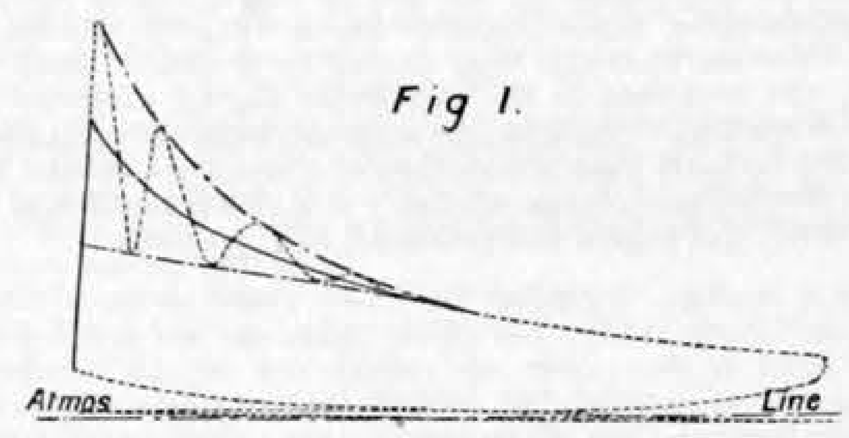


Fig 1.

takes a wavy form. To arrive at a correct mean of these waves, I join the highest and lowest points of the curve, and bisect the vertical ordinates as shown.

The indicated horse-power computed from the original diagram and the corrected diagram will be the same.

Expenditure of heat.—Since 772 foot-pounds is 1 thermal unit (B.T.U.), therefore $1\text{-H.P.} = \frac{33,000}{772} = 42{\cdot}746$ B.T.U.

Therefore 12-H.P. = 512 952 units of heat developed per minute. Taking 0·80 lb. of oil as used per I.H.P. per hour, and the calorific value of Daylight oil being 19,700 Th.U. per pound,

$$\text{the thermal efficiency (reckoned on the I.H.P.)} = \frac{42{\cdot}746 \times 60}{19{,}700 \times 0{\cdot}80} = {\cdot}162;$$

the highest thermal efficiency of any gas engine and producer being not more than 14 per cent.

The diagram of piston velocity.—This is obtained at the same time as the diagram of turning effort. The linear curve of piston velocity is drawn using Cartesian co-ordinates, whilst the polar

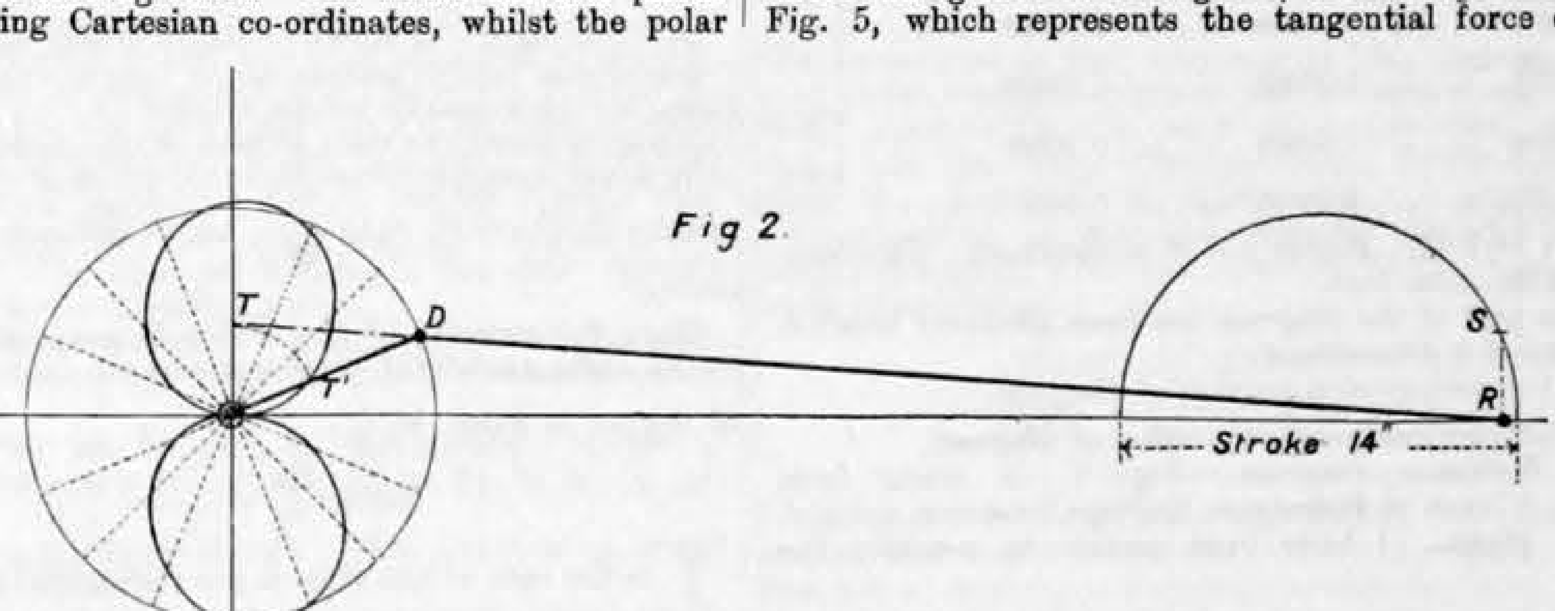


Fig 2.

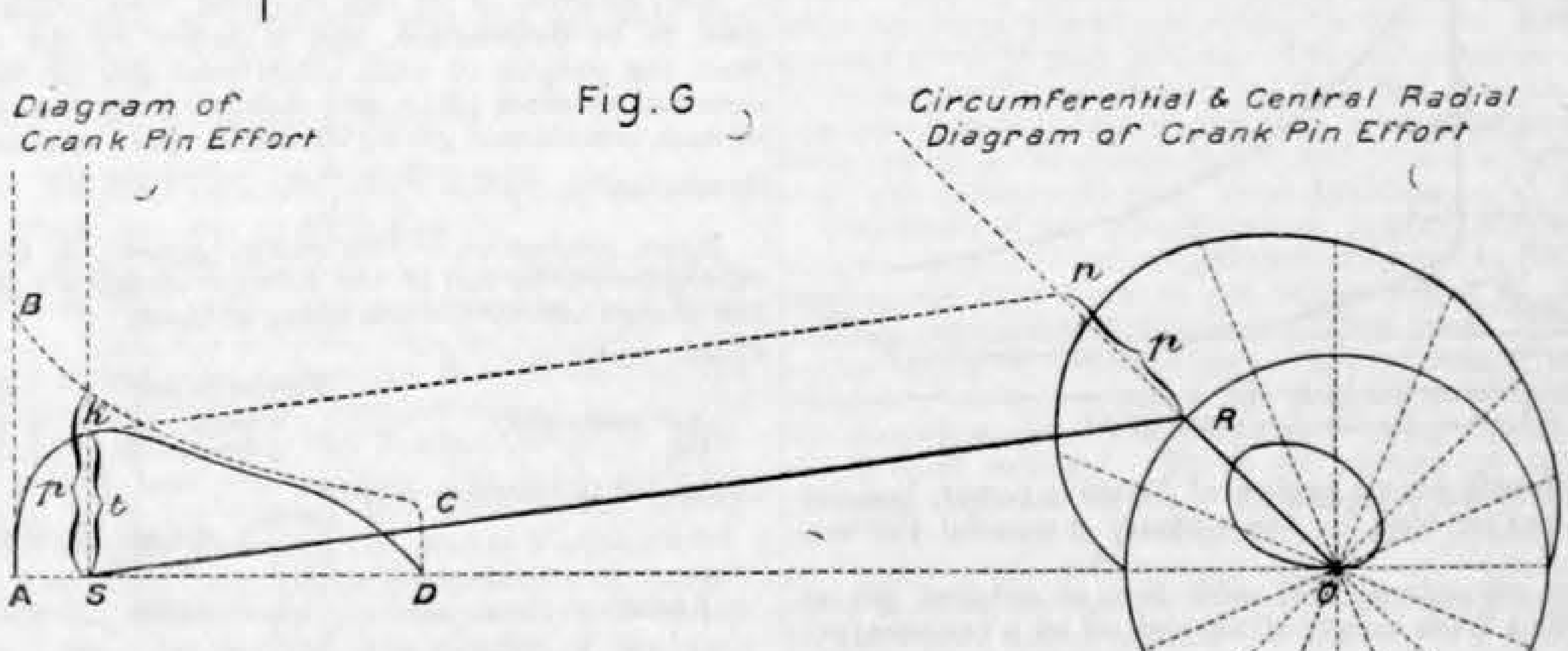


Fig. G

curve is exactly the same only using polar co-ordinates. This will be readily understood from Fig. 2.

O D = crank, D R connecting-rod.

O D T is a triangle of velocities, and for every position of the crank O D, distances as O T will represent the velocity of the piston. These distances set off as O T[1] on the respective crank positions—*radii vectores*—form the polar curve—set off on the respective positions of the crosshead as at R S form the linear curve of piston velocity. In order to deal with the crank efforts we must first find the resultant diagram, or as it may be termed, *the diagram of holding-down bolts* of cylinder, that is the resultant pressures tending to force off the cylinder cover. In the case of the oil engine this will simply mean the indicator diagram taken to the atmospheric line. The atmospheric line is then considered as our zero line of pressures. The resultant diagram—Fig. 3—therefore shows the difference of pressure on the two sides of the piston during one-half of a revolution. Another correction yet has to be made: the inertia of the reciprocating masses which is found from the formula

$$\frac{W}{g}\,\frac{V^2}{R}\,.\,\frac{1}{A}\ \text{per square inch of piston area.}$$

In the present case

W is taken as 224 lb., being the weight of piston, half of piston-rod, and crosshead.

V is 156·3 revolutions per minute, or 9·55ft. per second.

g is taken as 32·2.

R is the radius of the crank—7in.

A is the area of piston of 10¾in. diameter.

From this a virtual pressure of 12 lb.—calculated—per square

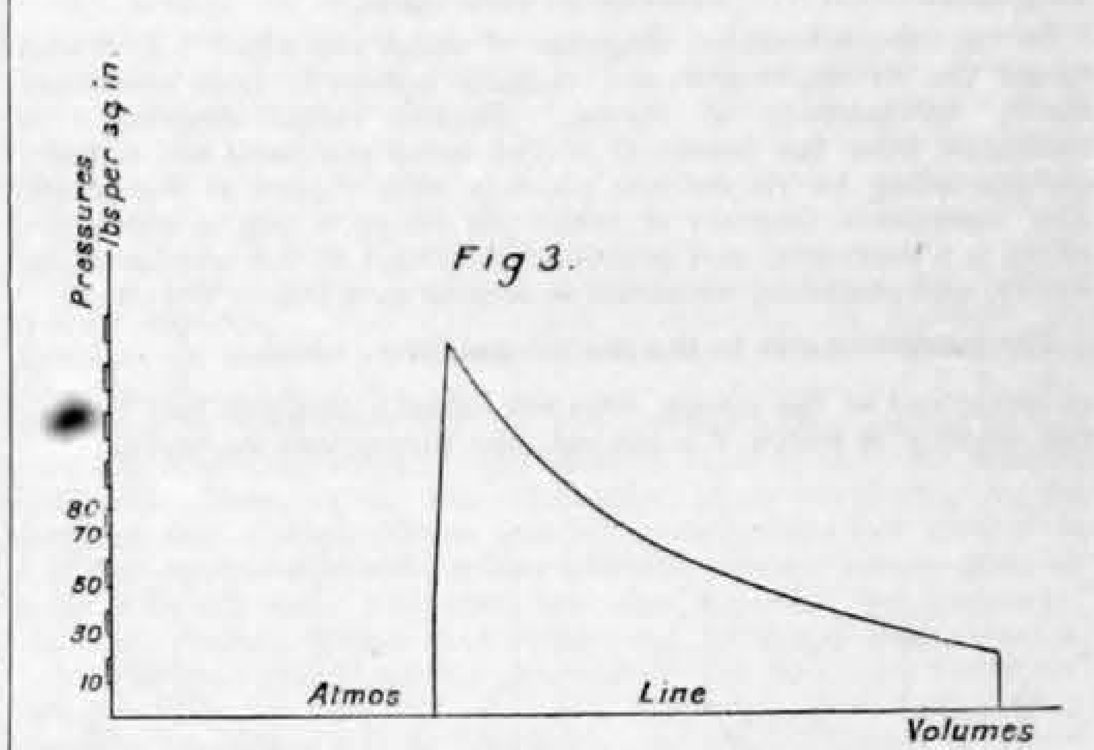


Fig 3.

inch of piston area is, during the early half of the stroke, used only in accelerating the reciprocating masses, and during the latter half of the stroke is the pressure required to retard them. This forms

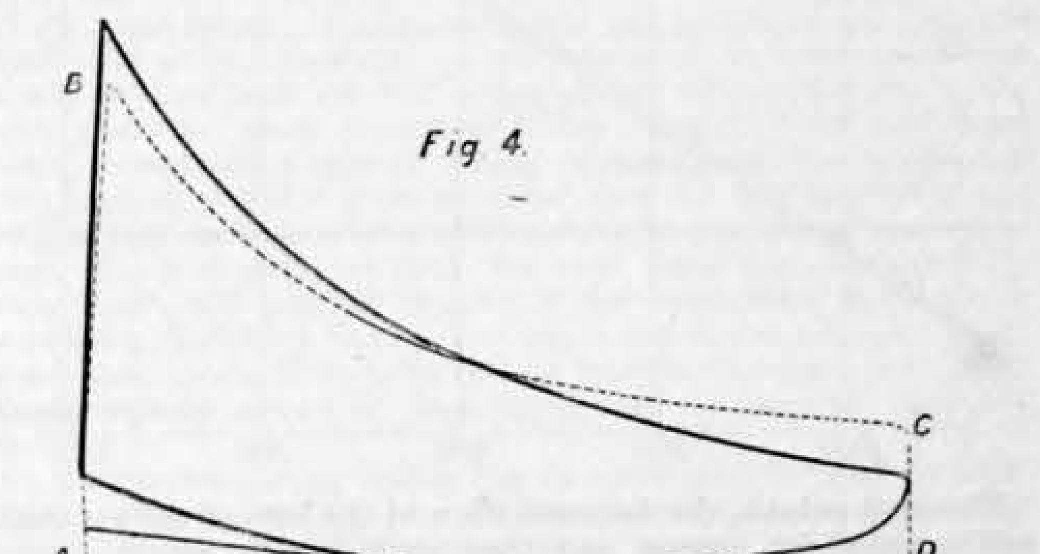


Fig 4.

virtually an addition to the gas pressure. Thus the dotted diagram A B C D is obtained, and is *the diagram of pressure on crank pin*, Fig. 4.

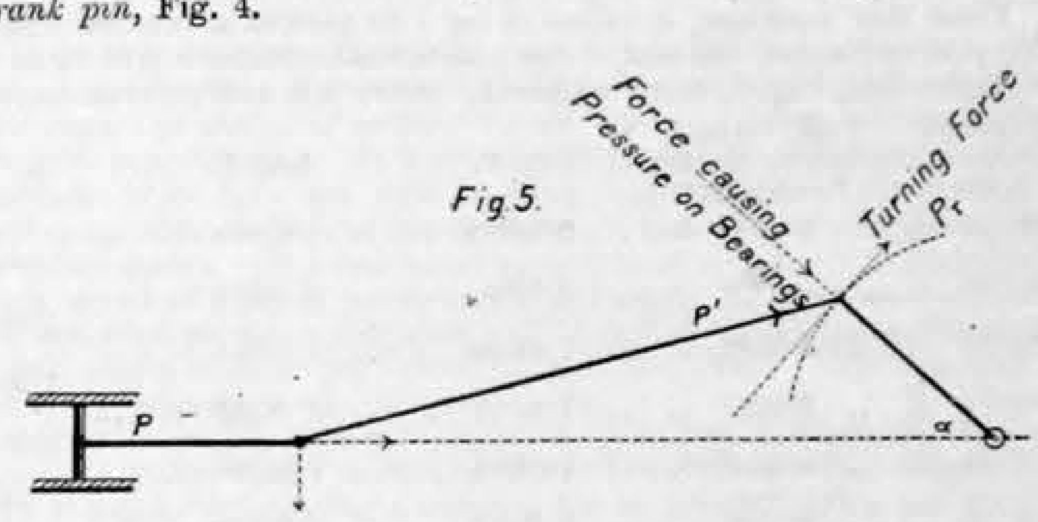


Fig 5.

From the diagram of pressure on the crank pin, or pressure transmitted along the connecting-rod, to the *diagram of crank-pin effort*, Fig. 5, which represents the tangential force on the crank pin during half a revolution, is but a step. The pressure on the piston is transmitted to crank pin by the connecting-rod. This pressure at the crank pin can be resolved into two; one acting tangentially at every moment to the crank pin, the other acting as a direct force through the crank, and only causing pressure on the bearings, the other causing a turning effort.

If the pressure on the piston was constant during the stroke, and connecting-rod was infinitely long,

$$\text{then } P_T = P \sin a.$$

A sine curve would therefore give the graphic representation.

Taking now into account the steam pressure varying during the stroke and the obliquity of the connecting-rod. The diagram of pressure on crank pin A B C D is reproduced as shown in Fig. 6. A D is the stroke of the crosshead. Produce O R and the perpendicular at S to meet in I; then I is the point about which the connecting-rod S R is rotating at the instant considered.

Let V_c = velocity of crank pin.

V_h = velocity of crosshead.

$$\frac{V_h}{V_c} = \frac{S\,I}{R\,I}$$

p = ordinate of diagram A B C D.

Let t = tangential effort at R.

Work done by p = work done by "t."

$$\therefore p\,V_h = t V_c.$$

Make R n = p, draw $n\,k$ parallel R S,

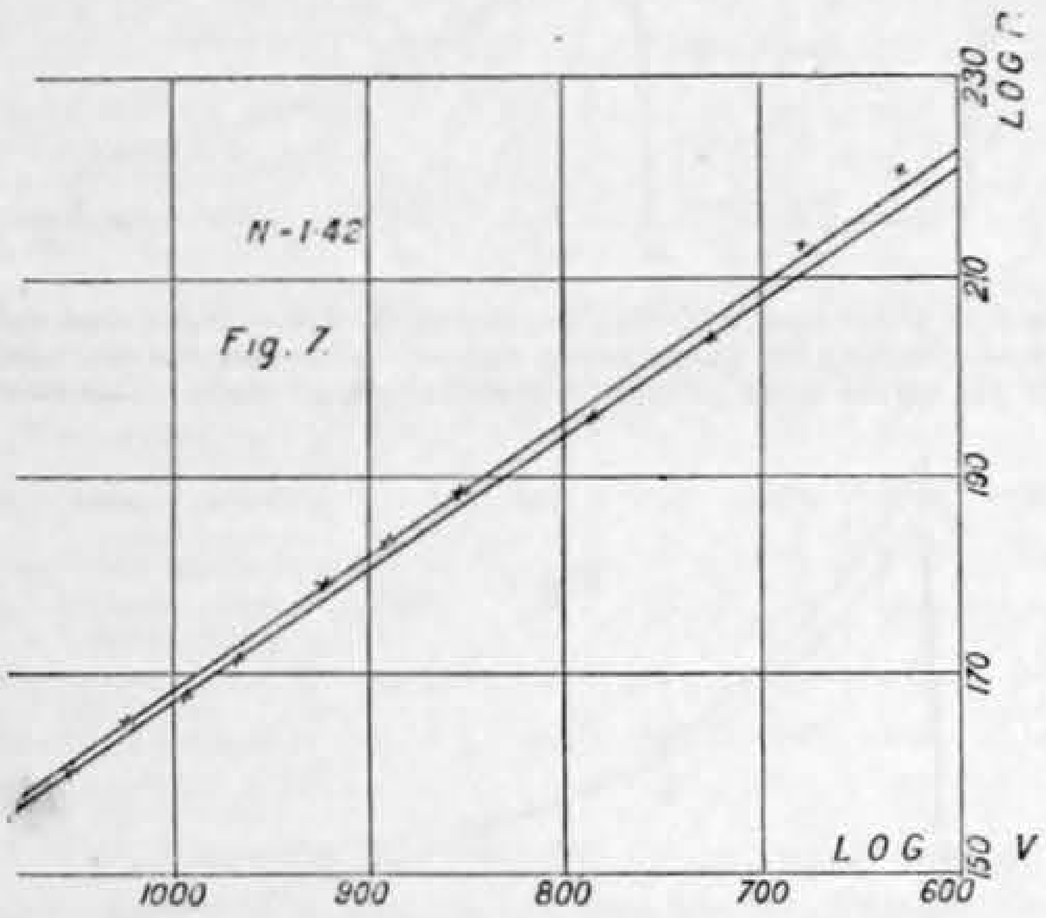
$$\frac{t}{p} = \frac{S\,1}{R\,1} = \frac{S\,k}{R\,n}$$

$$\therefore t = S\,k.$$

Tangential effort "t" vanishes at dead point.

In the circumferential diagram of crank pin effort t is drawn round the circumference and radially outwards from crank pin circle, substantially as shown. Central radial diagram t is measured from the centre O of the crank pin circle and radially corresponding to its definite position with regard to the crank. The theoretical diagram of crank pin effort is one in which the effort is a maximum and practically constant at the middle of the stroke, and gradually decreases to zero at each end of the stroke.

The correction due to the centrifugal force, which is $\frac{W}{g} \cdot \frac{V^2}{R} \cdot \frac{1}{A}$ at either end of the stroke, does not follow a straight line law, as the velocity of piston V is not constant throughout the stroke.



The next point is the determination of the laws of the expansion and compression curves and then deducing *temperature curves*, and, as far as I am aware, no results have yet been published. Many diagrams have been treated, but one example here will suffice.

In all engines for the expansion and compression portions of the stroke, a law such as $p\,v^n$ = constant holds true for the working fluid. Hence, log. p + n log. v = constant.

From this equation, if values of log v be plotted as abscissæ and log p as ordinates, the loci of the points thus obtained will form a straight line, Fig. 7, from which the index n is easily obtained :—

Absolute pressure, P. lbs.	Total volume, including clearance, V cubic feet.	Log. P.	Log. V.	n.
146·73	0·4360	2·16652	$\bar{1}$·63949	
				1·566
134·73	0·4604	2·12947	$\bar{1}$·66314	
				1·661
105·33	0·5340	2·02255	$\bar{1}$·72754	
				1·329
88·73	0·6075	1·94807	$\bar{1}$·78355	
				1·192
77·43	0·6810	1·88891	$\bar{1}$·83315	
				1·449
66·73	0·7546	1·82432	$\bar{1}$·87772	
				1·192
59·73	0·8281	1·77619	$\bar{1}$·91808	
				1·623
52·03	0·9016	1·71625	$\bar{1}$·95501	
				1·370
46·73	0·9751	1·66960	$\bar{1}$·98905	
				1·231
42·73	1·0486	1·63073	0·02061	
				1·448
38·73	1·1222	1·58805	0·05007	

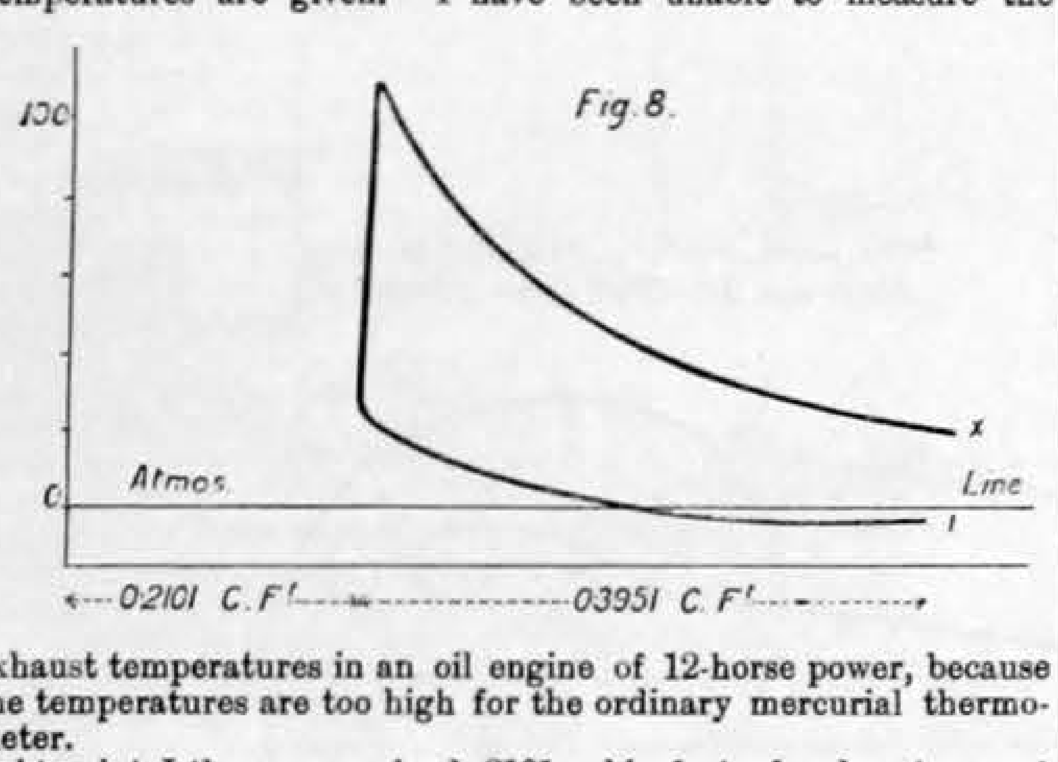
Mean value of n = 1·42. Hence $p\,v^{1·42}$ = constant. The clearance volume is 0·4236 cubic feet.

The compression part of the diagram has been similarly treated, and the mean value of n determined.

n = 1·33 for compression portion of diagram.

$p\,v^{1·33}$ = constant for compression portion of diagram.

The following indicator diagram — Fig. 8 — is taken from Professor Unwin's "Trials of Petroleum Engines," because exhaust temperatures are given. I have been unable to measure the



exhaust temperatures in an oil engine of 12-horse power, because the temperatures are too high for the ordinary mercurial thermometer.

At point I there are mixed ·2101 cubic feet of exhaust gas at 531 deg. Fah., with a fresh supply of air and oil at a temperature of 268 deg. Fah.

The resultant temperature of the mixture is first determined.

Then since the same weight of gas is dealt with from I to exhaust X,

$$\frac{P\,V}{T} \text{ is constant.}$$

In one stroke the proportion of exhaust gas, namely, CO_2, H_2O, air at 531 deg. Fah. present is $\frac{·2101}{·605}$ = ·347 of exhaust gases, and fresh supply = ·653 of C_7H_{14} (Royal Daylight oil) and air at 268 deg. Fah.

Air used per cycle = ·0476 lb. actually measured.

Oil used per cycle = ·00108 lb. actually measured.

Thermal capacity of supply = $w.s.t.$

Thermal capacity of air = ·0476 × ·2375 × 268

\+ Thermal capacity of oil + ·00108 × ·3112 × 268

= 3·0297 + ·09007

= 3·12 = thermal capacity of supply.

Exhaust gases are present in the following proportions :—

$$CO_2 = \frac{42·8}{617·2} \times ·02586 \text{ lb.}$$

$$H_2O = \frac{17·1}{617·2} \times ·02586 \text{ lb.}$$

$$\text{Air} = \frac{557·3}{617·2} \times ·02586 \text{ lb.}$$

and these are at a temperature of 531 deg. Fah.

Thermal capacity of exhaust—

$$= \frac{531 \times ·02586}{617·2} (42·8 \times ·216 + 17·1 \times 14·8 + 557·3 \times ·2375)$$

$$= 3·248 \text{ Th.U.}$$

Total thermal capacity, exhaust, and supply—

$$= 6·368 \text{ Th.U.}$$

Total heat before mixing = resultant temp. × w × s

$$\text{Result temp. } t = \frac{6·368}{·0745 \times ·2375}$$

$$= 360 \text{ deg. Fah.}$$

Absolute temperature T = 360 + 460 = 820 deg. Fah.

At point I. in diagram—

P = 10·60 lb. absolute,

V = 0·6052 cubic feet.

$$\therefore \frac{P\,V}{T} = \frac{10·60 \times 0·6052}{820} = \text{constant C}$$

$$= 0·007824,$$

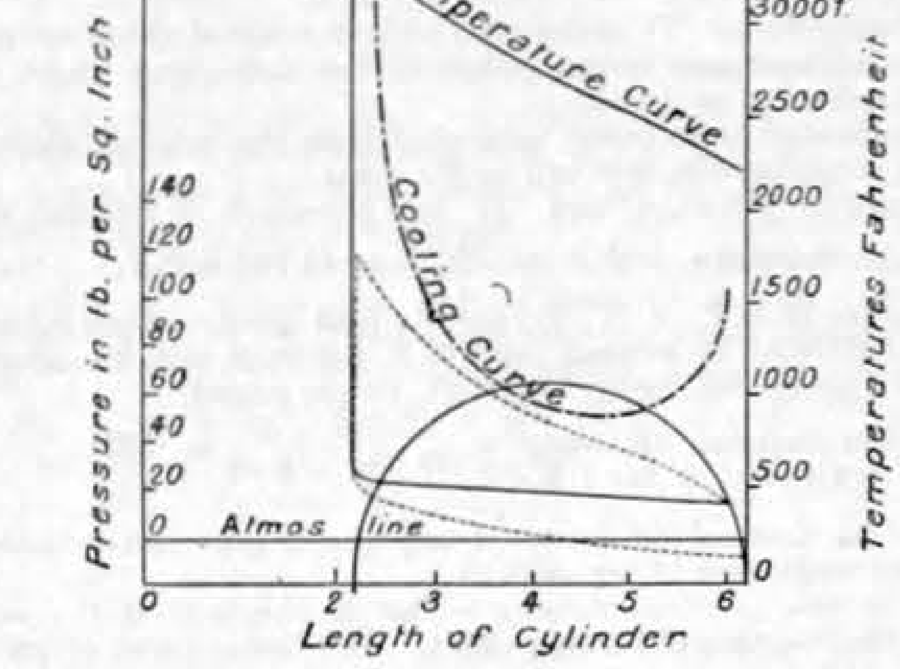
$$\text{log. C} = \bar{3}·89340.$$

Therefore, knowing this constant, take any other pressure and corresponding value of temperature T can be determined.

Volume of cylinder, including clearance. Cubic feet.	Absolute pressure. P lb.	$t°$ F.	($t°$ − 115°)F.	Cooling.
0·6052	10·60	360	—	—
0·40	18·60	490	—	—
0·30	26·0	537	—	—
0·21 ignition	37·7	551	436	—
0·22	132·7	3272	3157	6314
0·242	119·7	3243	3128	2310
0·275	100·7	3080	2965	1482
0·30	90·7	3020	2905	1283
0·35	72·7	2788	2673	1027
0·40	62·7	2743	2628	955
0·45	53·7	2627	2512	937
0·50	46·7	2523	2408	993
0·55	39·7	2330	2215	1107
0·58 exhaust	36·7	2260	2145	—

It is to be observed that higher temperatures are obtainable in the oil engine than either in the gas or steam engine for corresponding pressures; hence a greater thermodynamic efficiency will result. This result has also been proved by Professor Aimé Witz, of Lille, who says that in the petroleum engine where no loss is involved in working a producer, the thermodynamic efficiency may be expected to be more than double that of a steam engine and boiler. He finds the thermodynamic efficiency of a steam engine and boiler 7·0 per cent.; gas engine and producer, 12·7 per cent.

Fig. 9.



The *Cooling Curve* shown in Fig. 9 is obtained by assuming that "the rate of loss of heat from the fluid to the cylinder is proportional to the excess of temperature," *i.e.*, (t−115) deg. Fah., since 115 deg. is about the temperature of the cylinder or water jacket. If H is the quantity of heat lost by the fluid to the cylinder's walls in time T $\frac{H}{T} \propto t$ − 115 deg., and is the rate of loss of heat per second.

Since the velocity of the piston is proportional approximately to the ordinates of the semicircle drawn—see second figure—and, of course, is equal to $\frac{l}{T}$.

$$\text{Hence } \frac{H}{T} \div \frac{l}{T} = \frac{H}{l}.$$

$\frac{H}{l}$ is the rate of loss of heat per foot travel of piston; (or simply) Temperature curve ordinate divided by the semicircular curve ordinate give you the ordinates of cooling curve.

Determination of the heat reception curve.—The value of "j" has first to be determined, and is found by the following rule:—Sum the weights of each constituent gas by its specific heat at constant pressure (K_p), and divide this by the sum of the weights of each constituent gas by its specific heat at constant volume (K_v). Symbolically, "j" = $\frac{\Sigma\, w\, K_p}{\Sigma\, w\, K_v}$.

Before combustion.—The charge present in the cylinder of the oil engine at the end of the forward stroke is: charge drawn in + the charge left by the preceding exhaust.

Charge drawn in—

	Weight in lbs.	K_p	$w\,K_p$
Air (measured)	0·0476	0·2375	·0011305
Oil "	0·00108	0·4106	·00044345
Charge left in clearance volume—			
Air	$\frac{557·3}{617·2}$ × ·02586	0·2375	0·0055454
Steam	$\frac{17·1}{617·2}$ × ·02586	0·4750	0·00034032
Carbon dioxide	$\frac{42·8}{617·2}$ × ·02586	0·1712	0·0003879
		$\Sigma\, w\, K_p$ =	0·01802207

Similarly,

Charge drawn in—

	Weight in lbs.	K_v	$w\,K_v$
Air (measured)	0·0476	0·1685	0·0 8021
Oil "	0·00108	0·3410	0·0003683
Charge left in clearance volume—			
Air	$\frac{557·3}{617·2}$ × 0·02586	0·1685	0·0039346
Steam	$\frac{17·1}{617·2}$ × 0·02586	0·399	0·00028586
Carbon dioxide	$\frac{42·8}{617·2}$ × 0·02586	0·1712	0·0003683
		$\Sigma\, w\, K_v$ =	0·01297806

$$\text{"}j\text{"} = \frac{\Sigma\, w\, K_p}{\Sigma\, w\, K_v} = \frac{·018022}{·012978} = 1·388$$

Hence adiabatic operation for petroleum engine using Royal Daylight oil,

$$p\,v^{1·388} = \text{constant.}$$

External work may be expressed as

$$\frac{K_p - K_v}{1 - n} (T_2 - T_1).$$

Internal work done is

$$K_v (T_2 - T_1).$$

Thus, $\frac{\text{internal work}}{\text{external work}} = \frac{1 - n}{j - 1}$ which is a constant ratio.

Total heat expended is the sum of the internal and external work.

The ordinate being the "*pressure equivalent*,"

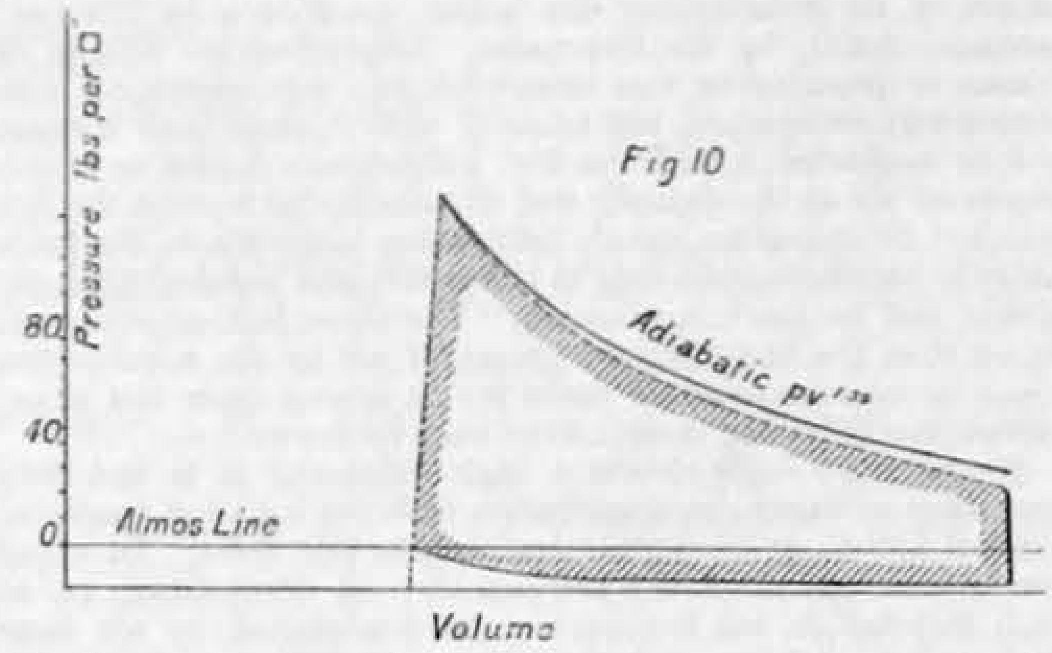
$$p_h = p + p\,\frac{1 - n}{j - 1} = p\,\frac{j - n}{j - 1}$$

$$p_h = p\,\frac{1·388 - 1·42}{1·388 - 1} = \frac{-0·03}{0·388} = -0·077\,p$$

$$p_h = -0·077\,p.$$

Values of	p.	p_h
	146·73	−11·30
	134·73	−10·37
	105·33	− 8·11
	88·73	− 6·83
	77·43	− 5·96
	66·73	− 5·14
	59·73	− 4·60
	52·03	− 4·00
	46·73	− 3·60
	42·73	− 3·19
	38·73	− 2·98
Ignition	37·43 × ·154	+ 5·77

From this diagram—Fig. 10—as n > 1 the temperature falls,



and part of the external work is done at the expense of the intrinsic energy of the working fluid.

J. F. Conradi, Stud. Inst. C.E.

IRRESPONSIBLE DETECTIVES.

Sir,—In your issue of June 8th, when writing on the United States armour-plate scandal, you justly condemn the American method of inspection, and conclude the second paragraph of your leader by asking, "Can we conceive the English Government allowing such relations with our manufacturers to be contemplated?"

In reply to this question I beg to quote the following specimen from the report of one of H.M. Inspectors of Mines for 1893, recently issued:—"During the year I have received a number of workmen's complaints, both anonymous and signed. In all cases they have received the earliest possible attention. . . . Such communications, whether anonymous or signed, receive equal attention, and are always treated as confidential information, but I again repeat that such letters should specify the nature and locality of the complaint as a guide to the Inspector when visiting the mine; for it is clear that few workmen can have sufficient knowledge of the ramifications of the whole mine, and understand its work so as to enable them to make a general complaint of mismanagement and neglect. . . . The workmen of this district have no ground of complaint with respect to the communications to the Inspector of Mines, for all are treated alike and investigated."

He also refers to the power of inspection by workmen given by General Rule No. 28, and says that "with few exceptions no such inspections are made," and he might have added that when they are made it is only for purposes of espionage.

The scandalous encouragement thus given to spiteful workmen would have resulted in a savage roar at Westminster from the "Labour" members if, for example, detectives had been sent to work amongst colliers to get evidence of gambling, obscene and threatening language, &c. &c.

It has been well known to colliery managers for some time that a considerable part of the Mines Inspectors' work is due to anonymous and false reports; and speaking from the cases I know of, there has not been in one single instance any ground for these reports. One of this class was sent from one colliery a fortnight ago to "pay off" an under-manager for doing his duty.

I would suggest that a parliamentary return be made of the following:—(1) Total number of workmen's complaints to Inspectors of Mines, (a) anonymous, and (b) signed; (2) how many cases were considered worthy of investigation; (3) how many complaints were justified.

Enginewright.

June 11th.

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

(*From our own Correspondent.*)

Business in the iron trade, with especial reference to the pig iron branch, continues to show slight signs of improvement. Stocks of crude metal are very low, and this week buyers entering the market to satisfy their requirements have had to pay dearer rates than was the case a fortnight back. Staffordshire cinder pigs are firm at 37s. 6d. to 38s.; part mines, 42s. to 42s. 6d.; and best, 55s. to 57s. 6d. Agents of Midland material quoted 39s. 6d. to 41s. for Northamptons; 42s. to 43s., Derbyshires; and 43s. to 44s., Lincolns. For Staffordshire cold-blast pig iron the price is un changed.

With reference to finished iron, the principal orders on the market relate to home consumption, but makers are hopeful that the second half of the year will show greater activity as regards export custom. Galvanised sheets, doubles, are this week £9 15s. to £9 17s. 6d., and £10 for delivery, f.o.b. Liverpool or equal; and black doubles, £6 10s. nominal. Iron hoops are rather brisk at £6 10s.; constructive angles, £6 15s.; thin strip, £6 10s.; bedstead angles, £5 15s.; small rounds, £6 to £6 5s.; nail rods, £6 15s.; and gas tube strip, £5 15s. For bars a more buoyant demand has been expressed, both for second and common qualities. The latter are £5 10s. per ton; merchant sections, £6 to £6 10s.; and marked, £7 10s. The steel works continue busy, and for new business makers will not accept less than £6 for small bars; £5 7s. 6d., girders; £4 7s. 6d., billets; and £4 5s., blooms.

The two blast furnaces erected by Mr. G. Addenbrooke, the former proprietor of the Bedworth Coal and Iron Company, Warwickshire, are being pulled down, the engines, boilers, and other ironwork having been purchased by a Sheffield merchant. They were erected in 1872-3 at an enormous cost, and one of them has never been used for the purpose for which it was built.

The recent placing by a Birmingham firm of pipe makers of an order for steel for 2000 tons of large-sized water pipes with Messrs. Bolckow, Vaughan, and Co., has been the subject of a correspondence here with a view to arrive at the relative position of Staffordshire and the North of England as steel makers. It seems that in the case of the chief Staffordshire steel-making firm who quoted, their rolls were not wide enough for such large plates, and in quoting they had to consider the cost of new rolls and accessories. This, therefore, increased the Staffordshire price considerably, and gave the Middlesbrough firm a patent advantage. Wages and common charges at the Staffordshire steel mill would also be much heavier than in the North—perhaps double—owing to the much smaller make. As small a difference in price as 6d. per ton in the tender will sometimes, it is said, decide a steel or engineering contract in a keenly competitive period like the present. It is urged, therefore, that the history of this order is no proof of Staffordshire's inability to make steel at a profit. Indeed, it is said by those who ought to know, that at the present time the leading local steel plants are paying well.

The necessity which, in consequence of increasing competition and low prices, many manufacturing concerns are now finding themselves under of taking up other branches of metalliferous production than those for which the works were originally laid out, was prominently referred to by the chairman of S. Heath and Sons, Birmingham, on Tuesday. He congratulated the shareholders on a 9 per cent. dividend on the ordinary shares, but said the good results of the year, which would be a surprise to many people, were not entirely due to the manufactures upon which the company mainly depended. The bedstead and other kindred trades, on which they mainly relied, had been so depressed that they had had to turn their attention to articles outside. They had been able to adapt their machinery to the circumstances with most satisfactory results. Everything was now paid for, and the company were ready for any emergency that might arise. If, in the face of a bad year, the company had produced such satisfactory results, he need not say how much better they would do with improved trade.

The rating of machinery question still occupies much attention here. Some of the local opponents to the Rating of Machinery Bill are pointing out that there is no sufficient necessity for legislation, and urging that there is no uncertainty in the present law. The supporters of the Bill, however, show that this is just opposite to the facts, and point out that one of the leading opponents of the Bill, the late Attorney-General—to say nothing of the report of the Select Committee of the House of Commons—states that there is great confusion, and admits the necessity of settling the question by legislation. How great this confusion is, can be seen by reference to the reports of the Select Committee of 1887. The Court of Appeal is, it is urged, of opinion that tenants' machinery is not rateable, and it is even said that some of the most active upholders of the Bill up and down the country are to be found among assessment committees themselves, these bodies desiring some definite legislation to guide them.

I am glad to hear that a fair amount of success is attending the appeals of the Wolverhampton manufacturers before the Union Assessment Committee against the heavy increased assessments which have lately been levied upon their works. The proceedings are being conducted in private, but I learn that some very large deductions have been allowed in certain cases—in one instance, that of a leading iron works in the district, the reduction being as much as £1000 on a re-assessment of £4000. After they have obtained all they can from the Assessment Committee, it is open to manufacturers to appeal to Quarter Sessions, and there is no doubt that in some instances this course will be taken, the manufacturers being very dissatisfied at the manner in which their machinery has been treated.

An interesting experiment with a view to prevent steam boiler incrustation has just been made by the engineers to the South Staffordshire Mines Drainage Commissioners. With an idea to counteract the effects of acid water on the boiler plates at one of the leading engine houses, a portion of the inside of one of the boilers was painted with soapstone paint, which had previously proved successful in preserving ironwork under water in the pits. The part upon which this experiment is being tried had previously been attacked by acid, and upon examination after a few weeks' trial, it has been found (1) that the paint remains and resists the acid, and (2) that the small quantity of oil in the paint has not led to any blistering of the plates. The Commissioners are to be congratulated on the solution of this very troublesome difficulty.

NOTES FROM LANCASHIRE.

(*From our own Correspondent.*)

Manchester.—The position generally throughout all branches of industry connected with the engineering, iron, and coal trades of this district continues about as unsatisfactory as it could well be. A prevailing want of confidence in the future checks all operations that can in any way be held back; in the iron market there is from week to week only a dull, dragging sort of business, with steadily weakening prices, whilst in the coal trade there is again an unsettled, uneasy outlook with regard to the wages question. The chairman and secretary of the Coalowners' Federation, in accordance with the rules, have proposed a joint meeting of the Conciliation Board to consider a reduction in wages, but the miners' officials have raised a quibbling objection to the form in which the request for this meeting has been made, and although it has been formally convened to be held in London next Tuesday, the miners' representatives decline to attend, this policy being pursued with the object of delaying by any means, and as long as possible, any consideration of the present rate of wages.

Business in the iron market continues extremely slow, and although there was a fair average attendance on the Manchester Exchange on Tuesday, pig and finished iron makers generally report an absence of business of any real weight giving out. Lancashire makers still quote nominally on the basis of about 40s. for forge, to 42s. for foundry, less 2½ at the works, but except where they sell occasional small parcels of foundry to special customers, they are at these figures altogether out of the market, and in forge qualities are just now selling practically little or nothing. District brands continue to be offered here at excessively low figures, without, however, bringing forward buyers for anything like quantities. Lincolnshire does not average more than 39s. for forge, to 40s. for foundry, net cash, delivered, equal to Manchester, and for prompt delivery, under even these low figures has here and there been accepted. For P.G. foundry, Lincolnshire makers have taken 43s., less 2½, and Derbyshire foundry is quoted at about 45s. to 46s., net cash, delivered Manchester. With regard to outside brands, the impending strike of Scotch miners necessarily has some hardening tendency, but no better prices are obtainable in this market, and there is still keen underquoting where any business comes forward. Delivered equal to Manchester, good foundry Middlesbrough scarcely averages more than 43s. 7d. to 43s. 10d., net cash, whilst Eglinton could still be bought at about 45s. 6d., net prompt cash, delivered at the Lancashire ports.

Manufactured iron makers in most cases report that they have great difficulty in keeping their forges going from hand to mouth more than about half-time, but their quoted rates remain unchanged. This, no doubt, is in a considerable measure due more to the fact that there is really no sufficient inquiry stirring to afford any real test of what makers might be prepared to accept, if anything like favourable specifications came forward, rather than to any real firmness in the market. For delivery equal to Manchester, £5 10s. for Lancashire to £5 12s. 6d. for Staffordshire bars remain the general quotations, with Lancashire sheets £7 to £7 5s., and Staffordshire £7 5s. to £7 10s., and Lancashire hoops are still quoted at £5 17s. 6d. for random and £6 2s. 6d. for special cut lengths, delivered Manchester or Liverpool.

In the steel trade the business doing continues extremely limited, with a generally weak tone in prices; ordinary foundry hematites do not average more than 52s. 6d., less 2½, ordinary basic billets £4 net cash, with steel boiler plates quoted at £6 5s. to £6 7s. 6d., and bridge and tank plates obtainable at £5 15s. to £5 17s. 6d. delivered in this district.

Only a slow, hand-to-mouth sort of business still comes forward in the metal market, but for manufactured goods list prices are maintained at late rates.

The position in the engineering industries, as reflected in the reports issued by the trades union organisations, still shows no movement whatever towards any improvement. In the monthly report just issued by the Amalgamated Society of Engineers, the returns as to unemployed members remain practically the same as those of the previous month, still showing nearly 9 per cent. on the books in receipt of out-of-work support, whilst the reports from all the principal centres throughout the country continue most unsatisfactory, the position being returned with exceedingly few exceptions as either only very moderate, bad, or very bad. The returns of the Steam Engine Makers' Society also show that the number of unemployed members remains practically unchanged. If anything, in both societies, there is a very slight decrease, which may be taken as indicating that the position gets no worse, but not sufficient to indicate any improvement. Here and there amongst machine tool makers I hear of rather more work of a special character stirring, but the general run of engineering continues extremely quiet, and the principal locomotive building works in the district are almost at a standstill, owing to the continued absence of orders coming forward. In fact, it is practically owing to the large number of men thrown out of employment by this one firm that the returns of out-of-work members in this immediate district continues so much above the average. Boiler makers still report rather more orders stirring, and some of the leading machinists are being kept fairly well supplied with work.

The condition of the coal trade is one of extreme depression, and, with plentiful supplies of all descriptions on the market, prices show a continued weakening tendency. There is no actually general quoted reduction upon late rates, but to a very large extent prices have during the week been easing down about sixpence per ton, and do not now average more than 11s. to 11s. 6d. for best coals, 9s. 6d. to 10s. for seconds, and about 7s. 6d. to 8s. per ton for common house coals, at the pit mouth. Only a very slow demand is reported for the lower descriptions of round coal for iron-making, steam, and general manufacturing purposes, and these are also easier, in most cases, to a similar extent as the better qualities, prices now averaging about 7s. to 7s. 6d. at the pit mouth. As regards gas coals, there are so far very few contracts of any great weight actually settled, and the advance of 6d. to 1s. per ton which has been talked of seems scarcely likely to be realised to any considerable extent. In locomotive fuel and supplies for railway companies, however, advances of 6d. to 9d. have been obtained upon last year's low rates, the pit prices which have been obtained ranging from 6s. 9d. for ordinary locomotive steam coal up to 7s. and 7s. 3d. for the better qualities, suitable for gas-making purposes.

In engine classes of fuel supplies are plentiful, notwithstanding the limited production of slack, and with low sellers from outside districts prices are scarcely so firm. Common slack is readily obtainable at 5s. to 5s. 6d., with best sorts quoted at 6s. to 6s. 6d. per ton at the pit mouth.

In the shipping trade rather an increased business is stirring, but very low prices are being taken, the official quotations having been reduced 6d. per ton during the week, and 8s. to 8s. 6d. per ton are now the average figures for Lancashire steam coal, delivered at the High Level, Liverpool, or the Garston Docks.

Barrow.—The past week has seen no change in the condition of the hematite pig iron trade, and makers in the North of Lancashire and in Cumberland have not done much in the way of business. The consumptive demand remains about the same, and prospects of an increased demand are poor indeed. The consumption on home account keeps fairly good, but on general foreign and colonial account it is particularly bad, and the business offering is exceedingly limited. Prices have fluctuated somewhat. Early in the week warrant holders were quoting 44s. 0½d. per ton, but since that time they have dropped again, and 43s. 8d. is now the ruling quotation. Makers, on the other hand, have been steady in their quotation of 45s. per ton net, f.o.b., for parcels of mixed numbers of Bessemer iron, but in some cases as low as 44s. 6d. per ton is being quoted. The stores of warrants continue to increase, a further 780 tons having been added this week, bringing the total held up to 147,951 tons. Thirty-six furnaces are blowing in North Lancashire and Cumberland.

Steel makers at Barrow are fairly employed in some of the departments. Some fair orders are held for heavy sections of rails, and the mills will be pretty busy for a week or two. The demand for rails is, however, not by any means good, and orders are difficult to get hold of. Heavy sections are quoted at £3 15s. per ton and light and colliery sections at £5 5s. and £5 10s. respectively. The demand for steel shipbuilding material is fair. The mills at Barrow are fairly well employed on orders booked a while ago. Ship plates are quoted at £5 7s. 6d., angles at £5 10s., and boiler plates at £6 per ton. The business offering in the other sections made in this district is exceedingly small.

Shipbuilders and engineers are well employed in every department. Builders are contracting for new work, but no new orders are reported.

The demand for iron ore is quiet, and practically confined to local smelters. Average sorts are quoted at 8s. 6d. to 9s. 6d. per ton.

Coal and coke find a pretty good sale. East Coast coke is still quoted at 17s. per ton delivered.

The shipments of iron and steel for the past week represents in the aggregate 27,635 tons, as compared with 12,073 tons in the same week of last year, an increase of 15,562 tons. The exports to date stand at 341,032 tons, as compared with 314,140 tons last year, an increase on last year of 26,892 tons.

THE SHEFFIELD DISTRICT.

(*From our own Correspondent.*)

THE May returns of the Hull Chamber of Commerce exhibit increased business with that port. The total weight sent from Yorkshire collieries to Hull was 171,856 tons, as compared with 103,408 tons for May of last year. For the five months of the year the weight of coal forwarded to Hull amounted to 756,168 tons, as compared with 585,720 for the similar period of 1893. Steam coal, of course, has been the cause of this brisk business, and, as may be seen from the figures, the trade which drifted elsewhere during the troubled period in the South Yorkshire district is returning. There has been a large trade done with foreign countries from Hull, viz., 54,528 tons, as compared with 24,510 tons for May of last year. For the first five months of the year Hull forwarded to distant markets 237,446 tons, against 147,650 tons during the completed period of last year. Sweden and Norway has taken the largest individual tonnage, with a weight of 19,132 tons for the month, and 91,002 tons for the five months, as compared with 12,551 and 45,800 tons respectively. The next largest market is Russia, which took 11,582 tons for May of this year and 29,220 for the completed period. The monthly business with Hull and the Humber ports has about trebled, and the trade done during the five months is nine times as great as when the dock strike paralysed trade.

Coal quotations do not vary much at present. Silkstone house coal is from 9s. 6d. to 11s. per ton; Barnsley softs, 8s. 6d. to 9s. 6d. per ton; inferior qualities, 1s. per ton easier. Barnsley hards, 7s. 9d. to 8s. 6d. per ton; Parkgate and other qualities, from 7s. per ton. Manufacturing fuel in fair demand at 4s. 6d. to 5s. 6d. per ton; smudge and small coal ranges from 2s. per ton. Coke dull at 9s. 6d. to 11s. 6d. per ton. Steam coal keeps in very good request, and contracts have been maintained more firmly than was at one time anticipated.

Further armour-plate orders have been received on account of the naval programme of the Government by Messrs. John Brown and Co., Messrs. Charles Cammell and Co., and Messrs. Vickers, Son, and Co. These fresh orders are for the conning towers and the casemate armour of her Majesty's ships Magnificent, Majestic, Renown, Powerful, and Terrible. Additional work is anticipated on an early date.

Business is again quieter in iron and steel. Hematite pig iron is very languid at 51s. to 52s. 6d. per ton; common forge iron is rather brisker at 38s. per ton. Bessemer billets fetch from £5 7s. 6d. to £5 10s. per ton; bar iron inactive at prices quoted last week. Railway orders are scarce, the companies limiting their requirements to what they cannot do without. Several of the foundries are well employed; the boiler-makers are generally well off for work.

The exports of cutlery during May amounted to £155,157, as compared with £186,541 for May of 1893. The chief cause of the decrease is the falling-off in the United States market, owing to the uncertainty about the Wilson Tariff Bill. The value sent to America last month was only £8520, against £22,480 for the corresponding month of last year. The other decreasing markets have been Russia, Germany, France, Spain, and Canaries, foreign West Indies, Chili, British Possessions in South Africa, British Possessions in East Indies, Australia, Argentine Republic, and British North America. The only markets showing an increase are Sweden and Norway, Holland, Belgium, and Brazil. For the five completed months of the year the value of exports was £752,424, as compared with £867,137 for the corresponding period of last year. In steel—unwrought—the value of exports £155,069, against £165,436. Here, again, the diminution is mainly owing to the drop in the United States market, which fell last month to £22,135, against £33,512 for May of 1893. Russia fell to £15,937 from £23,958, and decreases are also reported by Germany, Holland, France, British East Indies, and British North America.

If it be true that there is a prospect of the American Tariff Bill being settled by the end of June, Sheffield cutlers who make American patterns will be thankful. At present they are suffering severely in consequence of the scarcity of work, many of them being unable to earn half-a-sovereign per week. The depression has continued so long that several of our manufacturers have entirely abandoned the American trade and sought new markets. Any change for the better which the Wilson Tariff may give them—and no great benefit is expected—will not induce these firms to return to American patterns. Local houses whose chief specialities are sold to the States are well prepared for the settlement of the Tariff question when it comes. The Germans have also been making stocks with a view to taking advantage of the re-opening of the market, and it is quite expected that the Solingen firms will give Sheffield makers considerable trouble in the way of work. In several kinds of table cutlery the new Tariff, as amended by arrangement, will actually impose higher rates than those under the existing McKinley Tariff, and where the duties are reduced on second-class goods, it is pretty certain that the Germans, with their remarkably low means of production, will underquote Sheffield lists.

In the electro-plating trades the departments devoted to cups, shields, and other trophies for athletic contests, are exceptionally busy, but there is very little doing in the general trade, either for the country or for foreign and colonial markets. Several of the manufacturers state that business is at present in a more depressed state than it was while the coal war was on at the end of last season. The low price of silver is still attenuating the demand in plated goods, and many people who would previously have taken electro-plate are tempted to pay a little more and obtain their goods in sterling silver.

In the edge tool trade reports are very conflicting. Our largest house—perhaps the largest in the world—state that they have rarely had such a pressure of orders for all kinds of edge tools as they are now experiencing. It is principally for the foreign and colonial markets that they are now booking large orders. The country trade, by which is meant the markets of the United Kingdom, is not very active. The makers of agricultural machinery and garden tools have had a fairly good season, although the adverse weather has retarded garden operations, and therefore lessened the demand which would have existed during April and May. There is now, however, pressure in goods of this sort.

About as uncalled-for a strike as we have had in Sheffield is now reported at the works of Messrs. John Crowley and Co., Sheffield. The company is resisting a demand for an advance of 2s. per week all round on its labourers' wages. The wages against which these labourers have struck are as follows:—Two men at 32s. per week of fifty-four hours; two men at 30s.; two men at 27s. 6d.; two men at 24s.; two men at 23s.; two men at 22s.; one man at 21s.; twenty-six men at 20s.; four men at 19s.; sixteen men at 18s.; one man at 17s.; nine youths are also on strike, one received 18s. per week, another 17s., a third 15s.; two had 14s.; one at 13s.; three had 12s. each. The company, fortunately, is able to continue its operations as usual, owing to its having two large establishments, so that the dispute, although these things are always annoying, does not interfere with the execution of orders in any department.

THE NORTH OF ENGLAND.

(*From our own Correspondent.*)

CONTRARY to the general expectation that the iron market in this district would exhibit improvement when the Scotch colliers decided to enter upon a strike, business has been quieter even than it was last week, and prices are very little more in favour of the sellers. Buyers continue their policy of purchasing only what meets their immediate requirements, and seem to think that after all there will be no strike, though the Scotch miners have already given in their notices. The coalowners are not in the least likely to give the advances; but the fact that there are so many non-unionists in Scotland, and that so many of the men abstained from voting in the recent ballot, lead to the belief that a stoppage—if it do occur—will be of short duration.

Consumers of pig iron, therefore, holding this opinion are in no hurry to buy, and sellers are not disposed to press iron upon the market, for they hope to get better prices for it than are now possible, especially if the strike takes place. They will have a better chance of realising higher figures even if there is no strike, because a brisker period of the shipping season is coming on, and the make is to be reduced by the blowing out of several furnaces which need relining. These will shortly go out if there is no stoppage in Scotland, but if that unfortunately should occur, then they may be kept at work longer, as their produce will be needed, and higher prices will be obtainable. Under present circumstances there is no inducement to keep old furnaces going, as it is difficult to make ends meet; in fact, the working of a considerable number of furnaces now involves a loss. Exports of pig iron are rather better than were expected this month, but less is taken out of the public warrant stores, and as the make is kept up, the stocks still increase. The pig iron exports from Middlesbrough this month have amounted to 37,243 tons, as compared with 35,184 tons last month, and 44,231 tons in June, 1893, all to 13th. The shipments oversea are above the average, but in view of the probable stoppages in Scotland, merchants are beginning to have more sent to Grangemouth, and are laying in stocks, which cannot be a bad speculation at present prices, whether there be a strike or not. In Connal's warrant stores on Wednesday night 98,086 tons of Cleveland pig iron were held, 730 tons increase for the month.

Prices of Cleveland pig iron are slightly better this week than last, for though there was some business in No. 3 G.M.B. early in the week, that would not be taken now, and 35s. 4½d. is what is asked and paid. Buyers offer no more for forward than for prompt delivery. Cleveland warrants have dropped in price in spite of the imminence of a strike, which should have strengthened them considerably. They could not have been obtained under 35s. 4d. cash just before the result of the ballot of the Scotch miners was made known, but have fallen to 35s. 2d. this week, though they have risen again to 35s. 5½d. The fall is not much certainly, but then the movement was expected to be the other way. For No. 1 Cleveland pig iron, 37s. 6d. is all that can be realised for ordinary brands; for No. 4 foundry, 34s. 9d. is the figure; for grey forge, 34s. 3d.; for mottled, 33s. 9d.; and for white, 33s. 6d. Mixed numbers of East Coast hematite pig iron maintain their value, and mixed numbers cannot be had under 44s. per ton f.o.b. The production of this description of pig iron has been reduced, as it was in excess of the requirements, and could not be made by some firms at the money they were able to obtain for it, while there seemed to be little chance of the cost being reduced. The price of foreign ore does not decline, notwithstanding that the consumption is smaller and freights are cheaper, but average Rubio still keeps between 12s. 3d. and 12s. 6d. per ton delivered on the Tees.

The Cleveland Ironmasters' Association have intimated to the representatives of the men that they cannot see their way to give their assent to the proposal for the adoption of eight hour shifts at the blast furnaces. They do not offer any opinion relative to the eight hours' day, but are not prepared to adopt the proposal in the terms submitted to them by Mr. Carlton, the men's secretary. That would increase the cost of producing pig iron, and taking into account the present condition and the immediate prospects of the trade, that is out of the question, it would only add to the loss that is being incurred at some of the works. Perhaps if the men had proposed to accept a proportionate reduction of wages in return for the reduction of hours some agreement might have been possible. It has been calculated that the adoption of the eight hours would add at least 1s. per ton to the cost of making pig iron. The system has been adopted at the Seaton Carew Works, and is likely to be at Carlton, the proprietors of which are not members of the Ironmasters' Association, but there has not been time enough yet to ascertain exactly the difference of cost. Messrs. Cochrane and Company, Ormesby Ironworks, propose to adopt the eight hours, when their connection with the Cleveland Ironmasters' Association ceases in August. The ironmasters also intimate that they cannot assent to the proposal to stop the furnaces for twenty-four hours, in order that the blast furnacemen may hold a demonstration, as the loss and damage would be so great. The Cleveland ironstone miners are to hold a demonstration at Boosbeck on July 4th, when they will be addressed by Mr. S. Woods, M.P., and Mr. Tom Mann. They have been more fully employed recently than for a long time past, as more furnaces are working on Cleveland iron.

The strike of moulders and pattern-makers at the engineering works and shipyards continues, and is seriously hampering operations at these and other establishments, in fact a large number of men engaged in other occupations have had to be paid off in consequence. The executive of the men's association will not let the firms whose men are on strike procure their castings from other places, and so more men than those who are directly connected with the strike are thrown out of employment. Some of the masters have been getting castings from Leeds, Bradford, Glasgow, Manchester, and elsewhere, but this the men have stopped, for if they ascertained that any firm was supplying castings to their employers, they at once warned such firms that if they continued to do so their own men would be called out. In some cases the masters have got their castings from Germany. It is nearly ten weeks since the moulders came out on strike at the engineering works, and so far nothing has been done to bring about a satisfactory settlement. Masters do not see their way to give any advance, much less such an exorbitant one as the men claim. The joiners also coming out at the engineering works and shipyards has further complicated matters, and in one case it has been found necessary to send two vessels built in this district over to Hamburg to get their woodwork completed. Ordinary ironfounders have no difficulties with their men at present, but work is very scarce. One of the chief establishments is not turning out more than a third of what is produced in brisk periods, and others have never known trade so bad. An order for a large quantity of cast ironwork for the Waterloo and City Railway has been placed at Stockton.

The dulness in the finished iron and steel trades is as great as ever—in fact, greater, because the strikes of moulders hamper operations in the shipyards, and plates, &c., cannot be taken so regularly, so that this reduces the output of the finished iron and steel works, and it helps to postpone the restoration of confidence amongst shipowners, who have given out very few orders for new vessels during the last three months. Quotations for finished iron and steel are the same as last reported.

The coke manufacturers of Durham are proposing to follow the example of the coalmasters in establishing a combination to fix the selling prices. A meeting of coke manufacturers was held on Monday, and most of the leading firms were represented and gave their adhesion to the scheme, though some of the producers of special classes are not prepared to join in the movement. The meeting arranged the minimum price, and this does not differ materially from the rate now current.

The coal trade is somewhat brisker, and is expected to become quite active again if the strike takes place in Scotland. The extra demand this week has led to the Northumberland coalowners putting up the price of best steam coal to 10s. 6d. per ton, f.o.b. Good blast furnace coke is sold at 12s. 3d. per ton, delivered equal to Middlesbrough, but may be expected to increase, as the supply is not in excess of requirements, and a greater demand will spring up with the commencement of the strike in Scotland.

NOTES FROM SCOTLAND.

(*From our own Correspondent.*)

THE resolution of the Scotch miners to come out on strike towards the end of the present month has not affected the markets to the extent that might have been expected, because it is not believed that the strike, if it should take place, will be of long duration. Perhaps at no former time have the Scotch miners, all over the colliery districts, voted with such a result—viz., a majority in all localities. This is, of course, the outcome mainly of the fact that the miners' societies have now all affiliated with the English Federation, by whom a strike was decreed. While a large majority voted in favour of a strike, there is no enthusiasm on the subject among the miners of Lanarkshire, and trade has been so manifestly bad in Fifeshire that no reasonable person there could justify a strike. The wages of the miners are admitted to be above the average, although of course considerably below what they were during the great strikes in England.

The men could scarcely have chosen a worse time to come out from their own point of view, because July is the industrial holiday month, when many works are closed at least a fortnight, even the busiest of times. As soon after the strike as supplies of coal are exhausted, therefore, consumers will close their works, and intimations have in some cases already been given to this effect. Strike clauses now exist in nearly all contracts, and these will be largely taken advantage of, in order that the manufacturer may avoid a heavy increase in cost of production.

The Glasgow pig iron market has been firmer, with rather more inquiry on the part of consumers and merchants; but speculators are chary of taking any considerable share in the business, owing to the uncertainty that exists as to whether the miners will hold out or not. Scotch warrants have risen several pence per ton; but there is little change in other classes of iron, Cleveland being indeed rather easier.

The prices of makers' iron are as follow:—G.M.B., f.o.b. at Glasgow, No. 1, 43s. per ton; No. 3, 42s.; Carnbroe, No. 1, 45s.; No. 3, 44s.; Clyde, No. 1, 49s. 6d.; No. 3, 46s. 6d.; Gartsherrie and Summerlee, Nos. 1, 51s. 6d.; No. 3, 47s.; Calder, No. 1, 52s.; No. 3, 47s.; Coltness, No. 1, 54s.; No. 3, 50s.; Glengarnock, at Ardrossan, No. 1, 50s.; No. 3, 47s.; Eglinton, No. 1, 46s. 6d.; No. 3, 44s.; Dalmellington, at Ayr, No. 1, 46s. 6d.; No. 3, 44s.; Shotts, at Leith, No. 1, 54s.; No. 3, 50s.

The shipments of pig iron from Scottish ports in the past week amounted to 5800 tons, being exactly the same quantity as in the corresponding week of last year. Of the total there was dispatched to Holland 1297 tons, Germany 495, Canada 200, United States 100, India 68, Australia 280, France 33, Italy 195, Russia 180, Belgium 38, Spain 15, China and Japan 110, other countries 375, the coastwise shipments being 2425, compared with 3387 in the corresponding week.

There is no change in the total number of furnaces in blast. The number producing ordinary is rather smaller, but this is made up by the placing of two additional furnaces on basic iron at Glengarnock, where the notice given to the men to leave has been changed into an engagement from day to day. There are now forty-six furnaces producing ordinary and special brands, twenty-four hematite, and three basic iron, total seventy-three, compared with seventy-one at this time last year.

Work is being proceeded with in a rather more vigorous style at the steelworks, but this is owing to the pressure to finish up urgent orders previous to the holidays, and there is in reality no change in the condition of this market. The same remark is applicable to the malleable iron trade.

The shipments of iron and steel manufactured goods from Glasgow in the past week embraced sewing machines worth £3683; other machinery, £7826; steel goods, £10,991; and miscellaneous iron goods, £13,145.

The coal market has been rather more active, and on several days somewhat excited, owing to the approaching strike. The shipments at Clyde ports have been comparatively heavy, but not quite so large on the East Coast. The total clearances from all the ports reach 161,437 tons, against 141,829 in the preceding week, and 138,709 tons in the corresponding week of last year. The demand for future delivery is only moderate, and this is ascribed to the fact that supplies are very ample, and prices low at English ports. The household requirements are at this time easily met. Purchases are, however, reported to have been made on a rather extensive scale by manufacturers anxious to keep their works fully occupied until the holidays, and prices have gone up in Glasgow market about 6d. per ton.

WALES AND ADJOINING COUNTIES.

(*From our own Correspondent.*)

MY forecast, that the East Glamorgan Railway Bill would not pass the House of Lords Committee, has been verified; though on Saturday, when several of the notabilities interested on one side or the other returned to Cardiff, there was a strong impression that it would pass. It is now stated that next year another effort will be made, but before that I shall expect certain railway movements on the part of the Taff Vale and the Rhymney that will make it still more unnecessary. The Taff Vale Railway Company has a line now at Aberdare Junction, which is little used, but will become more so, and a siding will connect it with the latest colliery venture, the Dowlais-Cardiff.

The coal trade continues in a very satisfactory condition, and for the third week in succession, notwithstanding that a "Mabon's day" intervened, the Cardiff exports showed an excess of 300,000 tons on the week or 40,000 tons more than that of the corresponding week last year.

Large contracts have been booked for the Admiralty, and amongst the successful I note the Cyfarthfa Company. Some of the leading coalowners are sold until the end of the month, and on 'Change this week, Cardiff, it was evident that there was no great disposition to book forward for large quantities, as higher figures are fully expected. Best steam coal now commands 11s. 3d. to 11s. 6d.; seconds, 10s. 6d. to 10s. 9d.; ordinary "dry coal" the same, and small, 5s. 3d. to 5s. 6d., Cardiff. Even best house coal has shown an upward tendency. The latest figures are: Best house, 10s. 9d. to 11s.; No. 3 Rhondda, 10s. 3d. to 10s. 6d.; brush, 8s. 9d. to 9s.; small, 7s.; No. 3 Rhondda, 8s. 6d. to 8s. 9d.; through, 6s. 9d. to 7s.; small, 5s. to 5s. 3d.

Coke prices are unchanged; demand is more, and there are signs of improvement. Pitwood remains the same after some drooping, best wood selling at Cardiff, *ex* ship, at 15s. to 15s. 3d. Patent fuel prices, Cardiff, are 10s. 6d. to 11s., demand improving. Swansea sales have been large. Last week 7500 tons were sent from that port to Italy, 1540 to Greece, 1610 to Algeria.

Trade at Swansea generally has been exceptionally busy. The total tonnage, 73,537, if it does not beat the record, certainly figures as one of the highest known. It was 30,000 tons above the totals for the corresponding week last year. In coal, patent fuel, and tin-plates the increase was marked.

At Newport business has also been good, and some notable cargoes have come in of iron ore, awakening the hope that better times are at hand in the iron and steel trades. On one day Ebbw Vale received 2000 tons; the Blaenavon Company, 1750; and 1790 tons to Tapson and Co. On the 12th the Ebbw Vale Company received no less than 5750 tons. Large quantities are also coming in from Cyfarthfa and Dowlais.

Latest prices Cardiff iron ore are:—Best Rubio, 11s. 6d. to 11s. 9d.; Tafna, 11s. 3d. to 11s. 6d.; Garrucha, 11s.; Porman, 10s. 6d.; all c.i.f. Cardiff or Newport, Mon.

Iron and steel quotations, Cardiff and Swansea, are the same as last week. Swansea has been importing pig iron heavily, and I note that a cargo of steel rails has come in from Harrington. One of the principal ironmasters, speaking this week upon the iron and steel trades, observed to me that things were improving, and he considered that even a better condition was coming. The demand for rails and sleepers is certainly better, and at Dowlais last week there was a good deal more activity. One of the consignments of the week has been 842 tons steel sleepers to Bombay. In steel bars a good average quantity has been dispatched from Cyfarthfa and Dowlais, and now that a better demand is springing up by tin-plate manufacturers, this branch of industry is in a more promising state.

Last week the export of tin-plates from Swansea totalled 93,120 boxes, the largest that has taken place for some time. The receipts from works only amounted to 65,337, so that stocks again fell, and now consist only of 261,020 boxes, as compared with 288,803 boxes last week.

The total shipments of plates to the United States from Swansea last month amounted to 12,202 tons, compared with 19,560 tons, May, 1893. Considerable tonnage is coming in for loading to America, and on 'Change this week it was the subject of discussion that a few days again would end all doubt about the tariff, when, in all probability, there would be restarts in many directions, and an increased make. Russia is putting in for increased quantities, and shipments to Batoum and Odessa are amongst the fixtures. Venice is also amongst the latest customers, and Canada maintains an average demand. With a good spurt from the States it is anticipated that stocks would be cleared out. Prices unchanged, but firmer; and business confined steadily to "hand to mouth," as a change is certain.

Some few steel quotations, Cardiff, mid-week, may be of interest:—Heavy rails, £3 15s.; light, £4 10s.; Bessemer bars, £4 2s. 6d.; Siemens best, £4 5s.

It is expected that at the next meeting of the Coalowners' Association a deputation will wait upon the members from the colliers, the delegates petitioning that some means should be taken, such as "united action," in order to do away with the drooping prices in coal. In the opinion of the colliers the sudden alterations which take place occasionally in coal might be avoided if coalowners worked together in amity. They evidently forget that if a bond were to be entered into by Welsh coalowners to keep up prices, customers would go to other markets. The matter has been frequently discussed, and the fact pointed out. If prices continue to go up the subject will very likely be shelved until the next turn of the tide. Coalowners are as anxious as the colliers to maintain a fair average price; but the area of their survey is a wider one than colliers take. Thus if the sliding scale indicates a reduction, the first thought in the mind of the unsophisticated workman is, that there is something the matter with the scale. Possibly, with free libraries and better culture, these fancies will take flight.

At Ebbw Vale last week 4000 colliers were out; but thanks to vigorous action, and discussion, common sense prevailed, and the difficulty is now over. At one time the manager expressed his determination to get the horses up, and close every colliery. Work was resumed on Tuesday.

A strike has been averted at Rudry.

It has been decided at the rapidly improving port of Llanelly to go in for increased dock accommodation.

The toll clause—Bute Docks—has been withdrawn, to the great satisfaction of the public.

The Lletty Shenkin coal strike has come to an end, and the offer to supply house coal at 6s. 6d. per ton at Cwmbach, 7s. at Abernantygroes, and 7s. 6d. Aberaman or Aberdare, is accepted by the men.

The South Glamorgan Company has sunk successfully at Pencoed.

The important trespass action Hankey *versus* Wimborne, of the Plymouth Company against the Dowlais Company, is now on. It is understood that a large sum is at stake, the value of the coal area of the Plymouth Company alleged to have been worked by the Dowlais Company.

A Wheelwrights' Association has been started at Merthyr. The Plymouth fitters are still out, and are getting weekly allowances from a society to which they are federated.

NOTES FROM GERMANY.

(*From our own Correspondent.*)

THE reports from the different iron markets are more or less of a cheering character. Demand and inquiry have continued to improve during the week. A good activity exists in most branches of the iron industry, and makers are showing a tendency to harden their prices.

On the Silesian iron market a fair amount of business is coming forward, but quotations are still wanting in firmness, which is chiefly caused by over-production in some departments. The Rhenish-Westphalian ironworks continue to compete with the Silesian firms, and in many instances succeed in getting the orders.

On the Austro-Hungarian iron market all descriptions of raw and finished iron have been meeting with an increased demand during the past week, owing in a great measure to consumers now gradually getting through the supplies which they had bought in and were holding in reserve. With stocks rapidly disappearing at the blast-furnace works, there is necessarily a further hardening up in prices, and prospects for the future are decidedly good. Orders of importance have been rather scarce on the French iron market lately, but the greater part of the works continue well employed on orders of previous date. Quotations are still the same as during former weeks, bars being quoted 155f. p.t., while girders still stand at 165f. p.t. at works.

Demand and sale continue weak on the Belgian iron market. Pig iron is neglected. There has been talk of the forming of a pig iron convention lately, which would help makers successfully to compete with the works of Longwy and Luxemburg. Returns for the first four months of present year show export in steel to have considerably increased; in steel girders export rose by 3000 t.; rails, 9000 t.; manufactured steel, 6000 t. The different sorts of manufactured iron, on the other hand, show a decrease since last year.

Import of coal to Belgium during the first four months of present year amounted to 450,914 t., against 455,169 t. for the same period the year before, of which 204,728 t. came from Germany, against 184,705 t. in the year before. Import from England went down from 119,451 t. to 94,665 t. Import in coke during the first four months was 96,721 t., against 82,293 t. in 1893—of which 95,080 t. came from Germany, against 81,150 t. in the previous year. Export in coal amounted to 1,321,511 t., against 1,365,302 t. in the year before; export in coke was 304,833 t., against 327,322 t. for the corresponding period last year.

The Rhenish-Westphalian iron trades are in a fairly active state, taking them as a whole. With regard to iron ore, Siegerland sorts meet with satisfactory demand, and prices are well maintained. For spathose iron ore M. 7·40 to 7·90 p.t. is quoted, roasted ditto fetching M. 11 to 11·50 p.t. at mines. Inferior qualities are paid with M. 9·80 to 10 p.t. Luxemburg-Lorraine minette is tolerably well inquired for at M. 2·60 to 3·20 p.t. net at mines, while Nassau red iron ore, 50 p.c. contents, has been quoted M. 9·20 p.t. A very confident tone is reported on the pig iron market, in spite of a slight falling-off in demand which has recently been noticeable for some sorts. Quotations must still be considered as unremunerative, on the whole. For spiegeleisen M. 52 p.t. is paid; forge pig, No 1, is quoted M. 45 p.t., while No. 3 fetches M. 40 p.t. Siegerland, good forge quality, stands at M. 45 p.t. Hematite is being sold at M. 63 p.t.; the price given for foundry pig, No. 1, has been M. 63 p.t., while for No. 3 M. 54 is offered. Basic is quoted M. 45 to 46 p.t.; German Bessemer, M. 47 to 48 p.t.; Luxemburg forge pig, 48f. p.t., free Luxemburg. On the malleable iron market the demand coming in for bars is chiefly on home account. From abroad very little inquiry is experienced, and prices, therefore, improve but slowly. In the girder trade especially competition is still exceedingly keen, and the prices which makers are forced to accept leave little profit. Hoops remain firm. Orders and inquiries continue to come in very regularly in the plate and sheet department, and a good activity is generally maintained at the mills. The foundries and machine factories are fairly well off for new work, but find it extremely difficult to secure higher prices. The following may be considered as latest list quotations p.t. at works:—Good merchant bars, M. 110 to 115; angles, M. 120 to 125; girders, M. 90 to 95; hoops, M. 115 to 120; billets in basic and Bessemer, M. 81; heavy plates for boiler-making purposes, M. 150; tank ditto, M. 130 to 135; steel plates, M. 125; tank ditto, M. 115 to 120; sheets, M. 140; Siegen thin sheets, M. 130. Iron wire rods, common quality, M. 120 to 125; drawn wire in iron or steel, M. 105 to 120; wire nails, M. 125; rivets, M. 130; steel rails, M. 112 to 115; steel sleepers, M. 106; fish-plates, M. 110 to 115; complete sets of wheels and axles, M. 270 to 280; axles, M. 220; steel tires, M. 215 to 230; light section rails, M. 95 to 100.

In May the mines of the Saar district have produced, in twenty-four days, 536,125 t., and sold 540,525 t. Output during the same month last year amounted to 481,880 t., while 479,405 t. were sold.

AMERICAN NOTES

(*From our own Correspondent.*)

NEW YORK, June 5th, 1894.

FINANCIAL matters are less satisfactory. Last week loans were contracted, deposits decreased 41,000,000 dols., the idle surplus reached 77,000,000 dols., and our Treasury gold fell to 79,000,000 dols. Business is flat, prices are low, merchants are not paying expenses, and jobbers are not trying to force business. Throughout New England mills and factories run only as orders warrant. In the iron trade everything is discouraging. The coal miners' strike keeps up, although frequently it is announced a settlement has been affected somewhere. Pig iron, for foundry uses, sells slowly. Nearly all the rolling mills are in some way affected by the strike. There is an improving demand for sheets, merchant steel, bar iron pipes and tubes. The country can afford to wait. Negotiations are being pushed to bring the strike to an end, but well-informed people do not believe it can be done without practically conceding the miners' terms.

LAUNCHES AND TRIAL TRIPS.

The passenger steamer Fingal, owned by the Edinburgh and London Steam Shipping Company, recently launched at Dundee by Messrs. W. B. Thompson and Company, Caledon Shipyard, has made her trial trip. The Fingal left the jetty shortly before twelve o'clock, and proceeded down the river till the Abertay Lightship was reached, when her bow was turned southwards, and a course steered for St. Abb's Head. The distance from the lightship to this headland—almost forty miles—was covered in a little over two hours. The Fingal carries two electric light installations, and in all there are about thirty-six engines on board.

The Campbeltown Shipbuilding Company's steamer Eira, of 790 tons net register, and 2000 tons deadweight, recently launched from their yard at Campbeltown, Clyde, made her trial trip recently, when an average speed of 11 knots was attained. The Eira is a steel screw steamer of the part awning deck type, designed to carry 2000 tons deadweight on 16ft. 8in. draught, and has been supplied with a set of triple-expansion engines by Messrs. Kincaid and Co., Greenock, built under the immediate superintendence of Mr. T. M. Broom, consulting engineer, Greenock. All the latest improvements for navigating the ship and for the speedy loading and discharging of cargo have been supplied, including steam steering gear, steam windlass, patent stockless anchors, Clarke, Chapman, and Co.'s steam winches, patent compass, &c. A large party was on board, including Lloyd's representatives, Greenock; Messrs. McKenzie and Watson, of James Gardiner and Co., shipowners, Glasgow; and Mr. E. Lewis, representing the owners, Messrs. Lewis and Co., Aberdovey.

At Renfrew, on the 8th inst., Messrs. Wm. Simons and Co. launched a dredger for the Russian Imperial Government. In addition to the usual chain of steel buckets, it is fitted with a powerful apparatus by which the mud raised by the buckets is reduced to a state of pulpy consistency, and discharged at a distance of 700ft. from the dredger through floating pipes, by means of a powerful centrifugal pump. Two pairs of compound surface-condensing engines and two steel boilers of 100 lb. working pressure are fitted on board, one engine being used for the dredging machinery, and the other for the mud discharge pump. This vessel is capable of raising and discharging 250 cubic metres of *débris* per hour. It is lighted by electricity throughout, and suitable steam heating arrangements are made in the crew's quarters. The Volgaskaiaja, as it is named, is to be employed on the river Volga.

Messrs. John Scott and Co. have launched a steel paddle ferry steamer for the Corporation of Birkenhead, specially designed for the Woodside and Liverpool stations. Her dimensions are:—Length, 150ft.; breadth, 28ft.; breadth over sponsons, 48ft.; and depth, 11ft. She is fitted with a spacious saloon nearly the whole length of the ship, 16ft. wide and 8ft. high, divided into smokers', general, and ladies' compartments. In the construction of these saloons lighting and thorough ventilation have had special attention, and passengers will no doubt find this the most comfortable boat in the ferry service. The hull and machinery have been constructed in excess of the latest requirements of Lloyd's and the Board of Trade. The hull is divided into twelve watertight compartments by longitudinal and transverse bulkheads, making her practically unsinkable, as she would float safely with any three compartments full of water and a full complement of passengers on board. The sponsons run nearly right round the vessel, and are plated on the under side of the girders and rivetted to the hull proper, thus forming other four watertight compartments.

On Saturday the trial trip took place of the s.s. Linlithgow, built by Messrs. C. S. Swan and Hunter, of Wallsend, to the order of Messrs. Raeburn and Verel, of Glasgow, for their India Mutual Line between London and Calcutta. The dimensions of the steamer are:—Length over all, 346ft.; breadth, 42ft. 6in.; depth, 29ft. 3in. The steamer will be classed in the British Corporation Register and 100 A1 at Lloyd's. She is fitted with triple-expansion engines by Messrs. George Clark, Southwick Engine Works, Sunderland, having cylinders 26in., 42in., and 69in., by 48in. stroke, two large steel boilers, 160 lb. pressure, and forced draught on Messrs. James Howden and Co.'s system. The Linlithgow is the sister ship of the s.s. Osborne, launched by the same builders a few weeks ago for the same line. She is designed for a high rate of speed, and on trial attained 12 knots average. The engines worked smoothly and satisfactorily, and the speed was attained with steam blowing off. The owners were represented by Mr. W. H. Raeburn and Mr. Thomson, superintending engineer of the firm, and the builders by Mr. Hunter, Mr. C. S. Swan, and Mr. R. F. W. Hodge, the engineers by Mr. George Clarke, jun.

The s.s. Larch, belonging to Messrs. Crosby, Magee, and Co., of West Hartlepool, has for some weeks been undergoing a very thorough and extensive overhaul and re-arrangement of her machinery and boilers at the Central Engine Works of Messrs. Wm. Gray and Company, and on the 5th inst. went on her trial trip in the bay. The alteration consists of supplying new main boiler working at 150 lb. pressure per square inch, and fitting the main engines with two new cylinders of new proportions adapted to utilise the higher boiler pressure without involving the necessity for a new crank-shaft or other main working parts. This is a similar alteration to that recently carried out at the same works to the s.s. Mark Lane, the s.s. Sweden, and the s.s. Albania, and on the trial trip the results were such as to justify the progressive policy adopted by the owners, so far as could yet be seen. The engines ran exceedingly well, giving no trouble whatever, and at a speed of seventy revolutions per minute drove the ship at the rate of ten knots per hour. The saving in coal consumption is expected to be very considerable, and to fully justify the expenditure. Several details of importance have been introduced in making the alterations to the machinery, amongst which may be mentioned Mudd and Airey's patent metallic gland packing, which ran perfectly well on trial. The trial of the machinery was witnessed by Mr. Crosby, one of the managing owners, Mr. Airey and Mr. Nevison, superintending engineers, and several other gentlemen interested.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

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

30th May, 1894.

10,462. HANDLES of CRICKET BATS, C. T. Hornsey, London.
10,463. CELLS of ELECTRIC BATTERIES, J. M. Moffat, London.
10,464. BOILERS, W. Saur, London.
10,465. BOXES, J. Wilson, Bradford.
10,466. PRINTING and DYEING CALICO, E. B. Manby, Manchester.
10,467. PREPARING and SPINNING YARNS, F. Reddaway, Manchester.
10,468. TIRES, I. M. W. Bourke, jun., London.
10,469. SUGAR CANE MILLS, A. Chapman, Liverpool.
10,470. SAFETY CAGE for use in MINES, T. Edwards, Cardiff.
10,471. PARALLEL TUBE EXPANDER, G. E. Asbury, Newark-on-Trent.
10,472. VENTRILOQUIAL ENTERTAINMENT, W. F. Holt, Dublin.
10,473. CYCLE PEDALS, C. Lee, A. Owen, and E. S. Bond, Birmingham.
10,474. PEDALS for VELOCIPEDES, H. Bailey, Birmingham.
10,475. LETTER-BOXES, J. France, Birkdale, near Southport.
10,476. PAPER FILE, &c., T. M. Easton and A. Coker, Northampton.
10,477. STEAM HOISTING ENGINES, J. Caldwell, Glasgow.
10,478. PREPARING IRON or STEEL BLOOMS, T. W. Walker, Glasgow.
10,479. APPARATUS for WASHING, &c., CLOTHES, W. L. Bradford, Manchester.
10,480. GAFF HOOKS, J. Hall, Birmingham.
10,481. SPRING TIRE for BICYCLES, E. M. Mitton, jun., Birmingham.
10,482. PORTABLE INSTRUMENTS for use in INDICATING LEVELS, A. Anderson, Glasgow.
10,483. DRYING FLAKED MALT, &c., S. J. Stonehouse, Greenock.
10,484. CARBURETTING COAL GAS, T. A. Garnett, G. Forster, D. Lister, H. Taylor, and F. Birchall, Liverpool.
10,485. PNEUMATIC TIRES, N. F. Willatt, London.
10,486. WATCH PROTECTOR, G. F. Hughes London.
10,487. ELECTRICAL MEASURING INSTRUMENT, H. W. Sullivan, London.
10,488. ADJUSTMENT of an INNER CHIMNEY for LAMPS, R. Campe, London.
10,489. SPINNING TOP, C. E. Gyngell, London.
10,490. STEEL WIRE HEATING APPARATUS, J. Platt, Yorks.
10,491. CUTTING MACHINE, J. A. Tillcock and W. D. Conning, London.
10,492. CURLING IRON POCKET STOVE, C. M. Walker, London.
10,493. CIRCULAR KNITTING MACHINES, G. Sowter, London.
10,494. SHOP WINDOWS, J. C. and W. T. Reinhardt, London.
10,495. CYCLE FOOT-BRAKES, E. Ireland, London.
10,496. STRAINER, J. C. Williams and J. J. Thomas, London.
10,497. GAS BURNER, F. de Mare, London.
10,498. NOVEL PUZZLE, W. A. Hurst and E. J. Pope, London.
10,499. HONEY EXTRACTORS, E. and H. W. Lanaway, Redhill.
10,500. COMBING COTTON, R. Staub and A. Monforts, London.
10,501. SELF-ACTING MULES or TWINERS, W. T. Watts, Manchester.
10,502. OVERHEAD RAILWAYS, G. Henkel and G. Schuld, London.
10,503. PRESSES for GOLF CLUBS, F. E. V. Taylor, London.
10,504. TRANSPORTATION of MOWERS, J. R. Knights, London.
10,505. LITHOGRAPHIC PRINTING MACHINES, C. Pollard and G. Brayshaw, London.
10,506. ADJUSTABLE SPANNERS, A. J. Boult.—(*N. A. H. A. Spiering, China.*)
10,507. STEAM GENERATORS for HEATING, C. Bourdon, Liverpool.
10,508. LOOSE and other FLANGES, F. Schumacher, London.
10,509. BOILER and other FURNACES, G. A. Newton, Liverpool.
10,510. BRAKES for LIFTING APPARATUS, A. Bolzani, Liverpool.
10,511. TOY MOTORS, W. P. Thompson.—(*J. Schoenner, Germany.*)
10,512. CALCULATING MACHINES, F. W. Golby.—(*H. Esser, Germany.*)
10,513. STREET CLEANING MACHINE, &c, A. Zeiler, London.
10,514. REMOVABLE TIRE for ROAD VEHICLES, H. Kerr, London.
10,515. DYNAMO BRUSHES, W. H. Fleming, London.
10,516. BANJOES and other INSTRUMENTS, G. Goddard, Reading.
10,517. LAMPS, H. Salsbury, London.
10,518. HEATING ROLLS, F. Christy and L. F. Christy, London.
10,519. MANTELS for GAS LIGHTING, C. de la Roche, London.
10,520. CONSTRUCTION of FLOORS, &c., G. A. Wayss, London.
10,521. FASTENING for CABIN DOORS, A. I. Gonsalves, London.
10,522. LACING BOOTS, E. W. Veale, London.
10,523. SATURATING LIQUIDS with GASES, J. F. Beins, London.
10,524. ARRANGING SCREENS and SHADES, J. H. Roseman, London.
10,525. HYDRAULIC DREDGING MACHINE, J. M. Robbins, London.
10,526. FLUID SUPPLY and DELIVERY, J. W. Glover, London.
10,527. SEWING MACHINES, W. L. Wise.—(*R. Theiler, Switzerland.*)
10,528. APPARATUS for WEIGHING TEA, G. H. Driver, London.
10,529. PRINTING on WALL PAPERS, H. W. Sanderson, London.
10,530. STREET VEHICLES for TRANSPORT, D. Grove, London.

31st May, 1894.

10,531. LEAD PIGMENTS, C. P. Shrewsbury and H. R. Gregory, London.
10,532. WHEELS of WAGONS, J., S, and F. Carter, Billingshurst.
10,533. INDIA-RUBBER SHOE or FERRULE, P. Garton, Newton-le-Willows.
10,534. TIRE VALVES, H. Lucas and W. Starley, London.
10,535. SHOULDER PADS for CLOTHES, A. Rosenzweig, London.
10,536. DRIVING GEAR for CYCLES, A. Abrahamson, Woolwich.
10,537. ADJUSTING ROPES, D. Douglas and F. Somerscales, Hull.
10,538. DIRECT-ACTING DOBBIE, A. Beedham, West Failsworth.
10,539. GALVANISED IRON for SHEDS, T. D. Pearson, Wolverhampton.
10,540. WATCH KEYS, W. C. Fischer, Glasgow.
10,541. SPRAYING of LIQUIDS on SURFACES, J. Meikle, Glasgow.
10,542. PROCESS of WASHING WASTE SILK, J. Campbell, Bradford.
10,543. CYCLE DRIVING, T. Vann and J. Matthews, Birmingham.
10,544. BURNISHING MACHINES, F. W. Baylis, Redditch.
10,545. BULLET COLLECTING APPARATUS, H. G. Barnacle, Monchester.
10,546. SAND-BLAST APPARATUS, W. and J. Henshall, Manchester.
10,547. MOVING, &c., PLATE GLASS, G. W. Keen, Manchester.
10,548. AIR CUSHIONS for CYCLE TIRES, J. S. Weymouth, Bristol.
10,549. KEYLESS CENTRE SECONDS WATCH, R. Fennell, Coventry.
10,550. MAKING of GASES for HEAT ENGINES, W. H. Willatt, Hull.
10,551. PERAMBUCOT and LUGGAGE CARRIER, H. Bean, Leicester.
10,552. OUTDOOR GAMES, W. D. Bohm, London.
10,553. INCUBATOR for BIRDS, J. G. Green and J. Blum, Gloucestershire.
10,554. RAILWAY CHAIR MANUFACTURE, E. Rees, Monmouth.
10,555. MAKING of SALTS of AMMONIA, A. McDougall, Southport.
10,556. PREVENTING SHIPS' BOTTOMS CORRODING, S. Raineri, Liverpool.
10,557. ANGLE INDICATOR, J. Procter and W. Smedley, Chesterfield.
10,558. CORNICE POLES and FITTINGS, I. A. Read, Birmingham.
10,559. HOLDING GOLF BALLS during PAINTING, W. Ross, Nottingham.
10,560. TIN BOXES, C. Manners, Nottingham.
10,561. FIXING RAILWAY and TRAM RAILS, F. L. Wood, Stockport.
10,562. FIRING of BOILERS, T. H. and W. Blamires, Huddersfield.
10,563. DRESS PROTECTOR for BICYCLES, F. Austin, Petworth.
10,564. BLEACHING JUTE, J. Tait, Glasgow.
10,565. TRANSFORMERS for ELECTRIC CURRENTS, S. P. Thompson, London.
10,566. METALLIC FITTINGS of BRACES, T. Walker, Birmingham.
10,567. STRAINING BROKEN FENCE WIRE, D. Johnston, Glasgow.
10,568. SIGNAL LIGHTS and ROCKETS, G. Pinder, Birmingham.
10,569. DRAWING and CARPET PINS, J. Johnson, Birmingham.
10,570. FOLDING and other BEDSTEADS, G. A. Billington, Liverpool.
10,571. KEY for SECURING RAILS, E. S. Copeman, London.
10,572. SMOOTHING CEILINGS, C. Darrah and R. Brierley, Manchester.
10,573. COVER for CLOSING CANS, F. J. Tomlinson, London.
10,574. MOUNTING PADS for HORSESHOES, S. E. Chipperfield, London.
10,575. CONSTRUCTION of CARGO VESSELS, J. Priestman, Sunderland.
10,576. CONSTRUCTION of CARGO VESSELS, J. Priestman, Sunderland.
10,577. RAISING, &c., BLINDS, S. E. and T. F. Spencer, London.
10,578. IMITATION MITT RINGWOOD GLOVE, W. Tyler, Leicester.
10,579. COLLAR STUDS, A. Crafer and J. C. Saunders, London.
10,580. COLLAR and NECKTIE HOLDER, W. M. Kent, London.
10,581. CHURNS, W. H. Cockshott, London.
10,582. HOLDING the ENDS of NECKTIES, F. G. Fores, London.
10,583. CIGARETTE HOLDER, D. Christy and C. Thomas, London.
10,584. BARRELS or CYLINDERS, &c., W. Heslop, London.
10,585. MANUFACTURE of ARTIFICIAL WOOD, C. Geige, London.
10,586. WALL SOCKETS for LAMPS, G. C. Lundberg, London.
10,587. BURNERS for INCANDESCENT LIGHTS, J. Moeller, London.
10,588. TAPE MEASURES, W. Chesterman, London.
10,589. TREATING BLAST FURNACE GASES, O. Imray.—(*P. Gredt, Belgium.*)
10,590. SWITCH, The Edison and Swan United Electric Light Company, Ld., and C. F. Proctor, London.
10,591. INDIA-RUBBER SOLES and HEELS, O. Bräutigam, London.
10,592. CIGARETTE MAKING MECHANISM, R. Legg, London.
10,593. WALL PAPERS, E. G. C. de Beaulieu, London.
10,594. MAGNETO-ELECTRICAL TELEPHONES, M. Frank, London.
10,595. CIGAR CUTTER, M. Crabbe, London.
10,596. DENTIFRICE, C. Smith.—(*J. F. S. Wallace, United States.*)
10,597. TORCHES, &c., H. J. Haddan.—(*H. Wellington, United States.*)
10,598. FURNACES, H. J. Haddan.—(*H. Wellington, United States.*)
10,599. SELF-ACTING BRAKE, J. Kuban and T. Deuble, London.
10,600. OIL LAMPS, J. Mear, J. Mear, and S. F. Mills, London.
10,601. MANHOLE COVERS, F. T. Farrer and P. B. Evans, London.
10,602. CAPS, E. Cowley, London.
10,603. TOBACCO PIPES, C. J. Place, London.
10,604. CHLORINE, J. Y. Johnson.—(*Verein Chemischer Fabriken, Germany.*)
10,605. DRYING PRODUCE by HOT AIR, W. Jackson, London.
10,606. RADIANT TISSUE for LAMPS, F. de Mare, London.
10,607. CEMENT, J. P. Brasseur and N. Lambert, London.
10,698. PLOUGHS, J. Backhouse, London.

1st June, 1894.

10,609. GLAZING BRICKS, TILES, BLOCKS, &c, J. Green, Portsmouth.
10,610. STEERING NAVIGABLE BALLOONS, W. N. Hutchinson, Eastbourne.
10,611. GOLF MARKER, A. J. Hayward, Woodbridge.
10,612. POWER SAVING APPLIANCES, H. J. Turton, Birmingham.
10,613. OIL CANS, J. W. Kaye, Bradford.
10,614. PREVENTING INCRUSTATION, W. J. Tranter and O. Howl, Birmingham.
10,615. CRICKET BALLS, J. Dick, Glasgow.
10,616. AIR EXTRACTOR and PROPELLER, W. A. Brown, Leeds.
10,617. ROTATING CIRCULAR BRUSHES, H. L. Joy, Manchester.
10,618. DOUBLE-KNOT NETTING for FISHING, W. Stuart, Glasgow.
10,619. SPINNING and DOUBLING COTTON, E. Makin, jun., Manchester.
10,620. VENTILATOR, E. Nicholls, London.
10,621. DRAINAGE for FLOWER-POTS, &c., J. Lewis, Penarth.
10,622. SELF-BALANCE GATE-FASTENER, C. Whiteman, Rugby.
10,623. PETROLEUM, &c., ENGINES, W. E. Gibbon, Colchester.
10,624. TRAYS for TEA-SETS, C. Colver and J. D. Fawcett, Sheffield.
10,625. HANDLES of CYCLES, W. Holt, Manchester.
10,626. JACQUARD-CARD REPEATING MACHINES, W. Ayrton and E. N. Baines, Manchester.
10,627. SLEEVE LINKS, A. Hill, Liverpool.
10,628. CRANK ARMS of LOOMS, J. H. Bury and J. Booth, Halifax.
10,629. TOOL-HOLDERS for LATHES, W. C. Fischer, Glasgow.
10,630. GAS STOVES, R. Dobbie, Glasgow.
10,631. SHOP-FITTING BRACKETS, J. B. Bruce.—(*R. P. Palmenberg, United States.*)
10,632. MACHINERY or DRYING APPARATUS, J. Fielden, Rochdale.
10,633. BUTTER PRESS, G. Swarbrick, Manchester.
10,634. ARC LAMPS, J. W. Rogers, London.
10,635. HYGIENE CABINET ENEMA REST, T. S. Greenway, Wolverhampton.
10,636. STEEL FLANGED PALING, T. S. Greenway, Wolverhampton
10,637. FLOORING and WALLING, E. L. Pease, Stockton-on-Tees.
10,638. PLANTING SEEDS, E. Evans, Birmingham.
10,639. LOCKING WHEELS of BICYCLES, A. W. Pennington, Birmingham.
10,640. VEHICLE for COLLECTING REFUSE, W. Stottery, London.
10,641. DRIVING MOTIONS for CYCLES, H. Hanby, Leeds.
10,642. MINCING or CHOPPING ONIONS, M. Plato, London.
10,643. PROPELLING APPARATUS for SHIPS, W. Harvie, London.
10,644. EXTINGUISHING FIRES, C. Stevenson and J. B. Hamond, London.
10,645. SHIRT and other SOLITAIRES, G. W. Budd, London.
10,646. VALVES for PRODUCING MUSICAL TONES, R. Hope-Jones, London.
10,647. TRANSPORTING GOODS, E. Ruland-Klein, Germany.
10,648. FASTENING LADIES' DRESSES, W. P. Young and T. H. Gaskin, London.
10,649. PRODUCTION of an AERIAL BALLET, C. Nilsson, London.
10,650. LETTER FILES and such ARTICLES, G. Brooks, Birmingham.
10,651. TABLE CRICKET, N. C. Bathurst, London.
10,652. TOBACCO PIPES, L. F. D. Saget, London.
10,653. A NEW GAME, H. S. Grant, London.
10,654. DOUBLE CHAIN GEAR for CYCLES, H. J. Rowling, London.
10,655. VENETIAN BLINDS, A. Neuber, London.
10,656. CIGAR-TIP CUTTERS, W. H. Campbell, London.
10,657. RIBBED STOCKINGS, W. Buckler, London.
10,658. ELECTRIC CHIMES, F. W. Golby.—(*A. Neumann, Germany.*)
10,659. SUSPENDING INCANDESCENT LAMPS, F. W. Golby.—(*A. Neumann, Germany.*)
10,660. INCANDESCENT LAMPS, F. W. Golby.—(*A. Neumann, Germany.*)
10,661. SMOKE EXTRACTOR, E. Wood and A. Waldren, London.
10,662. MOTIVE POWER ENGINES, T. Clayton and W. C. Barker, London.
10,663. WINDOW BLINDS and MAPS, F. W. Maishman, London.
10,664. COOLING WORTS, J. H. West, London.
10,665. RED and WHITE FLASH SIGNALS, G. Blakeley, Bournemouth.
10,666. DISC WHEELS, A. J. Boult.—(*W. Mellwig and G. Bartsch, Germany.*)
10,667. TREATING BREWERS' MASH, R. W. Preston and J. M. Hogarth, Liverpool.
10,668. HAMMOCK FRAME or SUPPORT, W. C. Poles, Manchester.
10,669. COFFIN or CASKET MANUFACTURE, G. E. Shaw, London.
10,670. GOLF BALLS, H. H. Perkes and W. G. Clinning, Liverpool.
10,671. SPINNING FLAX, R. H. Reade, J. G. Crawford, and H. McKibbin, Manchester.
10,672. ELECTRIC ACCUMULATOR PLATES, C. Hampel, Liverpool.
10,673. MAGAZINE REVOLVERS, A. J. Boult.—(*B. Friedemann and H. Trümper, Germany.*)
10,674. COIN-FREED MACHINES, J. Price and G. Haydon, London.
10,675. LUBRICATION of CRANK PINS, &c., H. Lindley, London.
10,676. SURFACE PROTECTING COMPOSITION, E. F. Wailes London.
10,677. STREET GULLIES, A. Fox and P. J. Jackson, London.
10,678. STREET PAVING, P. J. Jackson and A. Fox, London.
10,679. CYCLE BRAKES, C. J. Jacobs and H. J. Hair, London.
10,680. BRUSHES for BLACKING SHOES, W. H. Owen, London.
10,681. WARDROBES, R. Kirchhoff, J. Schulz, and M. Sendik, London.
10,682. BEER RAISING APPARATUS, C. F. F. P. Uhlmann, London.
10,683. CYCLE WHEELS, L. Savery and G. H. Gregory, London.
10,684. ASCERTAINING the POSTAGE of LETTERS, J. Golaz, London.
10,685. TOBACCO PIPES, S. R. English, London.
10,686. HORSESHOES, The Cockshutt Plough Company, London.
10,687. ELECTRIC FIRE ALARM APPARATUS, L. Borel, London.
10,688. BLOCK PRINTING, W. Mills, London.
10,689. PNEUMATIC TIRE for VELOCIPEDES, H. Parsons, London.
10,690. AUGER BIT, A. G. Brown, London.
10,691. SURGICAL SYRINGE, A. W. and H. V. Down, London.
10,692. RAIL JOINTS, A. B. Ibbotson, London.
10,693. DEVICE for HOLDING MUSIC, J. W. Hibberd, London.
10,694. TOBACCO PIPE, H. Shields, London.
10,695. HOT-WATER BOILER for BATHS, R. W. Boyd, London.
10,696. PROTECTING SHIPS from TORPEDOES, G. H. Jones, London.
10,697. SEWING MACHINE BUTTON-HOLE ATTACHMENT, C A. Haupt, London.
10,698. AXLE-BOX MANUFACTURE, H. Sichelschmidt, London.
10,699. SEAMING SHEET-METAL COVERS, F. J. Tomlinson, London.
10,700. PNEUMATIC SIGNALLING APPARATUS, E. J. Wagner, London.
10,701. ELECTRICITY for MARINE PURPOSES, C. S. Snell, Cornwall.

2nd June, 1894.

10,702. GAS BURNERS, H. A. House, and H. A. House, jun., and R. R. Symon, London.
10,703. AXLE-BOXES, D. J. Morgan, London.
10,704. WATER-TAPS, G. Carnell, London.
10,705. AUTOMATIC FEED for GRINDING MACHINES, F. C. Askham, Sheffield.
10,706. TIRES for WHEELS of CARRIAGES, T. W. Robertson, Belfast.
10,707. GENERATING HOT AIR, W. Anthony, Cardiff.
10,708. SPITTOON and HOLDER for MATCHES, F. Lukey, Margate.
10,709. REFLECTORS for CYCLE LAMPS, H. Lucas, London.
10,710. LUBRICATING the CHAINS of CYCLES, F. Jones, London.
10,711. SAFETY COUPLING for TRAM-CARS, A. Hughes, Liverpool.
10,712. A CARD EDGE BEVELLING, C. Royle, London.
10,713. DRYING BRICKS, C. Dean and J. Hetherington, Liverpool.
10,714. LOCKING RAILWAY CARRIAGE DOORS, C. H. Relph, London.
10,715. LOCKING BARS for RAILWAY SWITCHES, A. M. Thompson and J. T. Roberts, Crewe.
10,716. ARTICLES of JEWELLERY, W. H. Douglas, Birmingham.
10,717. CLEANING CARPETS, &c., G. A. Wigley, Nottingham.
10,718. CURLING the BRIMS of HATS, R. Schofield, Manchester.
10,719. ELASTIC TIRES, C. K. Welch, London.
10,720. COVER for TEMPORARILY PROTECTING TIRES, C. K. Welch, London.
10,721. MANUFACTURE of WRITING PENS, J. H. Wilday, Birmingham.
10,722. ROTARY EDGE-SETTING MACHINES, G. W. Riley and S. J. Pegg, Leicester.

10,723. Valves for Steam Engines, J. Willoughby and F. Evans, Manchester.
10,724. Covered Cork, G. R. Foulston, Hull.
10,725. Splashboard Brackets, R. McKinstry and S. Beattie, Halifax
10,726. Window Blind Rollers, H. Lomax, Halifax.
10,727. Automatic Nosing Motion for Mules, A. Ainley, Huddersfield.
10,728. Milling Textile Fabrics, J. Reffitt and T. Laycock, Halifax.
10,729. Gear for Opening Sliding Doors, A. Rose.—(*H. Rose, Australia*)
10,730. Cranes, W. Purdy, Leeds.
10,731. Nut Locks for Screwed Bolts, G. Warsop, Nottingham.
10,732. Duplex Escapements, D. G. H. Ransom, Manchester.
10,733. Alterable Child's Chairs, W. S. McLennan and T. Morton, Glasgow.
10,734. Application of a Certain Composition, C. J. Hall, Manchester.
10,735. Washing Wool, &c., J. Petrie and J. Fielden, Rochdale.
10,736. Gassing Yarn and other Threads, S. Clough, Bradford.
10,737. Ring Spinning, T. Hiton, W. Shaw, and G. A. Davison, London.
10,738. Cardboard Boxes, G. Wilcox and H. J. Candlin, Manchester.
10,739. An Improved Chimney Cowl, W. C. Mowbray, London.
10,740. The Pedal Music Lever, P. M. Gyselman, London.
10,741. Apparatus for Ruling Dotted Lines, E. Carr, London.
10,742. Heald Operating Mechanism, J. and E. Hill, Keighley.
10,743. Suspension Chains for Garments, A. Prym, Berlin.
10,744. Regulating the Letting-off of Warp from the Warp Beams of Looms, W. Warrington, Manchester.
10,745. A Continuous Magnet Motor, I. Carruthers, Brighton.
10,746. Feed-water Heating Apparatus, J. H. Rosenthal, Glasgow.
10,747. A New or Improved Rotary Motor, J. Whittaker, Birmingham.
10,748. Folding Lamp and Candle Shades, L. Martindale, London.
10,749. Collapsible Bedsteads, A. H. Baird, Liverpool.
10,750. Golf Hole Indicator, A. E. L. Slazenger, London.
10,751. Self-supplying Ink Bottle, J. J. Duffy, Dublin.
10,752. Regulating Steam Valves, &c, W. Boaz, London.
10,753. Apparatus for Projecting Images, R. A. Scott, London.
10,754. Refrigerating Apparatus, A. J. Boult.—(*P. Schou, Denmark.*)
10,755. Horseshoes or the like, E. de Horsey, Liverpool.
10,756. Hydraulic Valve, J. C. Etchells, Manchester.
10,757. Finishing Boots, A. Pochin, H. Addison, and G. Shipley, London.
10,758. Cutting Boot Soles, W. P. Thompson.—(*A. M. Stickney, United States.*)
10,759. Hydraulic Valve for Packing Presses, J. C. Etchells, Manchester.
10,760. Cartridge Cases, A. T. Holgerson, London.
10,761. Spanners and Wrenches, R. M. Carroll, Liverpool.
10,762. Velocipedes, J. B. Cooke and G. Kay, London.
10,763. Apparatus for Net Fishing, G. A. Larsen, London.
10,764. Driving Mechanism for Cycles, A. J. Boult.—(*J. Laplant, South Africa*)
10,765. Motor-power Engines, J. Landry, G. Beyrout, and R. M. de Montaignac, London.
10,766. Coloured Pictures, C. D. Abel.—(*The Actien Gesellschaft für Anilin Fabrikation, Germany.*)
10,767. Nuts and Spanners, J. Adcock, London.
10,768. Shirt Fronts, T. McKeague, London.
10,769. Improved Construction of Garment, A. M. Burberry, London.
10,770. Elastic-tired Wheels for Road Vehicles, H. Carmont, London.
10,771. Pump Valves, C. Müller, London.
10,772. Deodorising Petroleum, A. J. Tempère, London.
10,773. Hair-brushes, H. R. Brewer, London.
10,774. Planing Wood-block Floors, W. Sykes, London.
10,775. Curling Tongs Holder, G. Kürschner, London.
10,776. Scouring, &c., Cotton Waste, F. N. Turney, London.
10,777. Case for the Protection of Pens, F. Timm, London.
10,778. Coal Plates, F. W. Kitto and W. Haworth, London.
10,779. Hand Tool for Breaking Coal, &c. P. Alriq, London.
10,780. Grab for Lifting the Cores Formed by Rock Drills, P. A. Crelius, London.
10,781. Manufacture of Compounds of Ammonia, &c., A. R. Davis, London.
10,782. Manufacture of Compounds of Ammonia, &c., A. R. Davis, London.
10,783. Enabling a Cyclist to Pull Another Cyclist, R. Hahn, London.
10,784. Pneumatic Tires, R. Pritt, London.
10,785. Oscillating Motor, J. S. McAndrew, Glasgow.
10,786. Game, J. L. Sherwill, Glasgow.
10,787. Swarm Arrester for Beehives, G. W. Hole, London.
10,788. Gas and Hydrocarbon Engines, F. Henriod-Schweizer, London.
10,789. Platen Printing Presses, W. R. Lake.—(*S. P. Steen, jun., and C. H. Elliott, United States.*)
10,790. Securing Ropes, W. R. Lake.—(*A. Sabroe, Germany.*)
10,791. Pressure Recorders, J. Naylor, jun., London.
10,792. Music Stands, H. Holtz, London.
10,793. Obtaining the Higher Homologues of Pyrocatechine, H. Baum, London.
10,794. Controlling Cashes, A. Rautenberg, Berlin
10,795. Manufacture of Armour-plates, &c., H. W. Gabbett-Fairfax, London.

4th June, 1894.

10,796. Devices for Athletic Purposes, J. Forrest, Lancashire
10,797. Machines for Finishing Combs, E. J. Smith, Bradford.
10,798. Lamps for Coal Mines, W. W. McLauchlan, Manchester.
10,799. Covers of Tires of Cycle Wheels, R. Hill, Stockton-on-Tees.
10,800. Making Railway Chairs, A. E. Muirhead, Glasgow.
10,801. Securing Pneumatic Tires, J. F. Luckman, Birmingham.
10,802. Covers for Pneumatic Tires, G. Finney, Birmingham.
10,803. Waterproofing Fabrics, W. Thomson and A. E. Mavor, Manchester.
10,804. Sewing Cloths, E. E. Evans and W. W. Tonkin, Stroud.
10,805. Door-steps, J. C. Boswell, Norwich.
10,806. Ventilators, J. Rothwell, London.
10,807. Pneumatic Tires for Cycles, &c., R. Scott, Newcastle-on-Tyne.
10,808. Unions for Metal Pipes, J. Kenyon, Barrow-in-Furness.
10,809. Water-gauge Cocks for Boilers, J. Hutcheson, Glasgow.
10,810. Cycles, G. Gibson, Croydon.
10,811. Fixing Casement Windows, T. Jenks and T. Hook, Bath.
10,812. Fixing Hub Axles of Cycles, C. Sangster, Coventry.
10,813. Furnaces for Brewery Coppers, R. H. Leaker, Bristol.
10,814. Cycles, A. Black, Glasgow.
10,815. Ball, A. W. Hughes, Birmingham.
10,816. Roughening the Surfaces of Paper Tubes, S. O'Neill, Manchester.
10,817. Cycles, I. H. S. Allan, Belfast.
10,818. Belt Fasteners, T. A. Abbott, London.
10,819. Aerostatic Vessel, F. W. Golby.—(*C. Oelling, Germany*)
10,820. Preparing Ore for Smelting, E. Böcking, London.
10,821. Portable Folding Bicycle Stand, T. B. Jack, London.
10,822. Slate Cleaner, &c., W. Evans, S. C. Middenway, and J. C. Matthews, Birmingham.
10,823. Extraction of Aluminium, A. F. B. Gomess, London.
10,824. Projectiles for Use in Fire-arms, H. Barnes, London.
10,825. Railway Brake Apparatus, J. Ackermann, London.
10,826. Method of Marking Cattle, C. P. Hayward, London
10,827. Extraction of Metal from Ores, M. Body, London.
10,828. Whistles, E. L. Parker and W. W. Twigg, London.
10,829. Rulers, Straight-edges, &c., F. H. A. Heyer, London.
10,830. Reversible Ingrain Carpets, Henderson and Co., Ld., and R. Britton, London.
10,831. Drink for Caged Birds, J. W. Carter, London.
10,832. Hand-stamping Apparatus, E. Edwards.—(*R Krayn, Germany.*)
10,833. Mounting Work in Lathes, E. Edwards.—(*F. H. Flottmann, Germany.*)
10,834. Cranks, H. J. F. Guillou, London.
10,835. Discharging Dredged Material, A. Brown, London.
10,836. Gearing Chains, O. Lindner, London.
10,837. Boilers, O. C. Davis, London.
10,838. Fountain Pens, P. Jensen.—(*F. C. Brown, United States.*)
10,839. Tea Cosies, A. Argles, London.
10,840. Reducing Vibration in Cycles, W. Edwards and J. H. Malpas-Roberts, London.
10,841. Condensed Food and Fodder, H. Bunker, London.
10,842. Preventing Fracture of Shafts of Vehicles, W. P. Thompson.—(*C. Boese and A. Berendt, Germany.*)
10,843. Submerged Structures, W. P. Thompson.—(*T. H. Cavanaugh and J. W. Robinson, United States.*)
10,844. Hinge Device for Windows, W. P. Thompson.—(*J. H. Weigel, Germany.*)
10,845. Treating Middlings, J. Higginbottom, Liverpool.
10,846. Disinfectants, S. A. Vasey and C. F. Townsend, London.
10,847. Stopping Leaks in Ships, W. F. Beart, London.
10,848. Drying Onions and Tomatoes, L. Stempel, London.
10,849. Mash Tuns or Substitutes, L. V. D. Hulle, London.
10,850. Pneumatic Cycle Tires, J. B. Dunlop, jun., London.
10,851. Railway Signals, H. H. Lake.—(*F. Beattie, United States.*)
10,852. Valve and other Motions, C. H. Moberley, London.
10,853. Storage Batteries, J. Y. Johnson.—(*La Société L'Accumulateur Fulmen, France.*)
10,854. Colours, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
10,855. Firing Shots in Quarries, &c., J. MacNab, London.
10,856. Tire for Cycle Wheels, H. V. Karlebye, London.
10,857. Door Springs, F. Knobel, London.
10,858. Wheels for Vehicles, &c, C. Schmidt, London.
10,859. Threshing Machine, F. Kommnick and F. Bertram, London.
10,860. Bicycles and other Vehicles, A. Leloup, London.
10,861. Overshoe, &c., M. and H. Frendenthal, London.

5th June, 1894.

10,862. Water-tube Boilers, &c., J. Garvie, jun., London.
10,863. Hunting Crop and Walking-sticks, D. Brain, London.
10,864. Safety Spring Halter Chain, J. S. Yule, Manchester.
10,865. Water Feed, J. M. Porter and J. Blakey, Leeds.
10,866. Engines for War Purposes, J. E. Brown, Alton.
10,867. Covers of Pneumatic Tires, A. Gower, Eastbourne.
10,868. Drawing-pins, H. Marles, Brighton.
10,869. Washing Machines for Laundries, W. H. Facon, Nottingham.
10,870. Operating Shuttle-guards, E. and G. Hindle and W. Isherwood, Halifax.
10,871. Swells of Shuttle-boxes, E. and G. Hindle and W. Isherwood, Halifax.
10,872. Self-adjusting Folding Chair, J. Harwood, Birmingham.
10,873. Clasp for Wearing-apparel, E. W. Rogers, Birmingham.
10,874. Cutting Cloths, G. H. Smith and B. Cooper, Manchester.
10,875. Appliance for the Use of Cyclists, G. Johnson, Sheffield.
10,876. Syphon Cisterns, G. Brindley, J. McEwen, and S. Thompson, Birmingham.
10,877. Seed Drill for Sowing Manures, G. Russell, Sinnington.
10,878. Ironing Machines, A. Metzger, Glasgow.
10,879. Golf Holes, A. E. Pullar, Glasgow.
10,880. Sunshade, W. Fairweather.—(*A. Paris, Germany.*)
10,881. Coke Ovens, H. A. Allport, London.
10,882. Destruction of Ashpit Refuse, J. Bennison, Manchester.
10,883. Drilling Gas and Water Mains, J. McNair, Wishaw.
10,884. Wheels, J. Scott, Belfast.
10,885. Seats, H. G. Wells, London.
10,886. Filter for Syrups and Liquids, G. Rae, Glasgow.
10,887. Tip for Ends of Walking-sticks, C. J. A. Francis, Glasgow.
10,888. Pad for Chair Feet, B. Barnett, Glasgow.
10,889. Pointing Black-lead Pencils, L. Wolff, London.
10,890. Bevelling Glass Circles, E. H. Pearce and E. Brown, Birmingham.
10,891. String Economiser, R. Robertson, Gateshead-on-Tyne.
10,892. Golf Waterproof Coat, C. H. Davis, J. Blake, and J. J. Farr, London.
10,893. Balls for Bowling Alleys, C. W. Rodman, London.
10,894. Cutting Teeth of Gear-wheels, J. L. Kunz, London.
10,895. Brake Mechanism for Velocipedes, W. H. Akester and H. H. Price, London.
10,896. Tobacco Pipes, H. McCullough, Belfast.
10,897. Pointing Bricks, C. Wilson and A. H. Pepperill, London.
10,898. Building Blocks, H. T. and J. Grainger, London.
10,899. Wire for Card Clothing, J. H. Roberts, Bradford.
10,900. Fly-trap or Catcher, C. Adams-Randall, London.
10,901. Jewelled Metalware, L. E. Ravault, Birmingham.
10,902. Speed Indicators, W. T. Lintner, London.
10,903. Sewing Machines, H. H. Lake.—(*S. H. Wheeler, United States.*)
10,904. Buttons, C. Radcliffe, London.
10,905. Spraying Machine, A. Bryce, London.
10,906. Evaporating Brine or Liquors, A. Chapman, London.
10,907. Watering and other Cans, G. A. Farini, London.
10,908. Door Springs, G. A. Farini, London.
10,909. Automatic Guards for Forks, C. E. Trickett, Sheffield.
10,910. Match Shield, P. Shields, Belfast.
10,911. Fire-proof Structures, A. W. Rammage and W. Clark, London.
10,912. Preserving Wristbands, &c., G. J. Newman, London.
10,913. Horse Rugs and Sleeping Rugs, J. Bartram, London.
10,914. Nails, &c, W. L. Wise.—(*H. A. Lepreux, France*)
10,915. Cameras, T. M. Clark, London.
10,916. Solarometers, &c., W. H. Beehler, London.
10,917. Safety Fuses or Cut-outs, S. Z. de Ferranti, London.
10,918. Cherry Stoners, &c., J. W. Brown, jun, London.
10,919. Umbrellas and Parasols, A. J. Boult.—(*B. Meyer, Germany.*)
10,920. Setting Tires, W. P. Thompson.—(*J. B. West, United States.*)
10,921. Justifying Type, W. P. Thompson.—(*J. L. McMillan, United States*)
10,922. Pneumatic Saddles, E. E. Preston and A. H. Bates, London.
10,923. Steel, W. P. Thompson.—(*E. Bertrand and O. Thiel, Austria.*)
10,924. Taps, J. Samuel, London.
10,925. Carding and other Engines, G. Turckx, London.
10,926. Apparatus for Exhibiting Goods, F. W. Harris, London.
10,927. Blotting Pad, M. Bernède, London.
10,928. Boxes for Pills and Cachous, E. A. Jeffreys, London.
10,929. Velocipedes and Locomotives, A. Hunnable, London.
10,930. Pianoforte Cases, C. Bechstein, London.
10,931. Cash Registers, J. R. Ward, London.
10,932. Hose Coupling, E. Nunan, London.
10,933. Matches, W. and C. Schael, Berlin.
10,934. Fixing Cranks, &c, on Shafts, G. Taylor, London.
10,935. Stop Motion for Looms, K. Hümig, jun, London.
10,936. Skiving Machines, H J. Haddan.—(*The Scott Shoe Machinery Company, United States.*)
10,937. Tension Devices, H. J. Haddan.—(*G. W. Baker, United States.*)
10,938. Harps, H. J. Haddan.—(*The C. F. Zimmermann Company, United States.*)
10,939. Mat Machinery, A. E. Hodder and W. Goodacre, London.
10,940. Coir Yarn Mat Weaving Machinery, E. Hodder, London.
10,941. Station Indicating Apparatus, P. Ellis, London.
10,942. Silk Hat Pads or Polishers, W. S. Simpson, London.
10,943. Rotary Engines, L. de Maio, London.
10,944. Centrifugal Cream Separators, E. G. N. Salenius, London.
10,945. Cream Separators, E. G. N. Salenius, London.
10,946. Improved Beverages, E. A. B. Beaumont, Brighton.
10,947. Life-buoys, J. P. A. Galibert, London.
10,948. Making Steel Tubes, J. Y. Johnson.—(*J. P. Serve, France.*)
10,949. Singeing Cloth, J. R. Reynolds and W. E. Whittle, London.
10,950. An Improved Inhaler, I. Quaglio, London.
10,951. Sole-levelling Machines, J. G. Lorrain.—(*E. E. Winkley and B. Phillips, United States.*)
10,952. Electrodes, C. Hoepfner, London.

6th June, 1894.

10,953. Horns for Railway Wagons, E. Rees, Monmouthshire.
10,954. Preventing the Fall of a Cage in a Pit-shaft, G. Archer, Ilkeston.
10,955. Railway Chairs, R. M. Harison, Glasgow.
10,956. Manufacture of Starch, R. Wilson, Glasgow.
10,957. Side Handles for Carriage Doors, J. Maxwell, Glasgow.
10,958. Carriage Tricycle, J. P. and P. C. McCormick, Dublin.
10,959. Direct-acting Rotary Steam Engine, J. P. Auld, Dublin.
10,960. Manufacture of Golf Clubs, Slazenger and Sons, London.
10,961. Cricket Bats, C. Rose, jun., Accrington.
10,962. Rotary Pumps, A. H. Tyler and J. S. Ellis de Vesian, London.
10,963. Closing Stage Curtains, E. Lytton, Manchester.
10,964. Billiard Cue Holder, J. F. Childs and E. F. B. Rolfe, London.
10,965. Sweeping, &c., Chimneys, J. Godwin, Manchester.
10,966. Window Sashes, J. Lawrie, Glasgow.
10,967. Electrical Switches, J. H. Tucker, Birmingham.
10,968. Inserting Press Papers, J. Reffitt and H. Cliffe, Halifax.
10,969. Drill Coulters, J. E. Holyoak, Leicester.
10,970. Machines for Washing Bottles, T. Hill, Hull.
10,971. Lasting Pincers, J. Allen, Leicester.
10,972. Organ Pipes, J. T. Cussons, Beverley.
10,973. Manhole Covers in Steam Boilers, J. Mills, Manchester.
10,974. Door Sneck or Catch, A. W. McMurdo, Glasgow.
10,975. Decorative Lamps, D. L. Simpson, Glasgow.
10,976. Blinds, C. Horton, Birmingham.
10,977. A Hand Banking Plough, W. Gregory, Egloskerry, R S O.
10,978. Measuring Instruments, W. T. Goolden and S. Evershed, London.
10,979. Packing for Piston Rods, T. Hosking, Liverpool.
10,980. Fender Curbs, F. W. Green, Birmingham.
10,981. The Cricket Bat Preflector, E. A. Penn, Coventry.
10,982. Sugar Shell, J. B. Harper and R. Gömmez, London.
10,983. Production of Vinegar, E. Pew and W. Blenheim, Surrey.

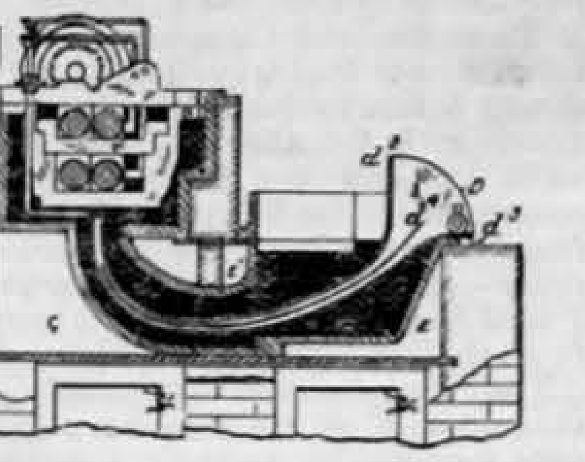
SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

518,342. Tin-plating Machine, *C. R. Britton, Cleveland, Ohio.—Filed July 3rd*, 1893.

Claim.—(1) In a tin-plating apparatus, the combination of a tinning pot, a grease pot, and a curved hollow neck connecting said two pots, with supporting masonry in which are formed two flues E and G, the former extending in front of the tinning pot, the latter behind the neck and under the grease pot, and a wall which divides the space above the neck into two flues E′, G, the former being connected with flue E, the latter with flue G, whereby the tinning pot on the one hand and the rear part of the neck and the grease pot on the other hand may be independently heated, substantially as and for the purpose specified. (5) In a tin-plating apparatus, the combination of a tinning pot, a grease pot, and a connecting neck, with two guides D D′ each having three flanges d^2 d^3 d^4, thereby forming, on each guide, two grooves which

518,342

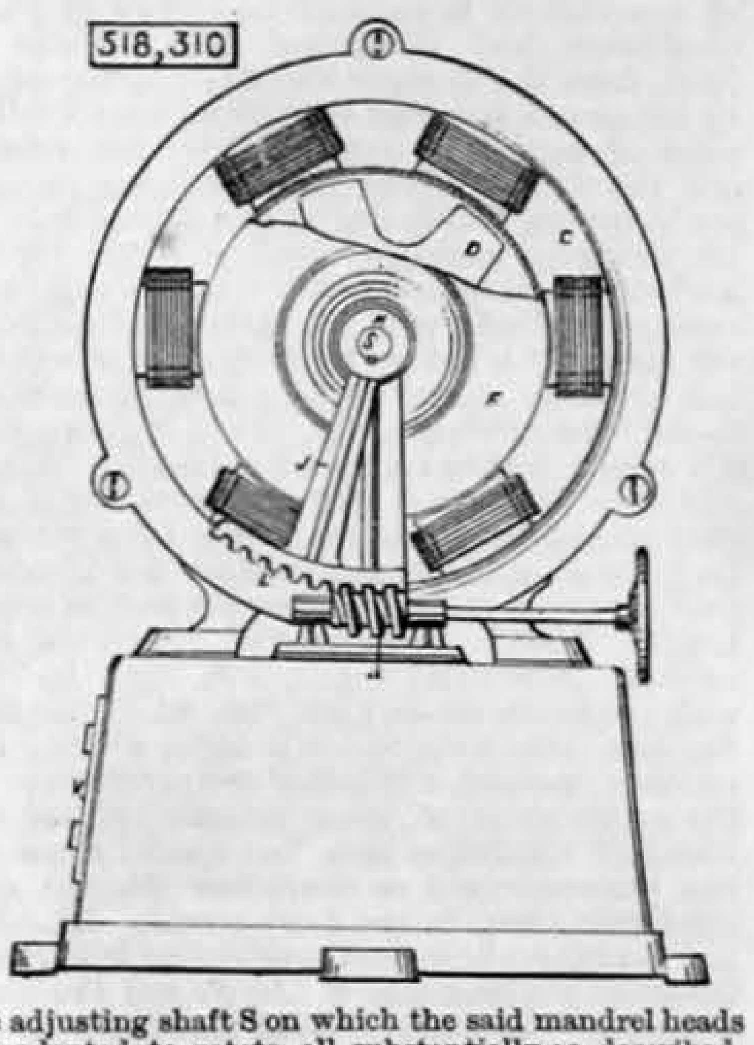


are arranged with respect to each other, substantially as described, whereby either edge of a plate may be placed in the upper groove on one guide, while the other edge is placed in the lower groove on the other guide, for the purpose specified.

518,310. Universal Phase Alternate Current Motor, *T. Duncan, Fort Wayne, Indiana.—Filed May 22nd*, 1893.

Claim.—(1) In an alternating current electro-magnetic motive device, the combination of a laminated field having its polar projections facing inward at an angle, as shown, and a closed secondary or armature, all substantially as set forth and described. (2) In a universal phase motor, the combination of a laminated iron field having polar projections with suitable coils wound thereon for the purpose set forth, a closed armature of low resistance and a magnetic path diverter for regulating the direction of the magnetic flux through the armature, substantially as described. (3) The combination in an electro-magnetic motor for single or multiphase alternating currents, of a field magnet adapted to be connected with said currents, a closed rotary armature, a magnetic path diverter and the adjusting lever, all substantially as and for the purpose set forth. (4) In a universal phase alternating current motor, the combination of an energising field magnet *c*, a closed cylindrical secondary or armature C, the bearing heads F supporting said armature, and

518,310

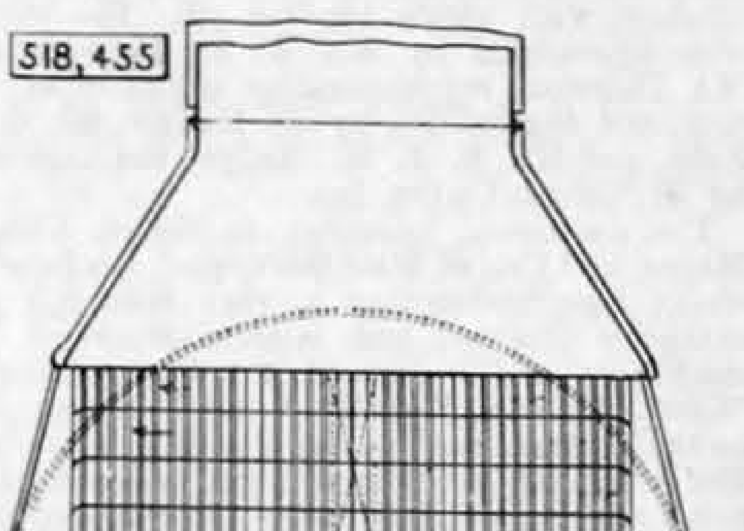


the adjusting shaft S on which the said mandrel heads are adapted to rotate, all substantially as described. (5) In a universal phase motor, the combination of the field magnet *c*, the armature C, the bearing heads F, the diverter D, the lever J H L, the worm gear M, the adjusting shaft S, and the plug or switch-board V, all as described and hereinbefore set forth. (6) In an electric motor for single and polyphase currents, the combination of a laminated field having its polar projections facing the armature at an angle, and provided with suitable coils located in the circuit or circuits of the supply, and a laminated diverter for varying the speed and direction of rotation, all substantially as described. (7) In an electric motor for single and polyphase currents the combination of a laminated field having its polar projections facing the armature at an angle, and provided with suitable coils located in the circuit or circuits of the supply, a laminated diverter for varying the speed and direction of rotation and the terminals, plugs, or switch-board as herein set forth and described.

518,455. Apparatus for Heating Air, *J. Howden, Glasgow, Scotland.—Filed August 21st*, 1893.

Claim.—(1) A steam boiler having an air-heating chamber in connection with the smoke-box, and through which pass the products of combustion, an air inlet or inlets to the chamber, flues for the passage of heated air from said chamber, and a partition or partitions in the latter to give divided streams of air through the chamber, substantially as described. (2) A steam boiler having an air-heating chamber in connection with the smoke-box, with vertical tubes therethrough for the passage of the products of com-

518,455



bustion, an air inlet or inlets to the chamber, flues for the passage of the heated air from said chamber, and horizontal partitions in the chamber, substantially as and for the purpose set forth. (3) A steam boiler having an air-heating chamber in connection with a smoke-box, with a central vertical division plate and horizontal partitions for the distribution of the air, a central air inlet at the said division plate, and side flues for the passage of the heated air from the chamber to the furnace, all substantially as described.

FOUR-COUPLED BOGIE TANK ENGINE, LONDON AND SOUTH-WESTERN RAILWAY

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