

HEAT TRANSMISSION THROUGH METAL PLATES.

By JOHN G. HUDSON, M.I.C.E.

DURING the year 1890 two series of articles giving a *résumé* of the information then available on this subject appeared in these pages.* The first series dealt with the transmission of steam heat, and the second with that of fire heat. Both branches of the subject have since then attracted the attention of engineers, the first in connection with the steam jacketing of engine cylinders, and the second in connection with the destructive action of intense heat on certain parts of steam boilers. Particulars of some interesting experiments have been published, and it is proposed to supplement the previous articles by a short consideration of the further information they afford.

In the "Annales du Conservatoire National des Arts et Metiers," Paris, 1890, under the title of "Experiences sur les Coups de Feu des Chaudières à Vapeur" Mr. Hirsch has given the results of a series of experiments made by him to ascertain the conditions needed to produce overheating of the bottom plating of externally-fired boilers such as are largely used in France. The experiments were extensive and admirably planned, and, with their results, are described with the precision and particularity peculiar to continental scientists. As they have not, so far as the writer is aware, been reproduced in any English technical journal, an outline of them may be of interest.

Mr. Hirsch first experimented on an actual boiler of the externally-fired type provided with four shell heaters, the whole being set in brickwork. For the purpose of the experiment, a small area of the bottom plating, directly over the bridge, and therefore exposed to the most intense action of the fire, was isolated by an internal tube in such a way that the evaporation effected by it could be distinguished from that of the remaining heating surface of the boiler. The grate area was 3.87 square feet, the heating surface of the main boiler 35.5 square feet, of which 1.33 square feet was isolated as described, and of the four heaters 108.0 square feet, making the total heating surface 143.5 square feet. The following were the principal results obtained:—

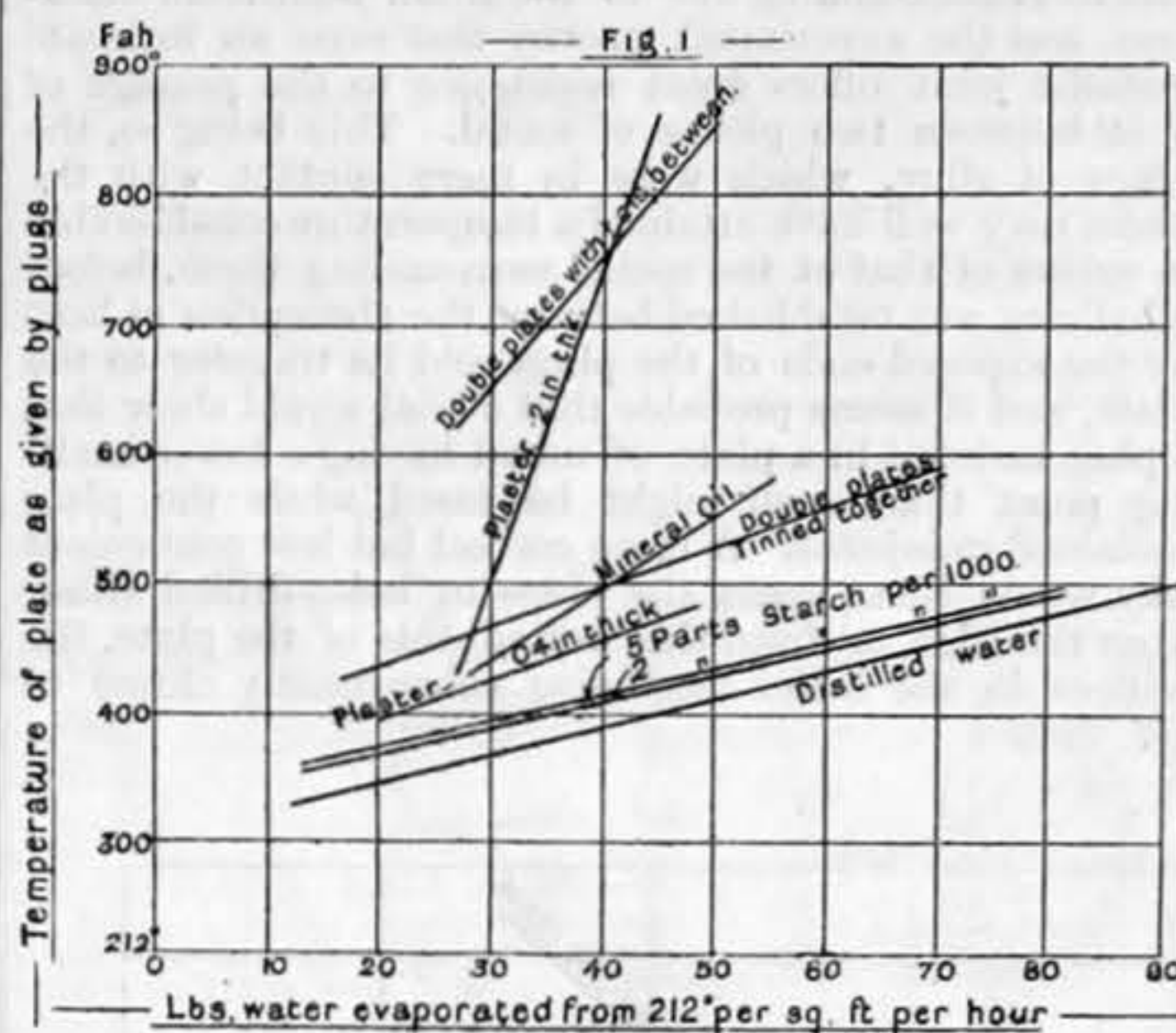
Date of Trial.	Coal burnt per sq. ft. grate, lb.	Cold water evaporated at 212 deg. per sq. ft. per hour.		
		By isolated area.	By main boiler.	By boiler and heaters.
Aug. 11	16.4	{ 25.625 20.910 }	9.74	2.4
Aug. 18	28.7	{ 29.315 27.670 }	13.66	3.38
Aug. 21	29.3	{ 36.9 32.600 }	13.04	3.19
Aug. 22	37.3	{ 50.225 32.600 }	17.08	4.23
Aug. 24	(a) 40.18	{ 35.260 37.720 50.250 }	18.95	4.69
Aug. 28	(a) 40.18	{ 41.615 39.565 }	19.31	5.25
Aug. 25	(a) 40.17 (b)	{ 29.725 26.855 }	16.77	4.15
Aug. 29	(a) 48.8 (b)	{ 43.665 33.000 }	19.38	4.8

(a) Damper full open. (b) Steam jet blower in flue.

Each trial lasted about two hours; but the evaporation by the isolated area was taken for shorter periods of from twenty-one to fifty-six minutes, which will explain the greater number of observations given in the third column of the table. It will be noticed as curious that in the two last trials, during which the fire was urged by a steam jet, the higher rate of combustion was not accompanied by any corresponding increase in the evaporation, the maximum rate of which was obtained with natural draught. Mr. Hirsch points out that the rates of both combustion and evaporation were greatly in excess of those ordinarily attained by similar boilers in actual work, and that the bottom plating of the main boiler was exposed to an unusually intense heat in consequence of the large area of the grate in proportion to that of the boiler surface, the closeness of the grate to the bottom of the boiler, and the constricted cross section of the passage over the bridge. He also mentions that the higher rates of evaporation were accompanied by considerable priming, the amounts of which he was unfortunately unable to measure. The steam pressure throughout the trials was maintained almost constant at 56 lb. per square inch. The boiler experimented on was one of two similar boilers at the Conservatoire des Arts et Metiers, and appears to have received no injury whatever from the forced firing during the experiments. This is ascribed to the care taken to maintain it in perfect condition, as the other boiler—which had never been worked beyond a very slow rate—showed distinct signs of overheating. Though not so stated, it is apparently to this circumstance that we owe this interesting investigation.

Having, as described, ascertained the maximum amount of heat transmitted per unit of surface in an actual boiler, Mr. Hirsch next sought to measure the temperatures attained under various conditions by the side of a plate exposed to fire when transmitting known amounts of heat. For this purpose he constructed an experimental boiler, the bottom of which was a piece of selected iron plate about 16 in. diameter, by fully $\frac{3}{8}$ in. thick. This plate was drilled on the lower side to receive an inner and outer circle of small plugs of alloy, each circle containing twelve plugs, the melting points of which, verified before use, varied from 230 deg. to 842 deg. Fah. The sides and top of the boiler were carefully arranged to prevent loss of heat by radiation, and of water by "sparkling" during violent ebullition, and the bottom was heated by a blow-pipe flame of combined air and gas burnt in a cavity surrounded by refractory material, and capable of being regulated to maintain any desired intensity of heat. With this apparatus Mr. Hirsch carried out a large number of experiments, varying the conditions so as to imitate as closely as possible those occurring in actual boiler

practice, in every case measuring the temperature of the plate by noting which of the plugs had fused, and the heat transmitted by the quantity of water evaporated. To represent a want of continuity in the metal of the plate such as might be caused by an imperfect weld, or a joint, the bottom of the boiler was in one experiment doubled by the addition of an inner plate about $\frac{1}{16}$ in. thick, a metallic junction being made by machining both surfaces, and tinning them together under pressure. In another experiment to represent the still worse case of a layer of cinder, finely powdered talc was interposed. In other cases the water was rendered viscid by the addition of starch; scale was imitated by coating the plate with plaster, and various oils, mastic, axle grease, and tar were



applied to represent other deposits. The results of the principal tests are shown graphically in Fig. 1.

The following are Mr. Hirsch's deductions from his experiments:—(1) That a sound plate well wetted on one side does not attain at any part a temperature high enough sensibly to affect its strength, even when exposed to intense heat. (2) The water may become viscid to a considerable extent without rendering it incapable of keeping the plate well wetted, or notably reducing its power of cooling the same. (3) As any doubling of the plate hinders the transmission, even a well-made riveted joint should not be exposed to intense heat. (4) A flaw in the metal or want of intimate contact at a joint, in the part of a boiler exposed to any severe heat, constitutes a serious danger. (5) Contact with even very hot brickwork is in no way dangerous, so long as the inner surface of the plate is well wetted. (6) Any coating of grease deposited on the inner surface of the plate greatly hinders the transmission of heat. (7) Should the greasy coating consist of a substance liable to decomposition by heat, overheating is specially to be feared. Greases of organic origin, such as linseed or colza oils, &c., are in this respect much more dangerous than mineral oils.

In the *Comptes Rendus de l'Académie des Sciences*, Paris, 1892, Mr. A. Witz describes some experiments he made with a small upright cylindrical boiler, to ascertain the maximum rates of evaporation obtainable by excessive firing. The following are some of the results:—

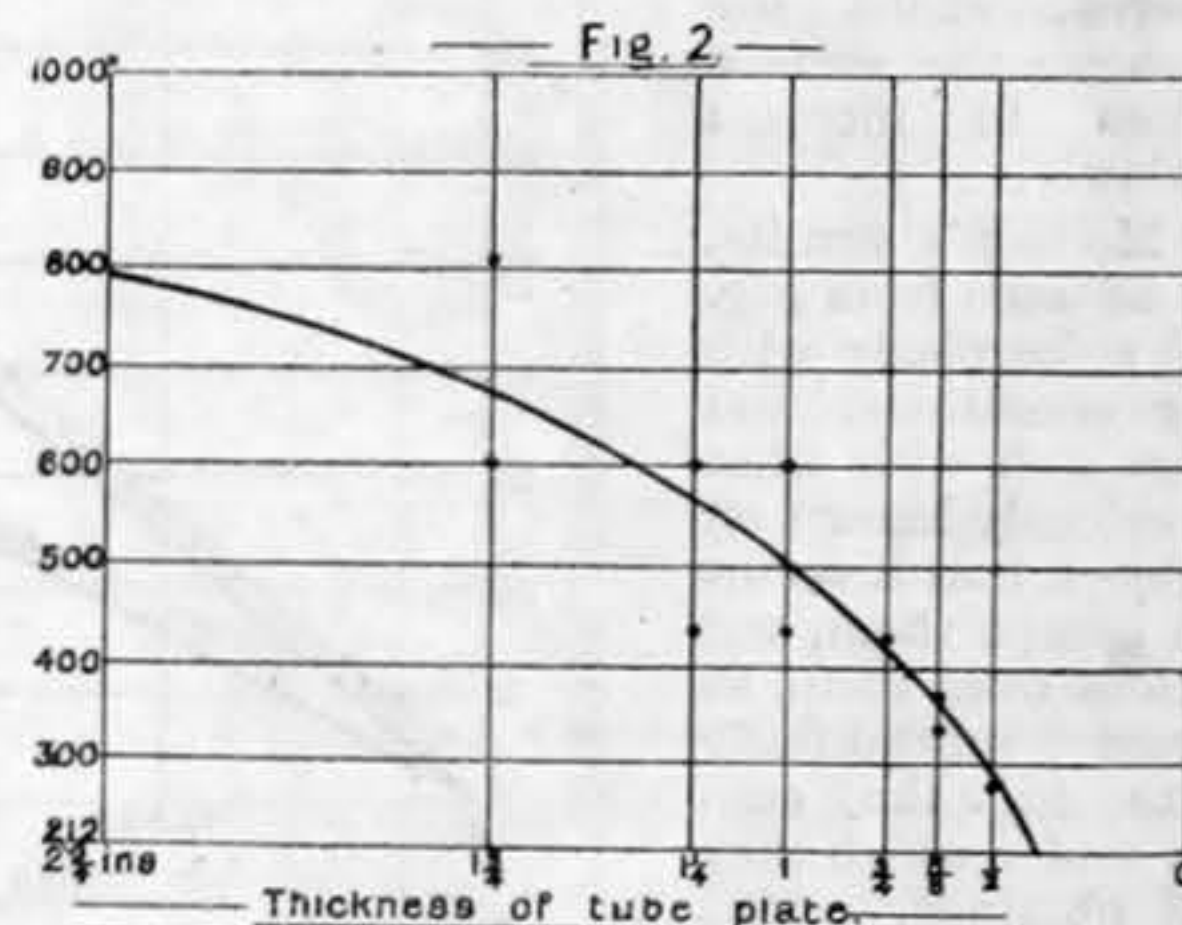
Trial	Temp. of feed, Fah. deg.	Lbs. evapd. per sq. ft. per hour.
a.—Seven Bunsen burners	59	13.0
b.—Ditto and one air blast	61	36.8
c.—Ditto and one oxyhydrogen blow-pipe	65	41.2
d.—Ditto and three oxyhydrogen blow-pipes	67	54.0
e.—Coke with air blast	67	88.9
f.—Seven Bunsen burners, one air blast, and one blow-pipe	57	136.0
g.—Coke with air blast	194	204.0

The depth of water was 3.15 in., except in trials f and g, in which the extraordinary rates of evaporation recorded were obtained by admitting the feed-water after the plate had first been allowed to become red hot. In none of the other trials did the plate become over-heated. The maximum rate of evaporation recorded, 204 lb. per square foot, or equal to boiling away 3.26 ft. depth of water per hour, may be compared with the 140 lb. evaporated by the thin copper tubes of Mr. Weir's steam evaporator, with a temperature difference of only 106.7 deg. Fah.,* which is believed to be the highest rate recorded for steam heating, as this is for fire heating. Mr. Witz concludes from his experiments that the plate becoming red hot, produces merely an excessive rate of evaporation, and not the spheroidal condition which might have been expected. He also describes some experiments in which the spheroidal state was produced, and maintained until the temperature of the plate exceeded 608 deg. Fah., when the spheroidal condition ceased and the evaporation, which had previously been extremely slow, suddenly increased thirty-one fold. The most striking feature of the above experiments is the apparent ability of a red-hot plate to abstract more heat from the fire than could be abstracted by the same plate when at a lower temperature. It has indeed been previously shown that the transmission per degree of difference increases somewhat with the temperature, but so marked an increase in the rate is inexplicable. The particulars of Mr. Witz' experiments are taken from the Foreign Abstracts, "Proceedings" Inst. C.E., vol. 108, p. 473.

In a paper read before the Institution of Naval Architects in March, 1891,† Mr. Yarrow gave details of a number of experiments relating to the distortion of locomotive type marine boilers, due to variations in the temperatures of the different parts arising from the working conditions.

He also exhibited before the meeting an experiment with two vessels each filled with water and heated by a row of gas jets. The bottom of one vessel was steel and the other copper, and each was fitted with an index pointer showing on a scale the comparative curvature of the two metals due to the difference between the temperatures of their heated and wetted surfaces. The steel plate was shown to be much more distorted under equal conditions of heating than the copper, as well as more sensitive to a change of temperature such as that produced by pouring some cold water into the vessel. Mr. Yarrow gave the relative expansions by heat for copper and iron as 3 to 2, and the relative powers of conducting heat as 6 to 1, the superiority of the iron as a material for boilers in the first respect being much more than counterbalanced by its inferiority in the latter respect, the copper having on the whole a figure of merit of 12 as against 3. Mr. Yarrow's experiments justified his well-known advocacy of thin tube plates, and copper as their material, the thinness giving elasticity to meet distortion due to variations of temperatures, whilst the high conductive power of copper reduced these variations and the consequent distortion to a minimum. In these experiments no attempts were made to ascertain the actual temperature of the metal, nor the rate at which heat was being transmitted.

The late Dr. Kirk also experimented with tube plates of different thicknesses, and has published the results obtained.* This apparatus consisted of a "malleable iron" vessel, the bottom of which represented the tube plate, and was fitted with one central steel tube $\frac{2}{3}$ in. diameter. This vessel was placed over a smith's fire and kept supplied with water, the temperature attained by the plate and tube being measured by plugs of alloy inserted in holes drilled half into each, at three or four points in the joint between them. The tube plate as first tested was $\frac{2}{3}$ in. thick, and after exposure to the fire for half an hour was found to be red-hot on its lower surface, except in the immediate neighbourhood of the tube. It was successively reduced to various thicknesses and tested at each, the results obtained being given by the diagram, Fig. 2. Each test lasted three-quarters of an hour, and



no further visible overheating took place. As the result of these tests, Dr. Kirk concluded that to avoid overheating, the thickness of a tube plate should not exceed $\frac{3}{8}$ in. as a maximum. In these experiments also no attempt was made to measure the rate at which heat was being transmitted.

Mr. Durston, Engineer-in-Chief of the Navy, in a paper read before the Institute of Naval Architects in March last,† described a great variety of experiments made with both experimental apparatus and actual boilers, the object being to obtain information regarding the causes of the injuries sustained by the tubes and tube plates of Navy boilers under the action of forced draught. The paper is so recent, and has attracted so much notice, that there is no occasion for any detailed reference to the experiments; and it need only be said that they were perhaps unavoidably qualitative rather than quantitative, as although plugs of alloy were very freely used to ascertain the temperature of the metal, the quantity of heat transmitted was only observed in one or two instances.

Mr. Zittenberg in a letter addressed to the editor of one of your contemporaries of April 14th, last, describes an experiment with a vessel having a copper bottom $\frac{1}{8}$ in. thick drilled nearly through to form a mercury pocket to receive a thermometer. When placed over a smith's fire, blast pressure $\frac{1}{2}$ in. of water, causing an evaporation of 35 lb. per square foot per hour, the maximum excess of temperature above that of the boiling water was 26 deg. Fah.

The only experimental data remaining to be noticed were contributed by Mr. D. B. Morison to the discussion on the report of the Research Committee of the Mechanical Engineers on the value of the steam jacket—"Proc." 1892, p. 483†—and relate to the transmission of steam heat through cast iron to water. The experimental apparatus consisted of a cylindrical shell provided with a cast iron inner liner, the annular space containing the heating steam, and the central cavity the water to be evaporated as the measure of the heat transmitted. The special object of the trials was to ascertain the effect of different thicknesses of metal on the transmission, and the first series of tests was made with the liner at its original thickness of .9 in., whilst for the second series it was reduced to .42 in., and for the third to .19 in. As was to be expected, it was found that the thickness had a great influence on the transmission, the general results being shown graphically by Fig. 3, which is a reproduction of Mr. Morison's diagram. It occurred to the writer that Mr. Morison's tests furnished valuable data, previously wanting, by which to ascertain the difference of temperature needed to overcome the internal resistance of any thickness of cast iron to the passage of any quantity of heat per unit of time and surface. It seemed a reasonable

* Vol. lxx., page 413 and 452 and Vol. lxx., page 449, 483, and 523.

* Inst. Engineers and Shipbuilders in Scotland, page 279, 1888-9.

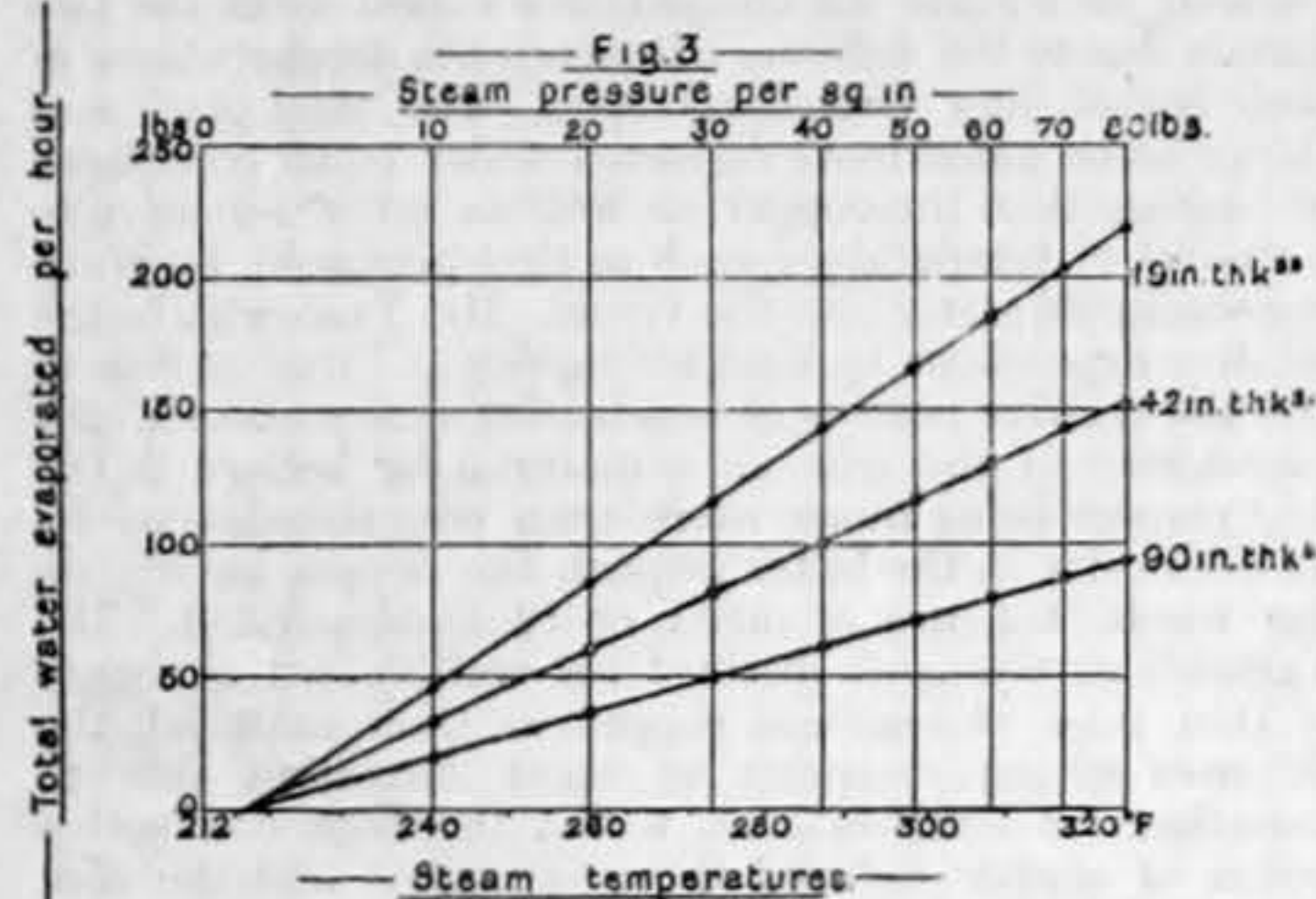
† Reprinted in THE ENGINEER for March 20th, 1891.

* Letter to the Editor, Engineering, July 15th, 1892, and September 9th, 1892.

† Reprinted in THE ENGINEER for 31st March, 1893.

‡ Reprinted in THE ENGINEER for 28th October, 1892.

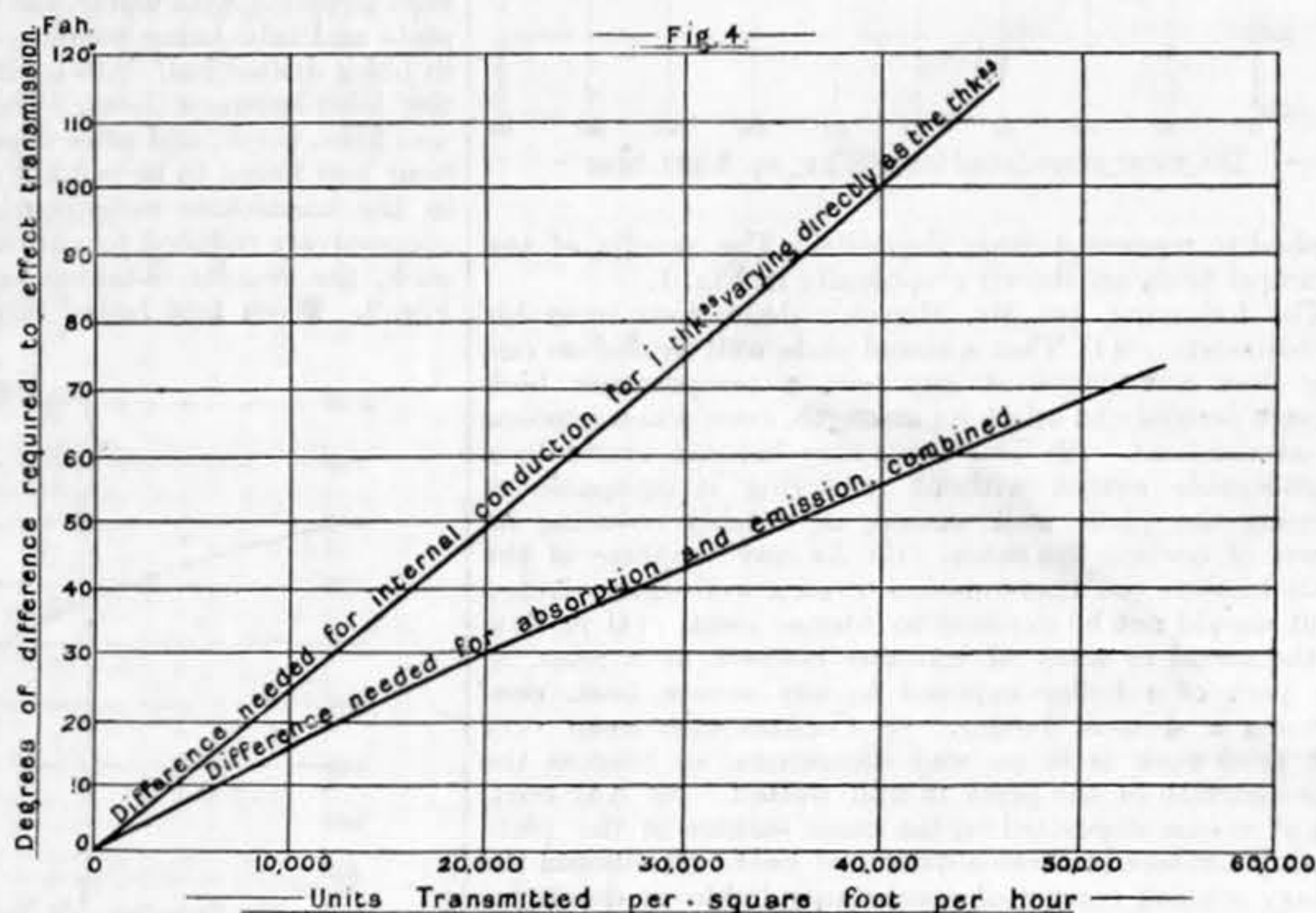
assumption that the quantity of heat transferred being constant, the excess of temperature needed for a given increase of thickness must represent the head or difference needed to transfer the heat through that extra thick-



ness, the other differences remaining unaltered. Analysing Mr. Morison's data in this way the writer arrived at the results shown graphically in Fig. 4, in which the upper curve gives the difference required to overcome the internal resistance to the transfer of different quantities of heat through 1 in. of cast iron, this difference varying directly with the thickness, whilst the lower curve gives the sum of the resistances of the two surfaces to absorption and emission respectively, there being no data by which to separate these quantities. It will be seen that both these curves are almost straight lines, the upper showing the internal resistance to increase somewhat faster than the quantity of heat transferred, whilst the lower shows the surface resistance to increase more slowly.

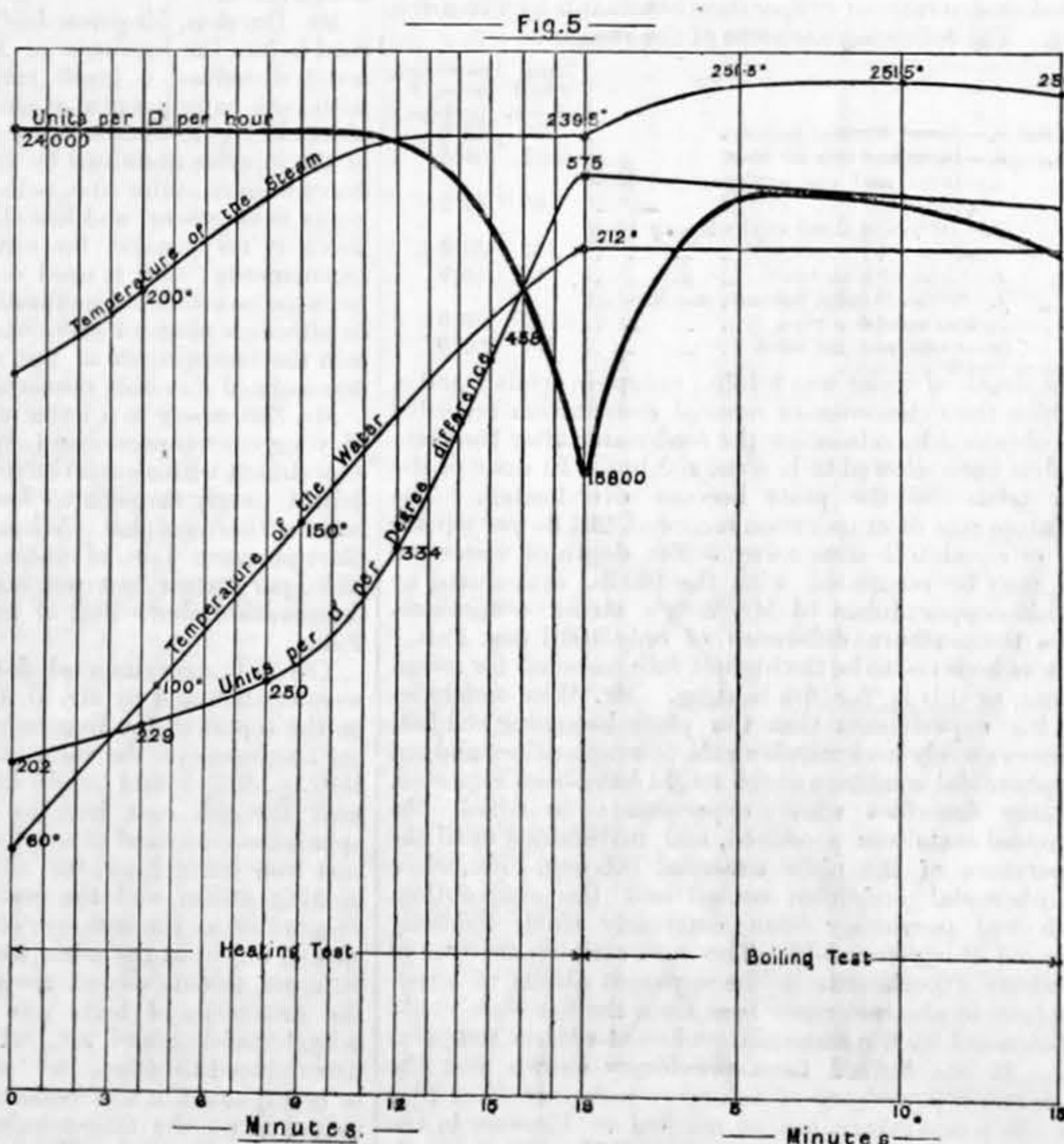
Mr. Morison's results, as will be seen from Fig. 8, vary so regularly with varying conditions, and agree so well with what was previously known on this subject, that it seems safe to accept them, and deductions from them, as at least substantially accurate for the conditions under which they were obtained, viz., transmitting steam heat through cast iron to water boiling under atmospheric pressure. Like all experiments in steam heating, however, they show a much smaller difference of temperature to suffice for the transmission of a given quantity of steam heat, than is needed for a like quantity of fire heat, judging by the recorded temperatures of plates exposed to fire heat. For example, Mr. Hirsch's very careful experiments already described, indicate that when transmitting 40,000 units, equal to evaporating 41.41 lb. per square foot per hour, the hotter side of a plate 3/16 in. thick will reach a temperature 180 deg. Fah. in excess of that of the boiling water, whilst according to Mr. Morison's data, *vide* Fig. 4, the heating steam, which would necessarily be hotter than the metal heated by it, would need to be only 95 deg. Fah. hotter than the water to produce the same rate of transmission. Assuming, as is probably true, that the difference between the conductive powers of wrought and cast iron will not account for any considerable proportion of this discrepancy, we must conclude that either there is some essential difference between the nature of steam and fire heat in this connection, or that the method of measuring the temperature of a plate exposed to fire heat, by noting the behaviour of plugs of alloy inserted in it, leads to an over estimate of the temperature attained by the plate. As regards the first alternative, it is natural to assume, in the absence of evidence to the contrary, that whatever the source of the given quantity of heat to be transmitted, the same head or difference of temperature must be needed to transmit the heat through the plate, and from the plate to the water. On this assumption there will be a constant difference between the temperature of the

water and that of the hotter side of the plate, and the only variable will be the difference required between the heating medium and the hotter side of the plate to maintain the latter at the given temperature, the amount of this difference, of course, depending on the nature of the heating medium. As regards the second alternative, there is much reason to question the assumption that the temperature of the plugs of alloy will necessarily be identical with that of the plate in which these are embedded. Mr. Hirsch's experiment with a second plate tinned to the inside of the bottom of his experimental boiler throws light on this point, as reference to Fig. 1 shows that the difference needed to transmit a given amount of heat increased by 100 to 190 deg. Fah. when this second plate was added. Only a small proportion of this increase could be due to the small additional thickness, and the experiment proves that even an intimate metallic joint offers great resistance to the passage of heat between two pieces of metal. This being so, the plugs of alloy, which were in mere contact with the plate, may well have attained a temperature considerably in excess of that of the metal surrounding them, before a balance was established between the absorption of heat by the exposed ends of the plugs and its transfer to the plate, and it seems probable that a trial would show that a plug inserted in a plate of metal having a lower melting point than itself might be fused while the plate remained uninjured. A more correct but less convenient way would be to insert the plugs in holes drilled either from the edge or from the wetted side of the plate, the orifices in the latter case being subsequently closed to



exclude the water. By the adoption of this modification the discrepancies between steam and fire heating might disappear.

Attention may be called to another way in which the use of alloy plugs may lead to an erroneous estimate



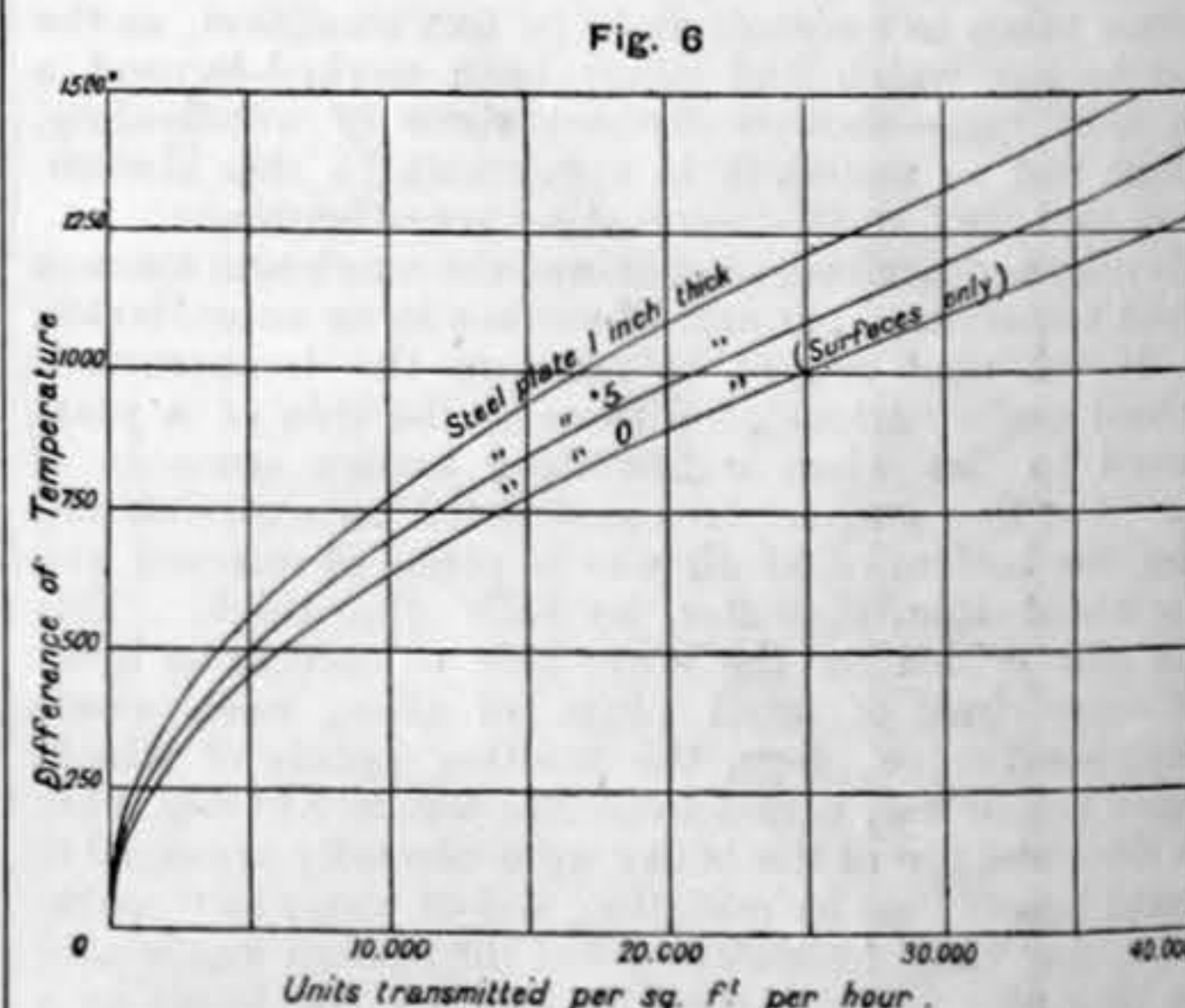
of the temperature attained by a plate during ebullition. If, as is often the case, the test should be commenced with the vessel filled with cold water, and the fire be at once raised to its full intensity, the transmission of heat will be at a minimum, and the temperature of the plate therefore at a maximum, just before ebullition commences, as at this time the cooling power of the water will have fallen off owing to its increase of temperature, whilst the rapid convection currents due to ebullition will not yet

have been established. This curious action is clearly shown in Fig. 5, which represents a heating and evaporating test made by the writer with a steam heated evaporator, and neglect of it may lead to a plug being found fused at the end of a test, which could have withstood the action of the heat when once ebullition, and the intended test, had commenced. In addition to illustrating the above point, Fig. 5 gives incidentally a complete record of the interesting changes occurring during such an experiment, and attention may be specially called to the curve giving the transmission per degree of difference. It is well known that this is less for heating than boiling, and the diagram shows how the efficiency gradually increased until the boiling point was reached. The subsequent slight falling off as ebullition proceeded, corresponds with the accumulation of air in the steam space.

In conclusion, it is believed, for the reasons given, that plug measurements as hitherto made tend to an over-estimate of the temperature, and cannot be accepted as satisfactory evidence that plates exposed to fire heat attain a higher temperature than similar plates transmitting the same amount of steam heat, particularly in the face of the strong *prima facie* reasons for expecting that the temperature would be the same in each case. Notwithstanding the comparatively very high temperatures recorded, and the considerable temperatures which at the lowest estimate must have been reached, the experiments quoted go to show that exposure to even very intense heat is insufficient to injure a sound plate of any material or thickness likely to be used in boiler practice, so long as one side is clean and in contact with water; but it should be pointed out that this might possibly not be the case if the products of intense combustion passed at a very high velocity over the heating surface. It is principally due to the high velocity the gases acquire on entering the tubes that these last suffer injury, whilst the plate surfaces of the furnace and combustion chamber, though exposed to a more intense heat, show no signs of over-heating, so long as they are free from greasy or other deposits. As regards the advantages gained by the use of the thinnest practicable tube and other plates, so ably advocated by Mr. Yarrow, there can be no doubt that such thin plates will not attain so high a temperature as thicker plates under equal conditions, and the difference, though small—the reduction being at best limited to some fraction of the head needed to overcome the internal resistance of the metal, leaving the greater surface resistances unaltered—may be just sufficient to enable them to accomplish the required duty without injury. The reduced discrepancy between the thickness of the tubes and tube-plates, aided by almost perfect design and workmanship, may also allow a certain amount of over-heating to take place without injury resulting, owing to the parts expanding and contracting together. Such expedients are perhaps the only ones available in special cases, where weight and space are strictly limited, but the margin of safety thus obtainable is perilously small, and the following seem to be the available means of increasing it, viz.: (1) Reducing the temperature of the gases to a safe limit before they reach the tubes, by increasing the proportion of heating surface they previously encounter. (2) Limiting the speed at which the gases traverse the tubes, until they have somewhat fallen in temperature. To effect this by simply enlarging the tubes throughout would involve losing the increased efficiency of transmission which accompanies a high velocity, and what seems to be wanted is a design of boiler in which the gases would pass successively through two or more series of tubes, the first having a collective cross sectional area large enough to keep the velocity within safe limits, and the last the smallest area, giving, consequently, the highest velocity practicable, in order to abstract the greatest amount of heat from the gases. The boiler of Mr. Webb's "Greater Britain" suggests itself as an example of such a design, though in it the opportunity has not been taken advantage of, both series of tubes having the same number and diameter. (3) Providing for the freer access of the water to the most intensely heated surfaces, either by enlarged passages, current plates, or by forced circulation by fans or pumps. The first and last of these suggested remedies have been applied with good results in the Navy, but the second does not seem to have been tried.

SUPPLEMENTARY.

Since the above was written, a valuable paper bearing on the subject has been read by Mr. Blechynden before



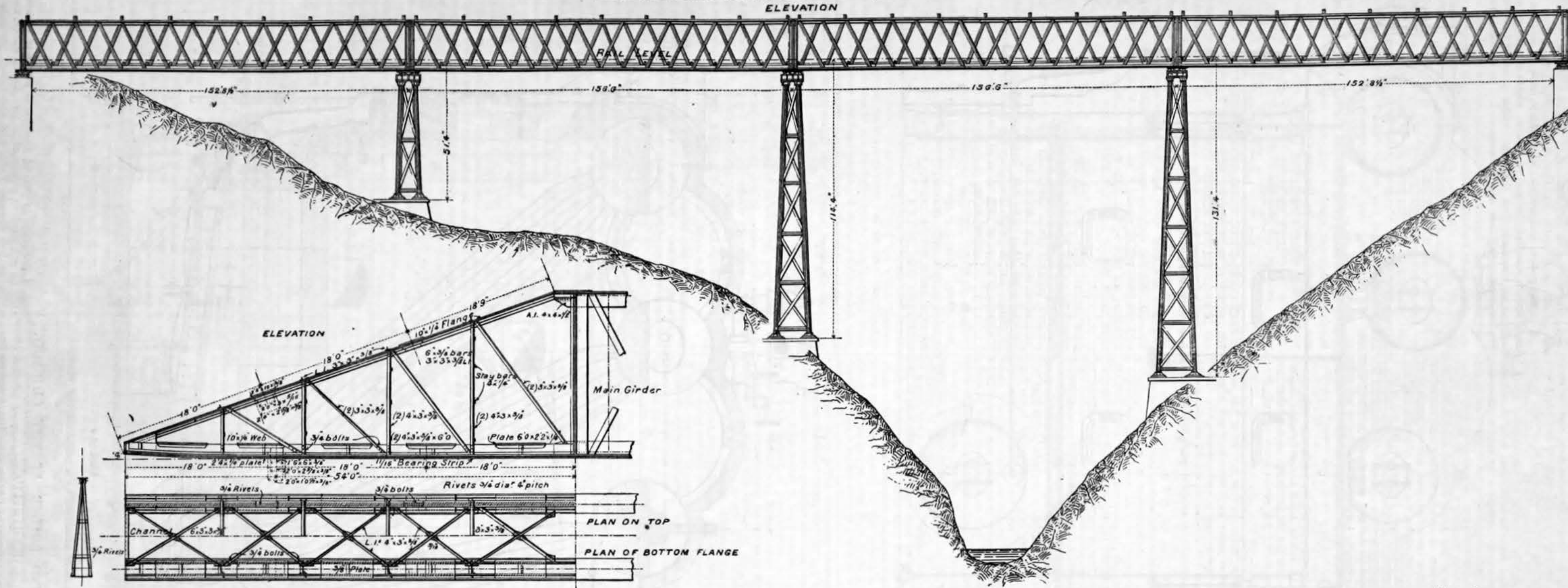
the Institution of Naval Architects at their recent meeting at Cardiff.* It describes an extensive series of experiments in heating and evaporating water under atmospheric pressure, the heat being transmitted through steel

* We complete the reprint of this paper in *extenso* on page 127.—Ed. E.

THE COSTA RICA RAILWAY—BIRRIZ VIADUCT

MESSRS. LIVESEY AND SON, MM. INST. C.E., ENGINEERS

ELEVATION



SWAIN ENG.

plates ranging from 1·1875in. to 1·125in. thick, one or both of the surfaces being in some cases machined, and in others left with the original mill scale. The heating was effected by jets of combined air and gas playing on asbestos lumps, the temperature of the hot gases being measured by the apparatus known as a "Siemens Pyrometer," i.e., a block of copper or other metal heated in the furnace and then dropped into a water pot. The results obtained show clearly that, under the conditions of the experiments, the transmission per degree of difference between the temperatures of the hot gases and the water was directly proportional to that difference, the total transmission being therefore proportional to the square of the difference. A striking feature of the tests is the large amount of heat transmitted in proportion to the difference. For example, 26,750 units were transmitted through a plate 1·1875in. thick, with a difference of only 1278 deg., corresponding with a furnace temperature of 1490 deg., and with the same plates when reduced to 1·125in. thick, 45,000 units with a difference of 1318 deg. This unusually large transmission was probably due to the surfaces having been very thoroughly cleaned, and to the absence of any sooty deposit on the fire side of the plates. Five plates were used, lettered A to E, the most complete series being with plate A, with which several tests were made at each of five different thicknesses. Taking the series of tests with this plate as fairly representative of the whole, and plotting the mean values of $H \div D^2$ for each thickness, the writer has arrived at the results shown in Fig. 6, where the upper curve gives the total difference needed to transmit given quantities of heat through a plate 1in. thick, the middle curve through a plate 5in. thick, and the lower curve through a plate of infinitely small thickness, the differences

indicated thereby being those needed to overcome the surface resistances only. The diagram, therefore, shows at a glance the gain to be obtained from a reduced thickness of plate. The deductions from these tests are not in accordance with previous data, but the tests are so numerous, and so consistent amongst themselves, that it is difficult to see where the error, if any, occurs.

BIRRIZ VIADUCT—COSTA RICA RAILWAY.

WITH this impression we continue the illustration of an important viaduct recently erected over the Birriz River on the Costa Rica Railway, a line for which Messrs. James Livesey and Son, MM. Inst. C.E., are chief engineers. A view from a photograph showing the bridge in course of erection was published in our impression of the 14th ult. The line passes through some very remarkable pieces of country, some idea of which may be gathered from our engraving, which is from a photograph. The viaduct is 618ft. 5in. between faces of abutments, and is divided into four spans; the two in the centre being 156ft. 6in. centre to centre of piers, and the two others, 152ft. 8½in. centre of pier to face of masonry; the spans of superstructure are all similar, the main girders being in each case 156ft. 3in. long over all. They are carried by three piers, 57ft. 4in., 114ft. 4in., and 131ft. 4in. in height respectively, from top of masonry pedestals to rail level; the depth from rail level to surface of water being 200ft. The piers, which are similar in construction to those in the Odil Viaduct of the Zafra Railway, are formed of four segments of pile iron riveted up with plates and distance pieces to form the four corner columns; an intermediate tee section column formed of plates and angle irons being placed transversely to sub-divide the space and reduce the span of bracing; the corner columns are stepped on cast iron base-plates secured by long holding-down bolts to the masonry pedestals and

passing through cast iron foundation girders acting as anchor plates for distributing the pull. The intermediate columns are also secured by short holding-down bolts and washer plates to the masonry pedestals. The piers are braced, both horizontally and diagonally, on all faces, as shown. The corner columns are surmounted by cast iron caps, on which the bed girders carrying the superstructure rest, and to which they are connected; these bed girders are four in number, two horizontal, and two transverse, all firmly bolted together, the transverse girders being made of sufficient strength to carry the main girders during the process of launching hereafter referred to.

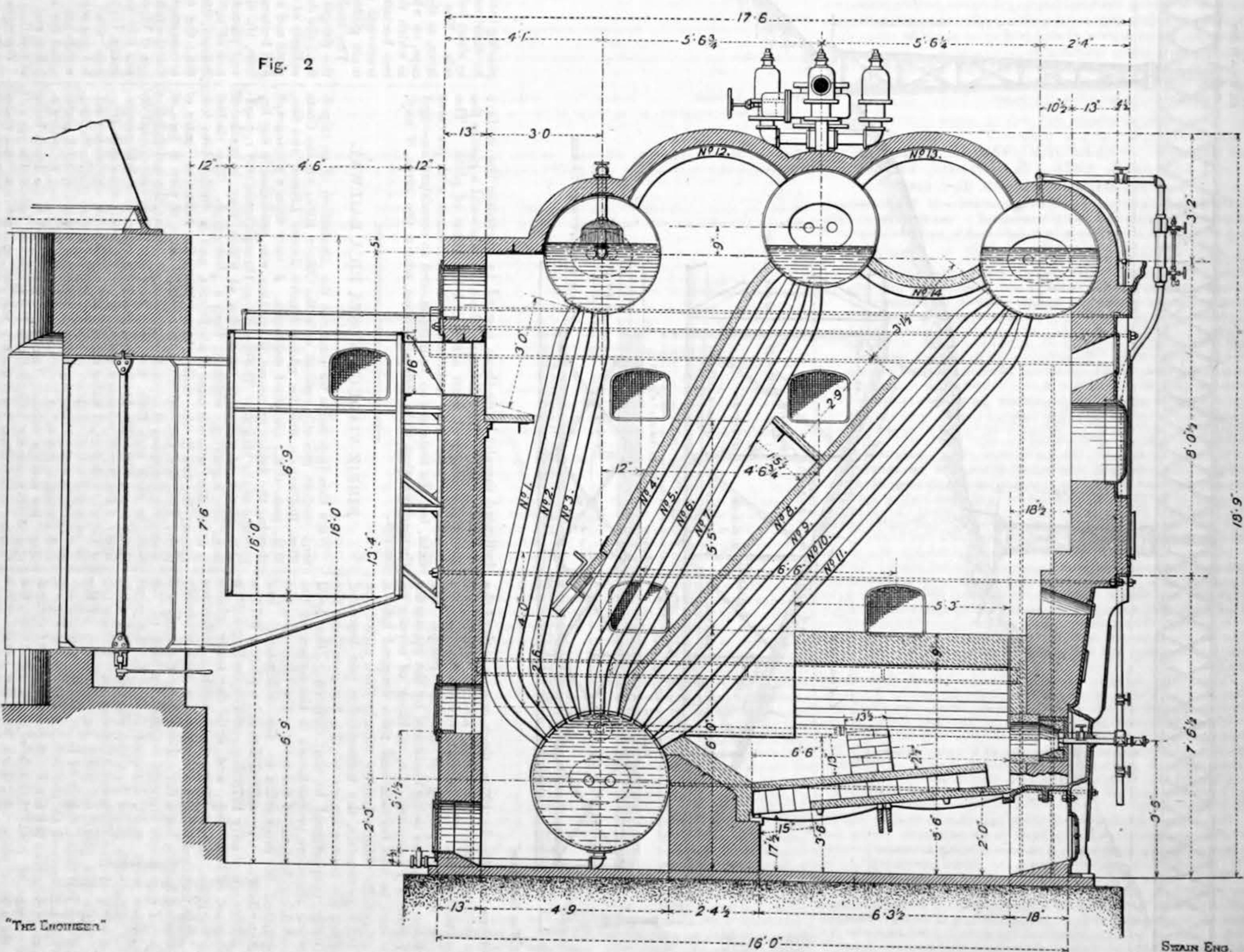
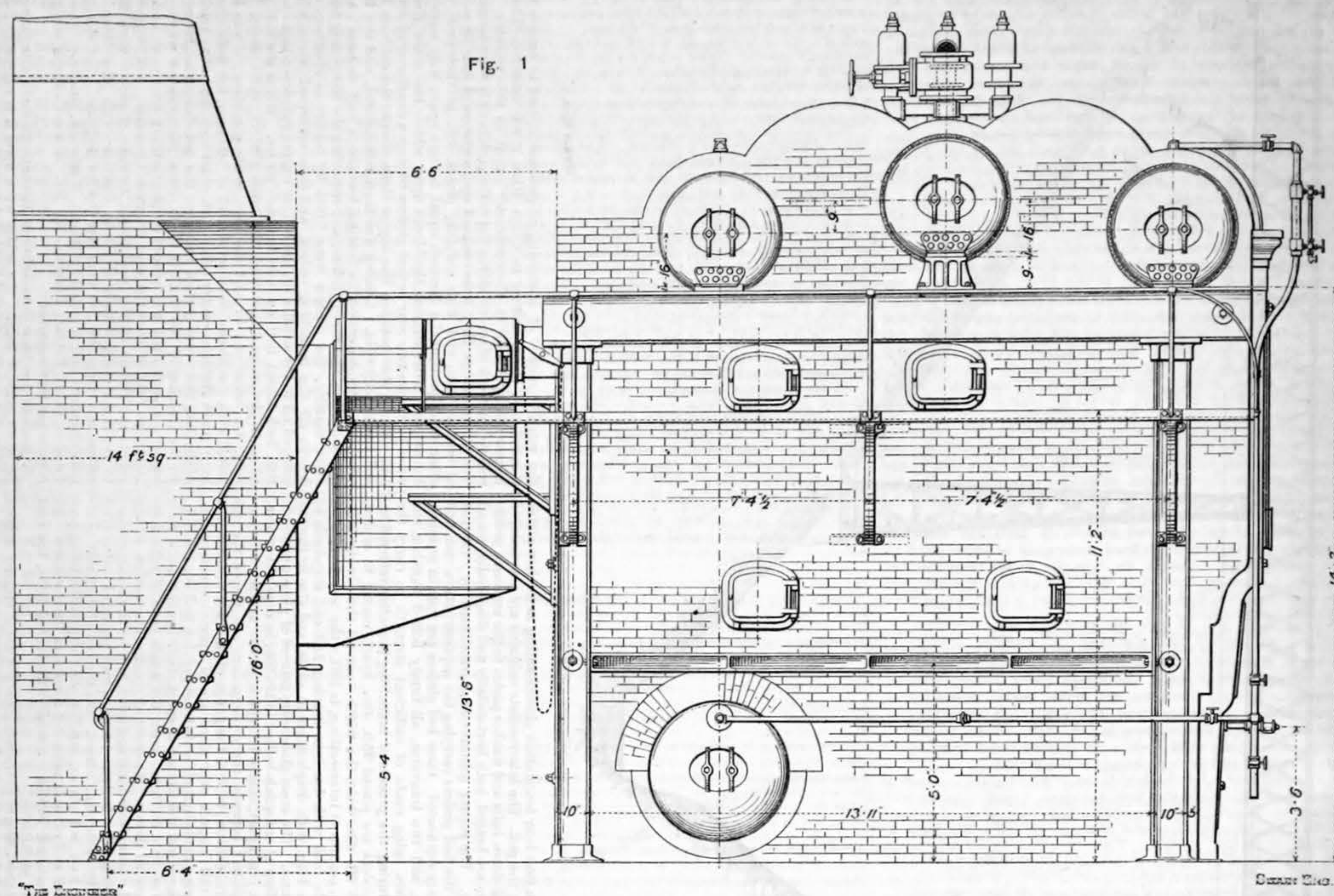
The main girders are placed 15ft. 4in. apart, centre to centre, the flanges are 2ft. 4in. wide, the width over all thus being 17ft. 8in.; the depth, centres of intersections, is 19ft.; the web is formed entirely of angle iron with bar iron bracing, and end standards of plate and angle iron, with diaphragms in same, and also in the top and bottom booms. The cross girders are formed of plate and angle iron, 1ft. 3in. deep at ends, fish-bellied to 1ft. 9in. in depth at centre, and placed 9ft. 6in. apart, centre to centre, or one at each intersection of main girder; between the cross-girders are placed the rail bearers, 3ft. 8½in. centres, to suit the gauge of railway, which is 3ft. 6in.; the end rail bearers over piers are of special construction, arrangement being made in their ends for expansion and contraction. On the rail bearers rest the timber sleepers, 9in. by 4½in., the rails are of Vignoles section, 50 lb. per yard, the whole secured with bolts and clip washers as shown. At every alternate intersection in top boom, is placed a transverse bracing girder, and between same angle iron wind bracing; the bottom boom is also provided with wind bracing secured by connecting plates. On the bed girders and abutments are cast iron bed plates, saddles, &c.; expansion being provided for at one end of each span by means of steel rollers. All joints and connections, *in situ* are made with turned bolts, the cost of riveting being prohibitive.

Owing to the great height of the viaduct, the use of staging or false work was out of the question. It was, therefore, decided to erect

the work by means of launching or protrusion, and to ensure that there should be no failure in Costa Rica, it was determined to rehearse the operation in the contractor's yard in this country. To relieve the work of undue strain the main girders only were launched over the openings, they were coupled up in groups of four by means of bracing rods, and with coupling plates, &c., at their ends, and after being protruded a distance equal to one span, they were disconnected. After striking the blocks upon which the main girders were built, the two rear or end girders became a cantilever of 156ft., and when in that position the sag or deflection at the extreme tail-end was exactly 6½in.; hauling was then commenced, and the time occupied, after deduction for fleeting, was about half an hour; after disconnecting the main girders, and removing the temporary transverse bracing, the girders were lifted by means of spanners and screws off the launching rollers, and then traversed laterally and lowered on to the saddles on the bed or capping girders; this operation took about half an hour for each girder. When the first pair of main girders was traversed, the cross girders, rail-bearers, bracing, &c., were put in and the span made complete; it was then tested with a uniform distributed load of 162 tons, the deflection of each main girder at centre being 1½th of an inch, and after removal of the load there was perfect recovery, the permanent set being nil. In the erection of the work in Costa Rica, the crab by which the hauling was effected was placed on the farthest abutment, and the steel wire carried over the rope intervening spaces. Still further to relieve the girders during protrusion, temporary prows were fitted to the nose ends, details of these, together with the launching rollers, traversers, &c., we shall give in a future issue. The work was manufactured and supplied by Messrs. Westwood, Baillie, and Co., of London Yard, Poplar, London, E., Mr. Minor C. Keith being the contractor for the railway.

Although the new line between Reventazon and Cartago is only fifty-two miles in length, the bridge work upon it is extremely heavy and varied, the total weight shipped from this country being about

THE STIRLING WATER-TUBE BOILER AT THE CHICAGO EXHIBITION



3500 tons, the whole of which, including the subject of our notice, was constructed from designs made to the instructions of Messrs. Livesey and Son, by Mr. Jonathan Packman, M.I.C.E., who also superintended the manufacture. We shall publish further engravings next week.

THE STIRLING BOILER AT THE CHICAGO EXHIBITION.

THE Stirling boiler, made at Barberton, Ohio, takes an important share in the work of supplying steam to the

Machinery Hall. Of these there are six boilers, set in pairs, each of 400-horse power, or 2400-horse power in all; that is, with an evaporative power of 72,000 lb. of water, the feed taken at 200 degrees Fah., and the steam pressure being 125 lb. per square inch.

Fig. 1 gives an outside side elevation, and Fig. 2 is a sectional side elevation of one battery of these boilers. This latter shows the construction most clearly. It may be seen that the general design is modelled very much after that of Thornycroft's water-tube boiler, it being a sort of triplicate of the one-half of the Thornycroft boiler. Three stacks of tubes slope upwards and forwards, two of which deliver the circulation streams of mixed water and steam into two of the three overhead drums, and the third of which serves to carry the downflow from the third drum placed at the back of the setting. A partition of firebrick rests on the upper side of the first stack of tubes, so as to be continuous from the lower drum to within 3ft. of the upper drum. A similar partition stretches downwards from the second steam drum to within 3ft. of the lower drum. Thus the flame first ascends through the front tube stack, is then led downwards through the second, and finally rises round about the third or cool-water downflow. The water in this rear set of tubes is cooler, not only because it stands in the tail end of the flow of the hot gases, but also because the feed is supplied to the drum at its head. It may be noted that there are cross baffle-plates of brickwork to insure that the gas flow plays through the spaces occupied by the tubes. The gases are led off near the top of the back wall of the setting, and pass through a feed-water heater placed at the rear on their way to the chimney. Four of these boilers stand together in the main boiler range, and these four are served by one chimney 7ft. in diameter, and 110ft. high above the grate.

The section shows the arrangement of oil-burner, which is of the "Burton" type. The furnace front is double, the inner front being lined with firebrick, and the whole of the burner, except the extreme point of the nozzle, being kept cool. The jet delivers into an expanding cone 18in. long, and lined with hard refractory brick. Beyond this is a large combustion chamber, roofed by a brick arch, and closed at bottom by a double brick floor resting on firebars. The air for combustion is heated as it passes in between the two floors. A mass of brickwork 28in. thick forms the rear wall to this chamber, and protects the large bottom drum from the full furnace heat.

All the four drums are 16ft. 4in. long. The lower or mud drum is 3ft. 6in. in diameter, while each of the steam drums is 3ft. in diameter. The steam drums are cross-connected by two series of bent tubes, the upper series making a steam connection, while the lower row makes the water connection necessary for the circulation. The water connection between the second and third drums is not shown in the section, it being made only at the sides or ends in order to protect it from heating and thus promote the circulation.

The number of downflow tubes from the third drum is comparatively small, the flow being of "solid" water, and, therefore, of small bulk as contrasted with that of the up-flowing mixture of water and steam. All the tubes have an outside diameter of 3in. There are 308 tubes connecting top and bottom drums, their average length being 13ft., while there are 54 horizontal tubes making the top cross connections, these having an average length of 4ft. 3in. This makes a total tube surface of nearly 3200 square feet, and the drum surfaces make up the total heating surface to 4000 square feet, or 10 square feet per horse-power. The tube joints in the drums are roller-expanded and project inwards 3ft. 8in., without, however, being beaded over.

Two pop safety valves, made by the Chicago "Scott" Valve Company, are placed on the central drum of each boiler, and the steam is collected from the same drum.

ON RECENT DEVELOPMENTS IN THE CLEVELAND IRON AND STEEL INDUSTRIES.

By Mr. JEREMIAH HEAD, M. Inst. C.E.*

THE twenty-two years which have elapsed since the inhabitants of this town and district had the honour of a visit from the Institution of Mechanical Engineers have produced so many developments in the industries of Cleveland that it would be quite impossible, within reasonable time, to deal with more than a small selection of them. The Cleveland iron industry, of which the town of Middlesbrough may be regarded as the centre, owes its rise and progress to three natural advantages, namely:—First, the existence in the Cleveland hills of ironstone of sufficient purity and in sufficient quantity for profitable working; secondly, the proximity of the sea, and of an excellent navigable river affording means of communication therewith; thirdly, the existence, at an average distance of say twenty-five miles, of the well-known Durham coalfield, which yields some of the best fuel in the world. Until these natural advantages were recognised and developed by Messrs. Bolckow and Vaughan and other pioneers, the trade of Cleveland was practically confined to agriculture. It might have remained so indefinitely, but for the opening of the Stockton and Darlington Railway in 1825, and its subsequent extension to Bishop Auckland and Middlesbrough. The new iron road afforded easy and cheap means of bringing together fuel, ore, and fluxes, and facilitating their conversion into the then much-needed rails and other railway material. Mr. Head next dealt with the origin and growth of Cleveland iron and steel industries, and gave an interesting and useful glance through the main statistics of the subject.

Ironstone mining.—In Cleveland ironstone mining, one of the principal improvements that have been effected during the last twenty years, is in the mode of drilling the holes into which the explosives are placed for blasting the stone. In 1871 these holes were made by the use of jumpers driven by men working singly or in couples. The average quantity of stone so obtained was from four to six tons per man per eight hours, including drilling, blasting, breaking, and filling, and the cost varied from 10d. to 1s. per ton.

Drills.—The machine drills now in use are of four kinds, namely:—(1) The hydraulic turbine drill, devised by Mr. A. L. Stevenson, and in use at the Lumpsey Mine, near Saltburn, belonging to Messrs. Bell Brothers. (2) The drill driven by the Priestman petroleum engine. This also was first introduced by Mr. A. L. Stevenson, and is to be seen at the same mine. (3) The pneumatic drill, perfected by Mr. William Walker, of Saltburn, and applied at the North Skelton and other mines. (4) The electric drill, recently adapted and used at the Carlin How Mine by Mr. A. L. Stevenson.

The principle adopted in all these four cases is that of rapidly rotating an auger-shaped drill, fixed in an adjustable frame, and supported upon a bogie which is capable of being advanced towards the working face and withdrawn, as found necessary. The hydraulic turbine drill is driven by water at a pressure of 140 lb. per square inch, obtained from a feeder tubbed back in the shaft, and brought to the machine by suitable piping. For the pneumatic drill, air at a pressure of 55 lb. per square inch is similarly brought from a reservoir and compressors at the surface. Whatever be the motor, the rapidity of drilling depends on the amount of power applied and the energy and expertness of the men in pushing forward the work. The hydraulic drill has the advantage that the requisite motive power is obtained at the mere cost of pumping up to the surface the water exhausted by the turbine. The petroleum

drill has the advantage that neither air nor water supply pipes are needed; and the pneumatic drill, that it assists the ventilation. A pneumatic drill attended by sixteen men will obtain from 800 to 1050 tons of ironstone per week of forty-five hours, which is equal to an average production of 10½ tons per man per shift of eight hours, or about twice the weight obtained by hand jumpers. The cost of getting is from 8d. to 10d. per ton, or about 2d. per ton less than formerly. These machines are capable of drilling a 1½in. hole 4ft. to 4½ft. deep in about a minute. In practice eighty to eighty-five holes are drilled in eight hours. As the electric drill forms the subject of a separate paper by Mr. Stevenson, it will not be necessary to say anything further about it here.

The hand ratchet drill, manufactured by the Hardy Pick Company, of Sheffield, takes a position intermediate between the old jumpers and the machine drills, and is well worthy of notice. It has of late been brought into use in several of the Cleveland mines. It is cheap in first cost, and easy to fix, especially in awkward positions where no other tool would be applicable. No complications in the way of pipes or conductors are required, nor any fuel supplies. Mr. William Charlton, engineer at Sir B. Samuelson and Co.'s Slapewath mines, has made some improvements in the details, and by aid of these nearly as much stone per man per shift can be obtained as with machine drills proper. The North Skelton, the deepest of the Cleveland mines, extends to 120 fathoms below the surface. Nevertheless, there is no great quantity of water below to contend with, 100 gallons per minute being about the average. For ventilation the Guibal fan is the one generally preferred. The largest, namely, that at Eston, is 40ft. in diameter by 12ft. broad, and delivers from 120,000 to 140,000 cubic feet per minute.

At the Cleveland mines the "Main seam," namely, the first opened out by Mr. John Vaughan, which is from 10ft. to 16ft. thick, is the only one worked at present. There are other seams above and below, but they are much thinner. The proportion of metallic iron in the raw stone varies from about 26·5 to 31·75 per cent. The general average may be taken at about 28·5 per cent. When calcined the ore yields from 38·0 to 43·5 per cent. of metallic iron, or about 40 per cent. on the average. The phosphorus in the raw stone varies from 0·4 to 0·8 per cent., averaging about 0·6. The sulphur averages 0·12 per cent. The duration of the best deposits is estimated at from fifty to sixty years. The quantity of inferior stone is as yet undetermined, but is no doubt very large.

Blast furnaces.—Since 1871 no great change has been made in the size, form, or performance of the then best designed blast furnaces using the best materials; but much better average results have been obtained than those named by Mr. Whitwell in 1878. The best performance which has come to my knowledge as regards any furnace on Cleveland iron is that obtained by Messrs. Cochrane and Co. at their Ormesby Ironworks. One of their furnaces, 90ft. high by 23ft. bosh and 10ft. hearth, is producing on the average 700 tons of pig iron per week. Two others, 90ft. high by 23ft. bosh and 10ft. hearth, produce each an average of 825 tons. In one particular week no less than 949 tons was obtained from one of these furnaces; which, as regards cubic capacity, are the largest in Cleveland—and perhaps in the world. The effect of the internal shape of blast furnaces upon their power of production has lately been engaging the consideration of Mr. William Hawdon and Mr. Richard Howson, of the Newport Ironworks. They propose to alter the internal form in such a way that the materials shall be sustained in the upper part of the furnace, where they are as yet in a solid and open condition; while lower down the internal form will be such that the charge shall be able to descend more freely than at present, and shall thus become more permeable to the blast. One of the Newport furnaces working on Cleveland ironstone has been altered on this principle, with the result that an increase in output of from 30 to 50 per cent. has been obtained, together with a higher average grade of iron, and some saving in coke.

Hot-blast stoves.—The increased average output per furnace working on Cleveland ironstone, and the lessened consumption of fuel—where the best qualities are used—seem to be largely due to the higher temperature of blast rendered possible by the adoption of fire-brick instead of pipe stoves. In 1871 the only fire-brick stoves in the district were those devised by the late Mr. Edward A. Cowper, past-president, at the works of Messrs. Cochrane and Co., who, acting under the advice of Mr. Charles Cochrane, past-president, led the way in this great improvement; those at the works of Messrs. William Whitwell and Co., of Thornaby, who adopted their own particular type in 1869; and those at Consett, which, being erected under the supervision of the late Mr. Thomas Whitwell, were of the same kind. At the present time fire-brick stoves are almost universal, there being only two works without them. At first they were made 28ft. high by 22ft. diameter, and two were thought sufficient for one furnace. Now they are made 60ft. to 80ft. high by 22ft. to 26ft. diameter, and three, four, and even five are worked to a furnace. The temperature of the blast has risen from an average of 850 deg. Fah. to about 1450 deg. Fah.; and the pressure from an average of 3½ lb. per square inch to 5½ lb. in Cleveland, and 6½ lb. in hematite furnaces, and even higher.

Blowing engines.—Wherever hematite came to be substituted for local ores, the furnace gases were found to be of much poorer quality, owing mainly to their dilution by the steam from the water mechanically and chemically combined in that class of ore. Consequently where hematite ore is smelted, steam must now be economised, if it be desired to avoid the use of extra fuel at the boilers. Inasmuch, also, as all feed-water used in Teeside works is pumped from the river at Darlington, and paid for by meter at 3d. per one thousand gallons, the saving of water as far as possible is a consideration, as well as the saving of fuel. The methods which have been recently adopted for economising in blast engines are three: namely, feed-heating, condensing, and compounding. A very complete example of all three methods is afforded by the new plant at Messrs. Cochrane and Co.'s works. Three non-condensing blast engines exhaust into one common main. From this, steam is taken by a fourth engine, which exhausts into a surface condenser. The circulating water for the condenser is drawn from and returned to the river. From the exhaust main a portion of the remaining steam passes into a series of Berryman evaporator condensers, in which it is condensed, and becomes again available as feed-water. In its condensation it gives up its latent heat to the circulating water, which is from the Darlington mains; and from this it distils a sufficient quantity of feed-water to make up all waste. The exhaust steam, however, would soon heat up the circulating water to its own temperature of about 212 deg. Fah., and further condensation would thereupon cease, were it not for another expedient. The space above the circulating water is connected by a pipe with another Berryman condenser, cooled by river water, and beyond this with an air pump. Thus the Darlington circulating water is under a vacuum, and consequently evaporates at a correspondingly low temperature; it is therefore able to condense steam at atmospheric pressure, and to become itself gradually distilled. In this way, out of the 75,000 gallons per twenty-four hours evaporated by the boilers, only 12,500 gallons, or say one-sixth of the total, has to be supplied and paid for anew. The feed-water thus obtained is forced through a series of Edmiston filters to free it from grease and other impurities, then through another Berryman heater, utilising the remainder of the steam from the exhaust main, and so into the boilers. The pressure in the exhaust main varies from 2 lb. or 3 lb. below to 2 lb. or 3 lb. above the atmosphere. The temperature of the feed as it enters the pumps is 110 deg. Fah., and as it enters the boilers 210 deg. Fah.

Another application of compounding and condensing to blast-engines is that recently carried out at Sir B. Samuelson and Co.'s works by Mr. T. Westgarth, under the direction of Messrs. Hawdon and Howson. Of four non-condensing blowing engines of usual construction, one remains untouched; a second has had a jet condenser and air-pump fitted; the third and fourth have been compounded by the addition of extra cylinders, and have had similar condensers added. The condensing water is separately pumped from and returned to the river, a water tower intervening. The amount

of economy obtained has not yet been accurately determined; but Mr. Westgarth claims that one boiler in six has been dispensed with, without diminishing the output of pig iron, and without using any fuel specially for evaporation. At the Skinninggrove Ironworks two blowing engines work together, forming one compound jet-condensing engine, but they can be used separately if necessary. Messrs. W. Whitwell and Co. have a simple jet-condensing blowing engine, and there is one with a Morton's ejector at the Cargo Fleet Ironworks. All others in the district are simple non-condensing engines.

Boilers.—As regards blast-furnace boilers, in 1871 they were almost exclusively of the plain cylindrical type, 80ft. long by 4ft. to 5ft. diameter, and rigidly supported. These were found to strain themselves at every change of temperature, and to be far from safe. In some cases they were cut in two in the middle of their length, and connected by a short pipe. In others they were hung on volute springs on the plan suggested by the author. The elephant type first introduced by Mr. Charles Wood was substituted at the Tees Ironworks, and also to some extent at the Thornaby Works, with good results. The Howard boilers at the Lackenby Works were found unsafe, and others of the Lancashire type were substituted. Messrs. Cochrane and Co. still work Root's boilers, and have done so for eighteen years; but their use has not extended further. Only the purest water can be used; they are expensive to keep up, and require extra attention on account of the fluctuations due to the small body of water contained in the tubes. They also require some coal to be always burning as a wick for keeping alight the entering gases. The favourite boiler for furnace plants is now the three-flued Beeley boiler, which is a simple, compact, and efficient steam raiser. In boilers of all kinds the material used, the mode of construction and mounting, and the fittings have been greatly improved during the last twenty years.

Comparison with American blast furnaces.—On the occasion of the visit of the members of the Iron and Steel Institute to America in 1890, most engineers and ironmasters from this district were deeply impressed by the enormous outputs obtained per furnace at some of the American smelting works. This was found to be due in a large measure to the use of exceedingly rich ores; but that did not altogether account for the observed results. Mr. James Gayley, one of Mr. Carnegie's managers, has since published the performance of the Edgar Thomson furnace "I" during January, 1892. This furnace is 90ft. high by 21ft. bosh and 12ft. hearth, and has a capacity of about 23,000 cubic feet. The make during the month was 12,706 tons, the average yield of the ore 61 per cent., the fuel consumption 1700 lb., or about 15 cwt. per ton of pig iron, the best week's work 3005 tons, the best day's work 511 tons, the temperature of blast 1200 deg. Fah., and the pressure 10½ lb. per square inch. The volume of air delivered by the blowing engine was 27,000 cubic feet per minute, which is 1175 cubic feet per 1000 cubic feet capacity, or from three to four and a-half times what is usual in Cleveland. As regards the advantage obtained by richer ore, that is clearly unattainable here if local ores only are used. As regards difference in practice, the most noteworthy thing is the enormously greater quantity of air passed through the American furnace than is customary here, and the higher pressure of blast which has to be maintained for enabling it to penetrate the charge. The circumstance that the maximum American output exceeds the Cleveland maximum in about the same proportion as the air passed through per 1000 cubic feet of capacity seems in some measure to explain these wonderful results. Although the American practice of forcing furnaces, with the consequent rapid destruction of linings, has not found favour generally in Cleveland, still it has raised much discussion and indicated various lines of progress for the future. In America great stress is laid upon large blowing power, and upon blowing every furnace from a separate engine or engines, independently of any others. The quantity of air entering a furnace is regulated by the number of revolutions per minute which the engines make, without regard to the blast pressure obtained. The engines are indeed used as air meters as well as air pumps. Each one is provided with a governor, which keeps it approximately at a uniform speed, however much the resistance may vary. An ingenious centrifugal speed recorder by Mr. Edward Brown, of Philadelphia, is employed as a check, and has since been introduced here by Messrs. William Whitwell and Co. One of Messrs. Cochrane and Co.'s furnaces, which has just been re-lined, lasted eighteen years, and served for 500,000 tons of pig iron. The American highly-forced furnaces require re-lining in two or three years, which would scarcely admit of such a production as this per lining.

Slag disposal.—In 1871 little had been done in the way of utilising any of the slag made in Cleveland, which now amounts to 3½ million tons annually. Various unsightly mountains were being piled up on land dearly purchased for the purpose. By means of Mr. Hawdon's plant, which is being extensively adopted, the removal and loading of the slag goes on continuously and automatically at a cost of about 1·3d. per ton of slag removed, or 2·8d. per ton of pig iron. Slag wool, with the invention of which Mr. Charles Wood's name has always been associated, is still manufactured under his supervision at Messrs. Wilsons, Pease, and Co.'s works on a considerable scale. It is produced by blowing jets of steam across fine streams of molten slag as they issue from the furnace. The total quantity produced at the Tees Ironworks exceeds 1000 tons per annum.

Paving blocks.—About twenty years ago it was discovered by Mr. Woodward that blast-furnace slag run into an iron mould and then annealed would make an exceedingly hard and tough block suitable for road paving, and much cheaper than sets of granite or other natural stone. The manufacture of these blocks is now carried on at three of the Cleveland smelting works, by the Tees Scoriae Brick Company, and has become one of the staple industries of the district. Some only of the slag as it comes from the furnace is of suitable quality; and therefore the selected produce of five furnaces is required to produce a daily average of about 10,000 blocks. The total produce of the district is at present about 100,000 blocks per week, of a value of about 13s. per ton, or 75s. per 1000 blocks of ordinary size. The process of manufacture is as follows:—The slag, when coming from the furnace of suitable quality, is run into a bogie ladle. From this it is poured into cast iron moulds secured to the periphery of a horizontal wheel. Each mould has a hinged bottom. The wheel is slowly rotated, and the bottoms of the moulds are released in succession. The blocks, molten inside but chilled and solid at the surface, drop upon a soft bed of granulated slag, and are quickly removed and stacked in an annealing stove. When full, the doors of the stove are closed, and the blocks are allowed to anneal themselves without any extraneous heat. In about eight hours the doors are opened, and the blocks gradually withdrawn. They are then fit for use. Without annealing they would soon crumble to pieces from internal stresses. The waste, owing to unsuitable slag and other difficulties, averages 30 per cent. of those cast. About twenty different sizes and shapes are made to suit customers' requirements. The blocks are in great demand for street paving, not only locally, but also in many foreign towns where they can be cheaply conveyed by water. They find their way even to Canada. The cost of paving with them, exclusive of labour and freight, varies from 2s. to 3s. 7d. per square yard.

(To be continued.)

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Chief Engineers: Frederick W. Wells, to the Victory, for the Barrosa, and Walter J. Featherston, to the Pembroke, for the Circe, to date May 7th; William F. Stewart, to the Sandfly, to date June 1st; Edwin J. Austen, to the Widgeon, to date June 10th; Edwin C. Carnot, to the Victory, additional, for drawing office, to date June 23rd; and John E. Johnson, to the Pembroke, for the Gossamer, to date July 1st. James E. D. Graham, to the Hydra, and William J. Brown, to the Charybdis, to date July 28th.

* Abstract of paper read before the Institute of Mechanical Engineers at Middlesbrough.

POWER STATION, ELECTRICAL OVERHEAD RAILWAY—CHICAGO EXHIBITION

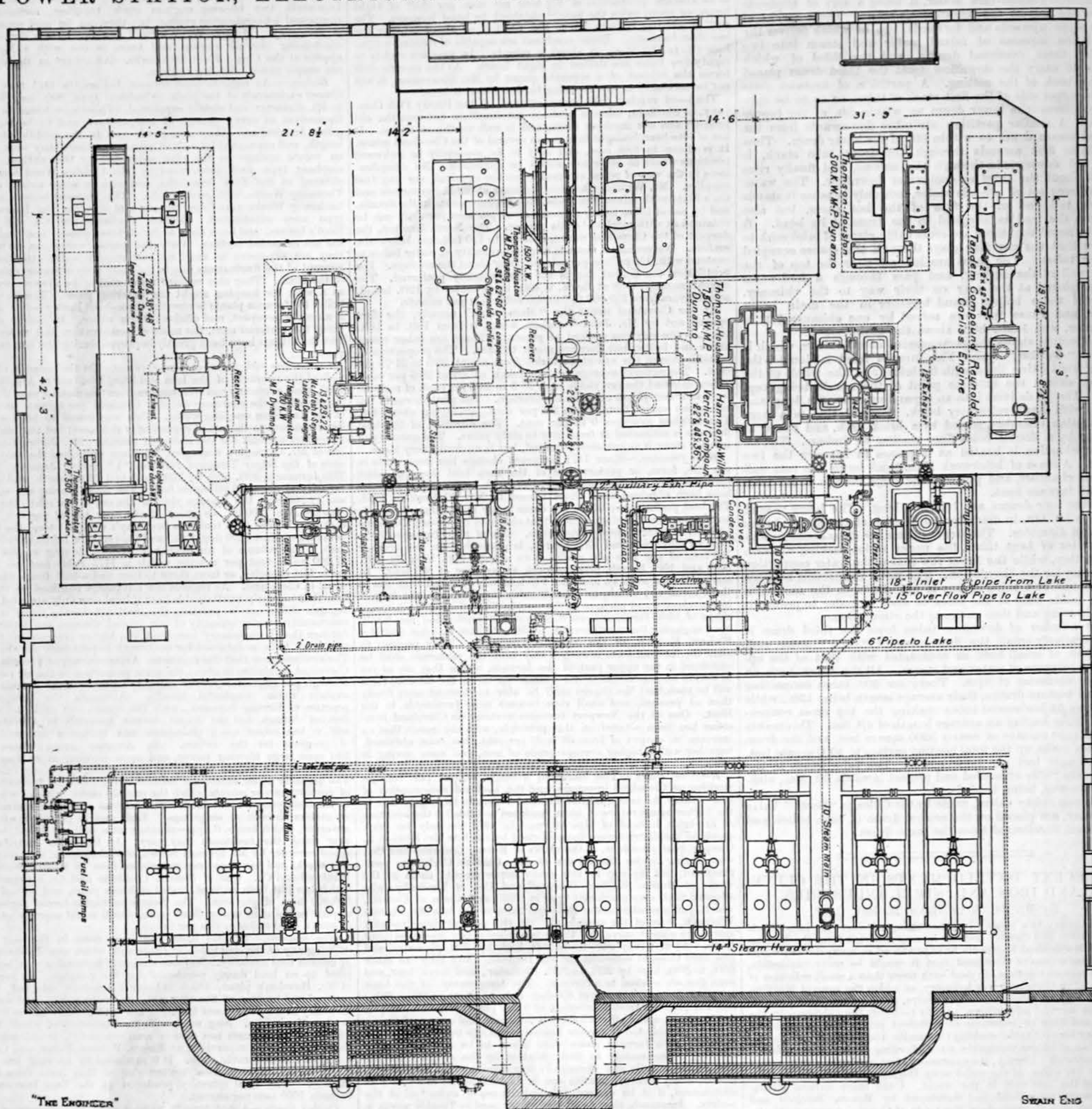


Fig. 1—GENERAL PLAN OF MACHINERY AND PLANT IN THE INTRAMURAL RAILWAY POWER STATION

ELECTRICAL ENGINEERING AT THE CHICAGO EXHIBITION.

(From our Special Commissioner.)

CHICAGO, JUNE 30TH, 1893.

On referring to the plans of Jackson Park published upon page 376 of your issue of the 28th of October, 1892, your readers will be able to note the course of the Intramural Railway. This is an elevated railway worked solely by electricity, and resembles the Liverpool Railway to a great extent. I am now in a position to describe the power station of this railway, and by the courtesy of Mr. B. J. Arnold, consulting engineer of the General Electric Company, I am able to send plans and elevations of the station, showing the general arrangement of the plant. In order to give a good idea of the various types of engines and dynamos installed in the building, I have had three special photographs made, so that I believe a person who is unable to personally visit the Exhibition will have a fair general idea of the power station, which is at the extreme south-east corner of Jackson Park. The road was constructed by the Western Dummy Railroad Company, and on completion was handed over to the Columbian Intramural Railway Company for operation, and Messrs. Remington and Co. built the superstructure of the line, which consists of three and a-half miles of double-track, and also the stations. The officers of the Columbian Intramural Railway are: President, B. E. Sunny; secretary, E. C. Ward; general manager, W. E. Baker; and the engineering staff consists of Messrs. R. J. Sloan, G. K. Wheeler, and B. J. Arnold, consulting engineers; Mr. G. P. Matlack, chief engineer; and Mr. C. H. Macloskie, electrical engineer. The Power-station Building is distant about 200ft. from the lake, and about 100ft. from the main oil tanks and the pumping station which supply the whole of the steam plant in the Exhibition grounds with liquid fuel brought through a pipe line

from the oil wells of Ohio. In Fig. 1 above, I give a plan of the building showing the general arrangement, but at the time of my visit, June 28th, much work still remained to be done. The building itself is constructed of wood framing covered with staff, except the wall at the back near the boilers and the chimney, which is built of brick. The timbers have been cut as little as possible, so that they may be of use after the Exhibition is over. In Fig. 2, page 118, I give a cross section and also a longitudinal section of the station, from which the general arrangements will be gathered. The building consists of the main structure for the steam engines and dynamos, and of an annex for the boilers; the former is 140ft. long by 80ft. wide, and 25ft. high from floor line to the lower side of the trusses; the floor itself is 10ft. above the ground line, and the basement is used as store-rooms and offices. The roof of the engine-house is carried upon wooden trusses, having a span of 80ft., and spaced at distances of 15ft. from centre to centre, and supported at each end by pine posts, 12in. by 12in., which are themselves carried upon a base formed of timber, 8in. by 8in., resting upon a double layer of planks 12in. by 4in., the two layers being laid with the planks at right angles to one another. The roof of the engine-house consists of corrugated galvanised iron fixed upon pine matchboarding. The roof of the boiler-house is nearly flat, and of a form very common in Chicago. It is supported upon eight trusses, each consisting of a wooden beam stiffened by two cast iron struts and tie bars. The actual roof covering consists of three layers of tarred roofing paper covered with tar and gravel. The framing of the walls of the whole building is covered with grooved pine lathing, and coated inside and out with diamond plaster, which dries hard, smooth, and white. The method of forming the foundations is of interest. It must be borne in mind that the whole of Jackson Park is somewhat like a sea shore; there is a great depth of very loose sand, and it

resembles the site upon which the Amsterdam Exhibition was built. Under these circumstances it is probable that piling is far the best for permanent structures, but the expense would have been very serious. It was therefore decided to excavate the sand to a depth of 3ft. 6in., which is below the frost line. At this depth a flat surface was obtained of such a nature that if a hole were dug it would be speedily filled with sand and water. Upon this bed were laid two layers of hemlock planks, 12in. by 8in., placed at right angles to one another, and thoroughly well spiked together. This formed a kind of platform which supported the whole superstructure. Upon this planking a concrete block, 180ft. long by 60ft. wide and 3ft. deep was built. The concrete consisted of one part of Portland cement and four parts of sand obtained at the site, and four parts of broken limestone, thoroughly well mixed, and rammed in position. As will be seen from the section, page 115, the upper surface of this block is level with the original ground line, and I understand that the total load upon the subsoil is 700 lb. per square foot. No special tests were made upon the site itself, as the whole soil upon which Chicago is built is of the same nature, and sufficient data had been already obtained for architects' practice in building the fourteen and fifteen-storey buildings which are here so common. Recent tests made by the surveyors have shown that after all the plant was in position there was no visible settlement of the foundations. Upon the top of the large concrete blocks are built the foundations for the separate engines. These blocks are 10ft. high, made of brick set in cement mortar consisting of one part of American Portland cement to three parts of sand. The separate weights have been well distributed over the foundations; the largest engine is placed in the centre, and of the next two one is placed at each end. The flooring in the engine-house is level with the top of the brick foundations, and when the basement is completed visitors will be able to

COMPOUND REYNOLDS-CORLISS ENGINE AND DYNAMO, CHICAGO EXHIBITION

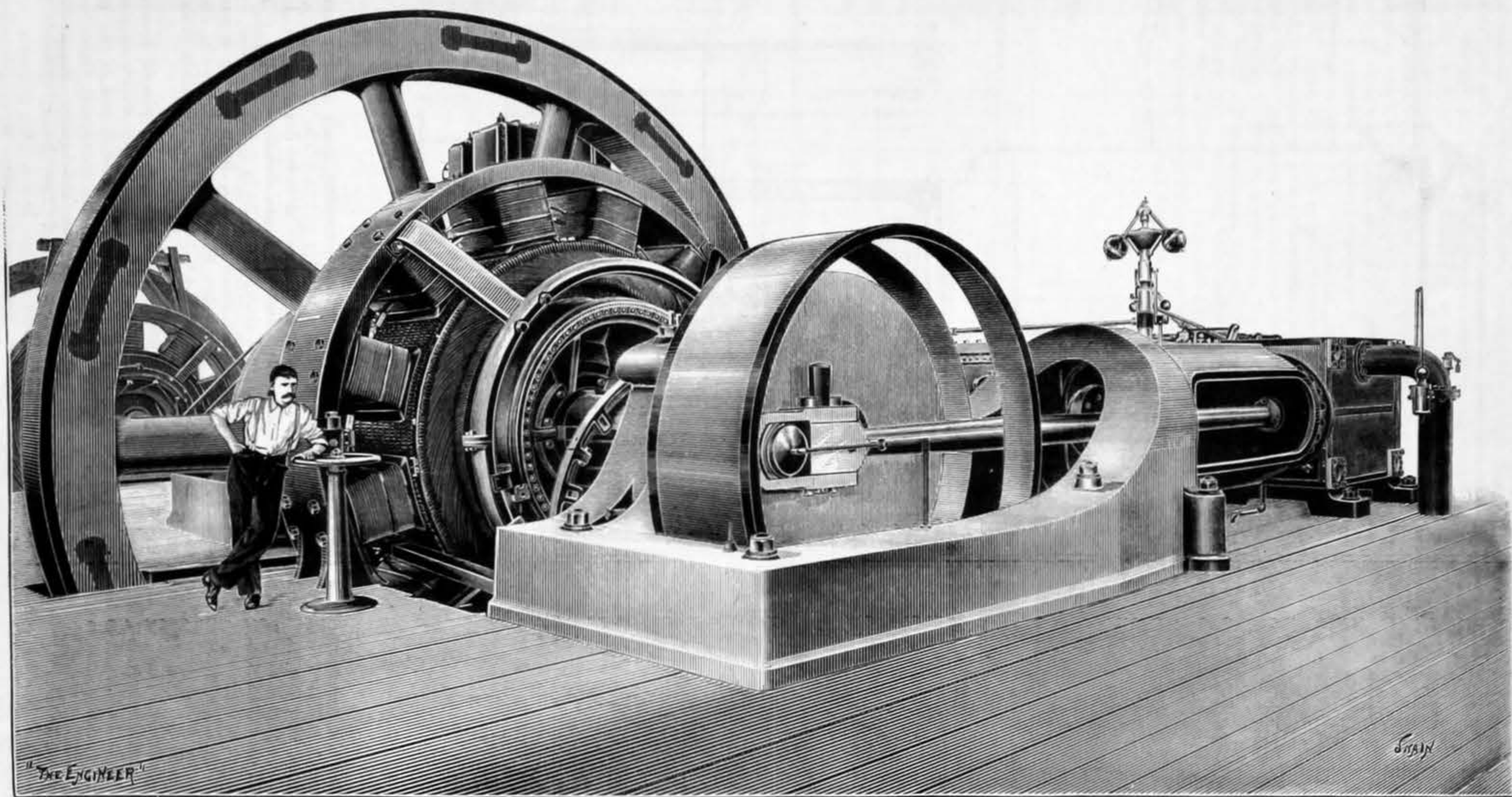


Fig. 4—COMPOUND ENGINE AND 1500-KILOWATT MULTIPOLAR DYNAMO

walk through and see the boilers and condensing plant. Upon page 114 is given a sectional elevation of the foundations for the largest engine, which does not require further explanation. The finished flooring is not as yet in position, but will be ready in July. Referring now to the plans and sections Figs. 2 and 3, pages 114, 115, the oil is pumped by the small plant shown near the boilers from the tanks of the Exhibition Company, and is brought through pipes 2in. diameter laid underground. The pumps produce a constant pressure at the burners in the boilers of 5 lb. per square inch, and the fuel oil installation was supplied by the National Supply Company of Chicago. Several types of burners are now being used, and trials of relative efficiency are to be made later on, but it is too early to give any details. The carriage of coals to the boilers in the Exhibition would have been a very serious difficulty, which is entirely obviated by the use of oil.

Ten Babcock and Wilcox water-tube boilers are used. These have a nominal capacity of 3000-horse power, but with condensing engines will give about 5000-horse power. All the gases from the boilers discharge into one common flue, and by means of dampers can be allowed to pass either directly to the chimney or to the ends of the flue, returning to the chimney through two of Green's economisers placed at each side of the main shaft. This feed-heating plant was built by the Fuel Economiser Company of Matteawan, N.Y. I am informed that the temperature at the base of the chimney was only 200 deg. Fah. when recently tested. The steam from each boiler passes through a pipe 7in. diameter, into a pipe 14in. diameter, which is merely a straight length across all the boilers. No attempt has been made to use the ring system of mains. Steam pipes 10in. diameter are led off the 14in. pipe for each of the steam engines. Only one steam valve is provided in the 14in. pipe, and this is at the middle of its length, so that if an accident occurred to this pipe close to the main valve, five boilers would be rendered useless. The steam pipes, 10in. diameter, are carried downwards, and run underneath the floor to points near the engines, whence branch pipes are led to the engines and pumps. The whole of the pipes are supported from the boilers and from the ground, as it was not thought advisable to make attachments to the building for this purpose. All the valves are provided with gun-metal seats supplied by the Chapman Valve Company.

The largest engine is placed, as previously stated, in the middle of the engine-house. I had a special photograph taken of this engine and dynamo on June 20th, and this is reproduced in Fig. 4. At that time the dynamo was not completed, and it will be observed that there are no brushes upon the commutator, and that one of the brush carriers is resting upon the shaft. This engine is a very fine specimen of the cross-compound Reynolds-Corliss type, and was built by the E. P. Allis Company, of Milwaukee, Wisconsin. I have already described some of the engines built by this firm and exhibited in the Machinery Hall, so that it will not be necessary to enter into detail here. The cylinders are respectively 32in. and 62in. diameter by 60in. stroke, and it will be seen from the plan that the high-pressure engine is at one end of the main shaft, and the low-pressure engine at the other, while the fly-wheel and dynamo are placed between them. The fly-wheel is 25ft. diameter by 24in. wide. The engine is capable of developing 2250-horse power when worked condensing, and will run at eighty revolutions per minute. The whole design of this plant recalls that of the Helios Company's exhibit at the Frankfort Exhibition. Such combinations, of course, take up a very large amount of floor space, and it must

be somewhat difficult to obtain a high load factor for lighting work. Here, however, the work is that of supplying current to an electric railway, so that the load is much more nearly constant and spread over a longer period. The main shaft of the engine is 24in. diameter by 30ft. long, and weighs 55 tons. It was brought from the works at Milwaukee upon a specially-constructed car furnished by the Chicago and North-Western Railway Company. The dynamo is capable of giving out 1500 kilowatts, and is a multipolar machine, built by the General Electric Company, and we may state at once that all the dynamos in the station are built by the same great corporation. The armature

fixed the sheet iron core-plates. These plates have dove-tails *d*—Fig. 5—upon the inner edge, which fit into corresponding spaces *l* upon the carrier. The exterior of the core is provided with deep grooves *c*, in which are placed the copper bars which constitute the windings; two bars, each 1½in. by ½in. wide, are placed in each groove, and well insulated from each other and from the

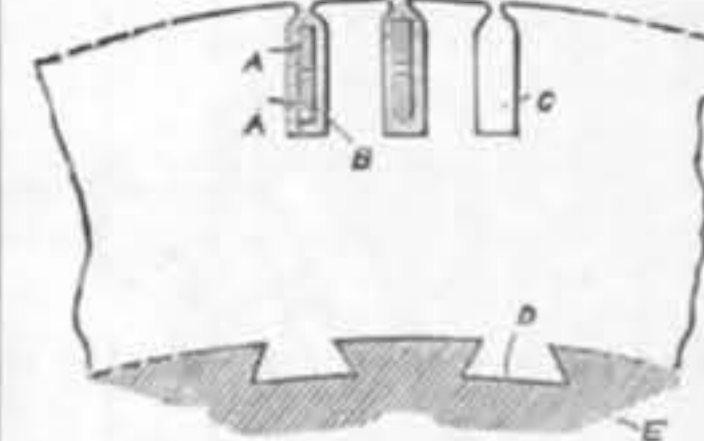


Fig. 5—1500-K.W. Armature Section and well insulated from each other and from the

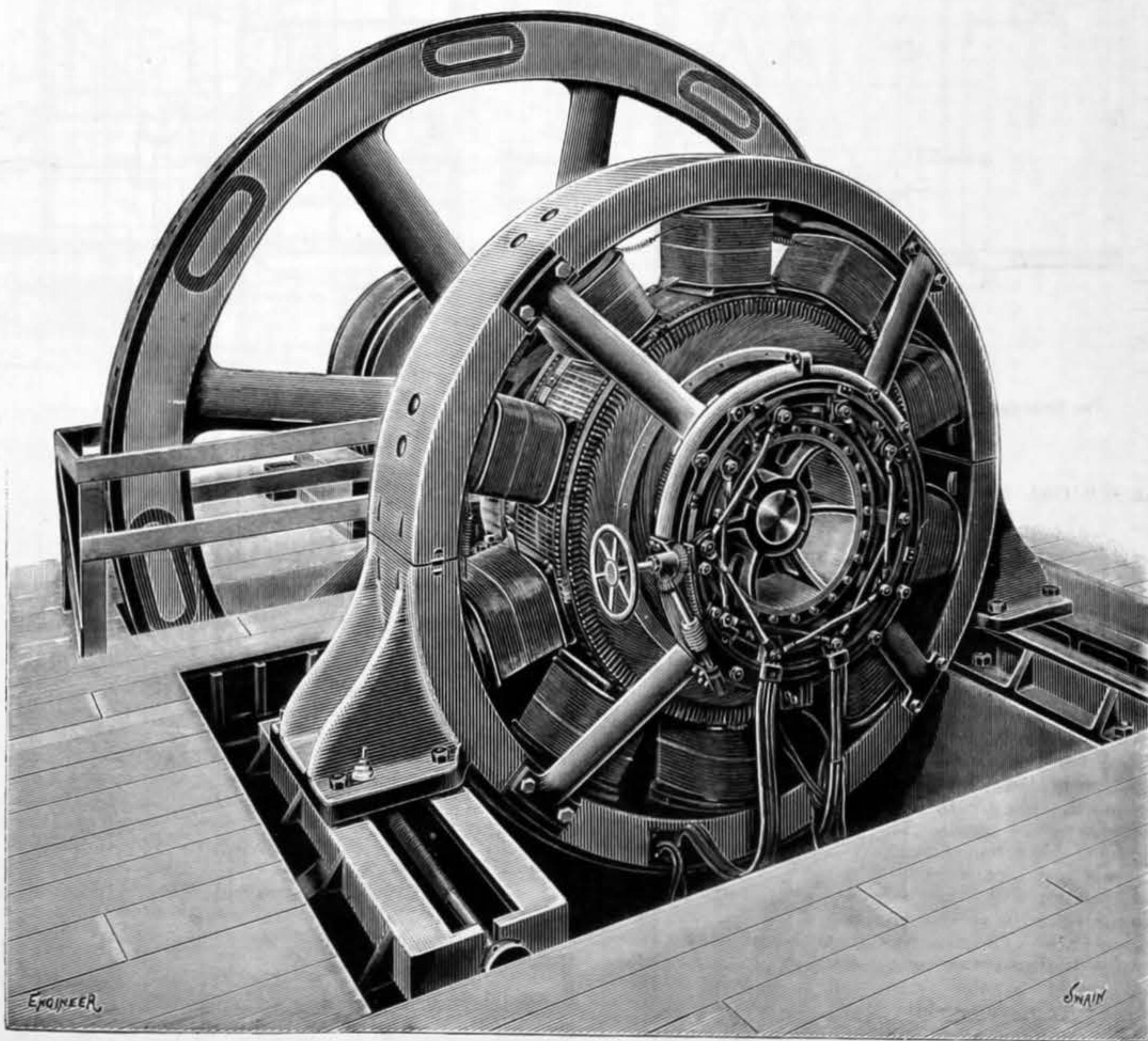


Fig. 6—500-KILOWATT MACHINE, INTRAMURAL POWER STATION

of this dynamo is 14ft. diameter, and was built up in position, as the Allis Company had no means of dealing with such a large piece of work, and it would have been almost impossible to transport it to the Exhibition if it had been built at Milwaukee. The total weight of the revolving mass, consisting of shaft, fly-wheel, and armature, is stated to be 200 tons. The drum or core of the armature was made at Milwaukee, and upon it are

core itself; the armature is, of course, drum-wound. There are twelve field magnets, which are compound-wound; the construction of the cast iron frame and method of securing the cores of the magnets has already been described. Upon the commutator will be arranged twelve groups of brushes, six in each group; all are of carbon, and the brush-carrier itself passes through a hollow square sleeve of boxwood which acts as insulation.

(For description see page 112)

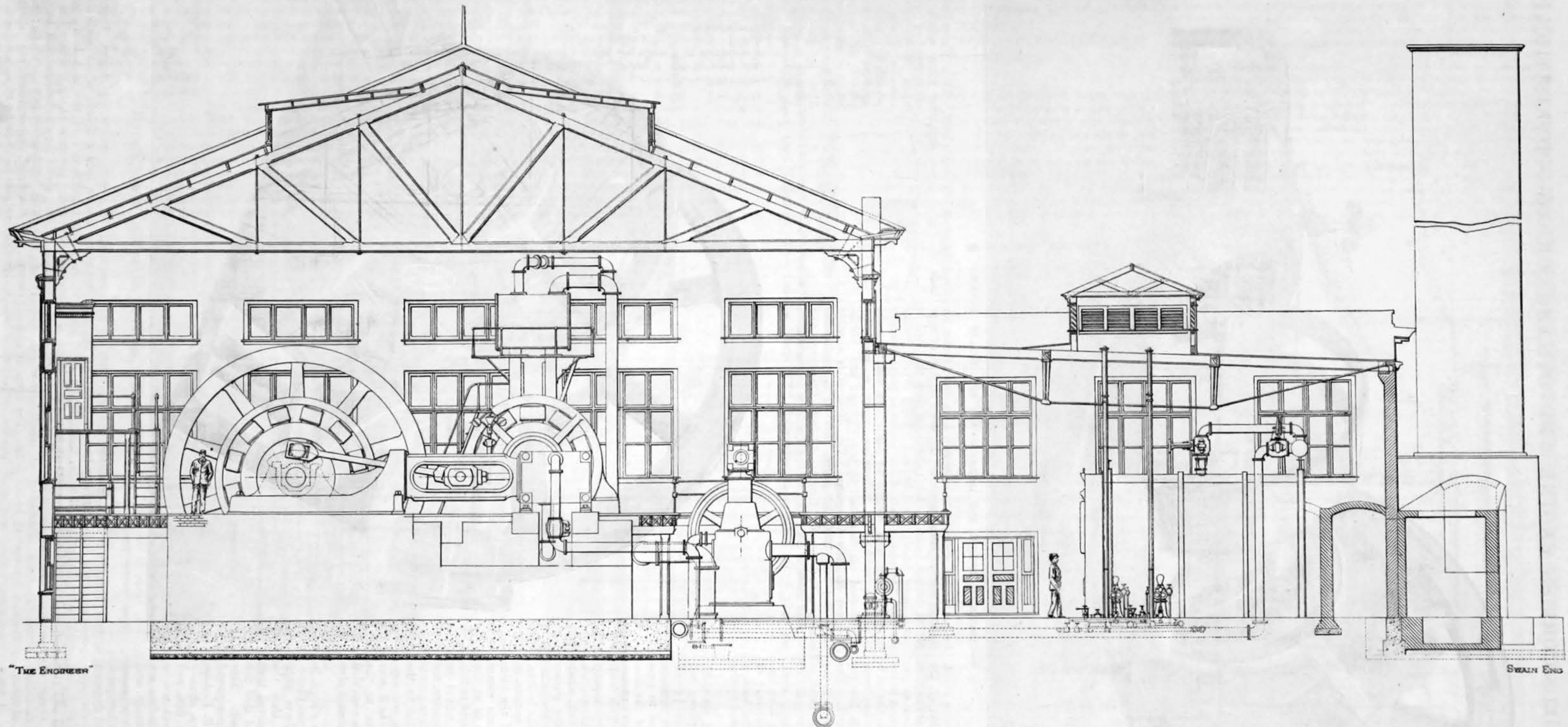


Fig. 2—SECTION OF ELECTRIC POWER STATION, INTRAMURAL RAILWAY

The machine develops 550 volts, and gives a maximum output of 2800 amperes. Arrangements are made by which any commutator can be turned up in position. The engines are run at a speed of about twelve revolutions per minute while the work is going on, and the slide rest is bolted upon the brush-carrier frame.

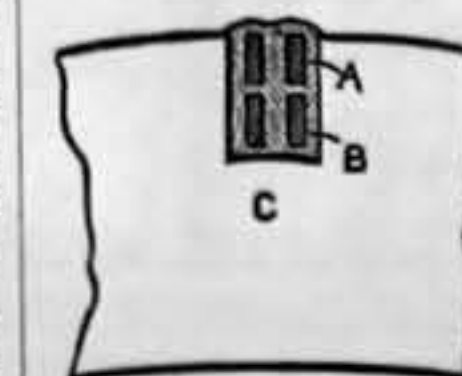
At the east end of the engine-house is installed the engine and dynamo which are illustrated in Fig. 6, reproduced from a photograph specially taken. This set is now in constant use, although at the time the picture was taken the floor was still unfinished. The engine is a Reynolds tandem compound Corliss engine built by the E. P. Allis Company, of Milwaukee, Wis.; the high-pressure cylinder is 22in. diameter, the low-pressure 42in. and the stroke 48in. This engine has a fly-wheel 20ft. diameter, and drives direct a multipolar generator built by the General Electric Company. The engine will work up to 1000-horse power condensing, and the dynamo is a 500 kilowatt machine, the speed is 80 revolutions per minute. The con-

struction of the armature is plainly visible in the illustration, and the ten groups of carbon brushes upon the commutator can be regulated for lead all at once by means of the hand wheel H, bevel, and worm gear. The brushes on these railway generators cannot be all lifted clear of the commutator together, as is the case with the direct coupled plant in the Machinery Hall by the same makers, but it is necessary to turn each set back separately. The field magnets cast iron frame and brush carriers can be drawn right away from the armature upon the bedplate to allow for inspections of the winding.

Next to the set just described, and between it and the large engine in the middle, is placed the set shown in Fig. 7. This consists of a Hammond-Williams cross compound vertical engine, built by the Lake Erie Engineering Company, of Buffalo, N.Y. The high-pressure cylinder is 22in. diameter, the low-pressure, 44in., and the stroke 36in. The speed is 112 revolutions per minute, and it is capable of developing 1000-horse power. The cylinders are not steam jacketed at all, and

in Fig. 7 is given a section showing the arrangement of the valves. Each cylinder has two exhaust and two steam valves. The valves work under pressure plates, and are like the Allen type, but each is made in two parts, one part sliding within the other, with steam balances, but slight excess of steam pressure to press the valve against the cylinder and against the plate. All the valves are four-ported. The high-pressure exhaust valves and the low-pressure steam and exhaust are provided with springs to make them self-adjusting. The high-pressure steam valve is operated by the governor, and is a plain box Allen balanced valve. The lap of the valves is adjustable by means of nuts on the valve rod. It will be observed that the eccentric controls the valve through a rocking shaft and levers. It is astonishing how fond American designers are of the rocking shaft, a feature which finds little favour in Great Britain. In some cases it seems almost as though designers went out of their way to be able to add a rocking shaft somewhere or other. It may be observed, however, that practice has

enabled them to learn that a rocking shaft needs a very long bearing, and these are usually put in. The dynamo is a multipolar generator, similar to those already described, and giving 500 kilowatts. All the machines develop about 550 volts, and I may say that about 500 volts is considered the standard potential for electric railway work here. The commutator



Armature Winding

has ten sets of six brushes in each set, and the winding of the armature is as shown in annexed sketch.

In each groove are placed four copper bars, each $\frac{9}{16}$ in. by $\frac{1}{2}$ in. well insulated from the core. At the west end of the building stands a tandem compound Greene engine, built by the Providence Steam Engine Company, of Providence, Rhode Island. This engine has a high-pressure cylinder of 20in. diameter and low-pressure 38in. diameter, and stroke of 48in. It runs at 100 revolutions per minute

(for description see page 112)

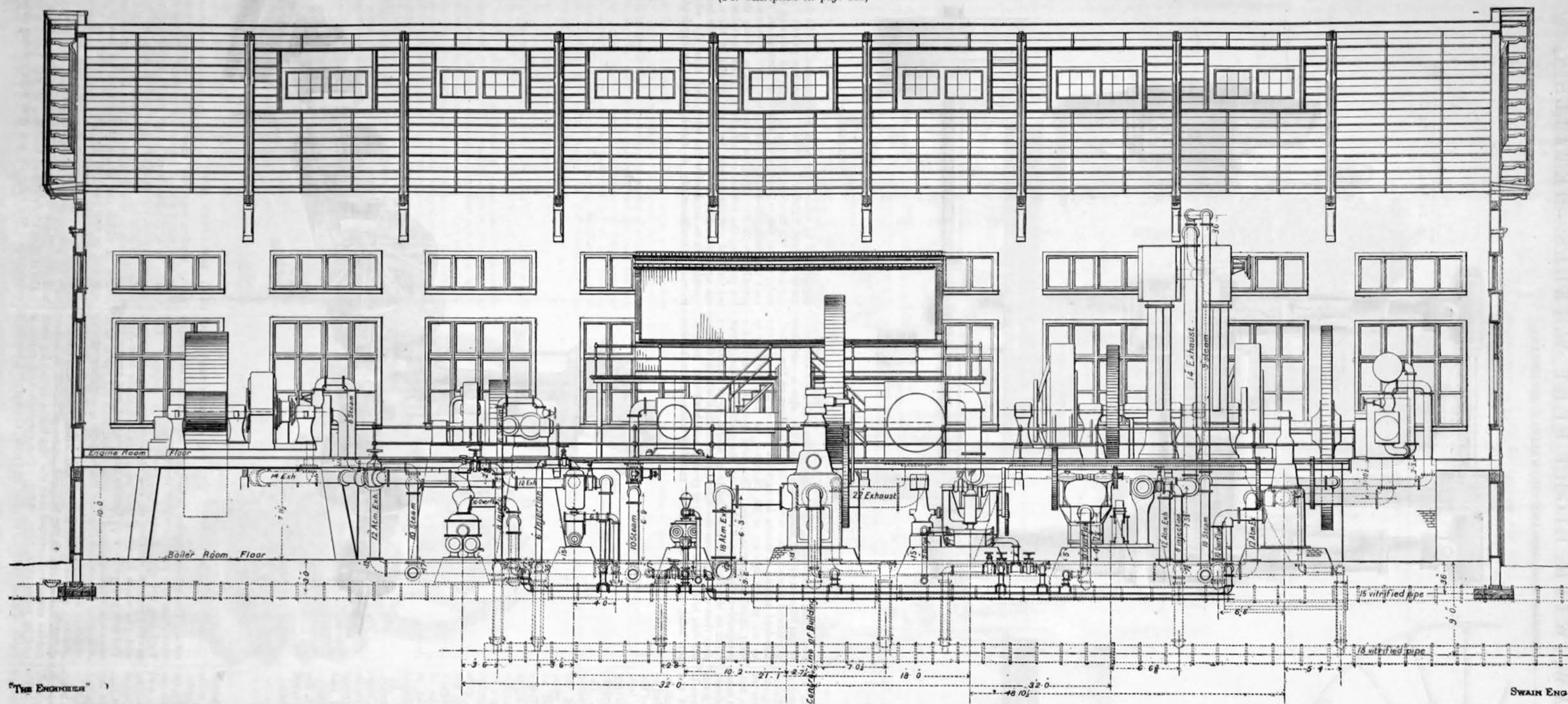


Fig. 3—SECTION BETWEEN ENGINE AND BOILERS OF ELECTRIC POWER STATION, INTRAMURAL RAILWAY

and will develop 1000-horse power, and drives by belting a multipolar generator of 500 kilowatts capacity. The fly-wheel is 18ft. diameter, and the pulley upon the generator is 61in. diameter by 50in. wide. A two-ply leather belt is now in use, but a three-ply belt will be substituted. It is tightened up by an adjustable jockey pulley, which did not strike me as a very favourable arrangement. The present belt is not running well, and is evidently too light for the work, as it is stretching on one side more than at the other. The generator has four poles and four sets of six-carbon brushes.

Between the last set described and the middle engine is placed a comparatively small set, consisting of a tandem compound engine built by Messrs. McIntosh and Seymoure of Auburn, New York. This engine develops 400-horse power, and runs at 150 revolutions, being coupled direct to a multipolar generator giving 200 kilowatts. This dynamo has six poles and six sets of three-carbon brushes. The field magnets are compound wound, and there is a German silver resistance coil as a shunt on the series winding to regulate the over-compounding of the machine. The current produced by this set is used for supply-

ing seven 75-volt 16-candle power lamps in series in each car on the railway. The switchboard is as yet in a very unfinished state, and the connections are merely temporary. The board consists of slate panels, and all the instruments were made by the General Electric Company. There are, of course, special large switches, one taking 3000 ampères. Current indicators of the Thomson-Houston pattern, indicating respectively up to 1500, 2200, 5000, 2200, and 600 ampères, and above these are placed five circuit breakers with blow-out magnets, and automatic resetting device. These the space at my disposal will not allow me at present to illustrate.

In the cross-section of the engine-house it will be seen that the condensers and boiler feed pumps are placed at the back of the engines, and that there is to be a gallery from which visitors can observe the working. The water for the condensers is brought through a vitrified sewer pipe 18in. diameter, connected to two lengths of cast iron pipe at the lake end, and there is a valve for shutting off in case repairs are needed. The end of the pipe in the lake is 3ft. below low-water level, and it slopes towards the power-house, so that the water flows to the pumps

by gravity. The pumps take this water and raise it about 8ft., and it is delivered from the condensers to a return pipe, also 18in. diameter, inclined towards the lake, and delivering at a height of 1ft. above high-water level.

Although I have stated that at the time of my visit the power station was still in a very unfinished condition, I do not mean that trains are not being run. All the engines but the largest were being run at the time I was there, and trains were running at five minutes' intervals, and I do not doubt that by the middle of July the whole power-house will be in good order and fit for ordinary visitors to inspect.

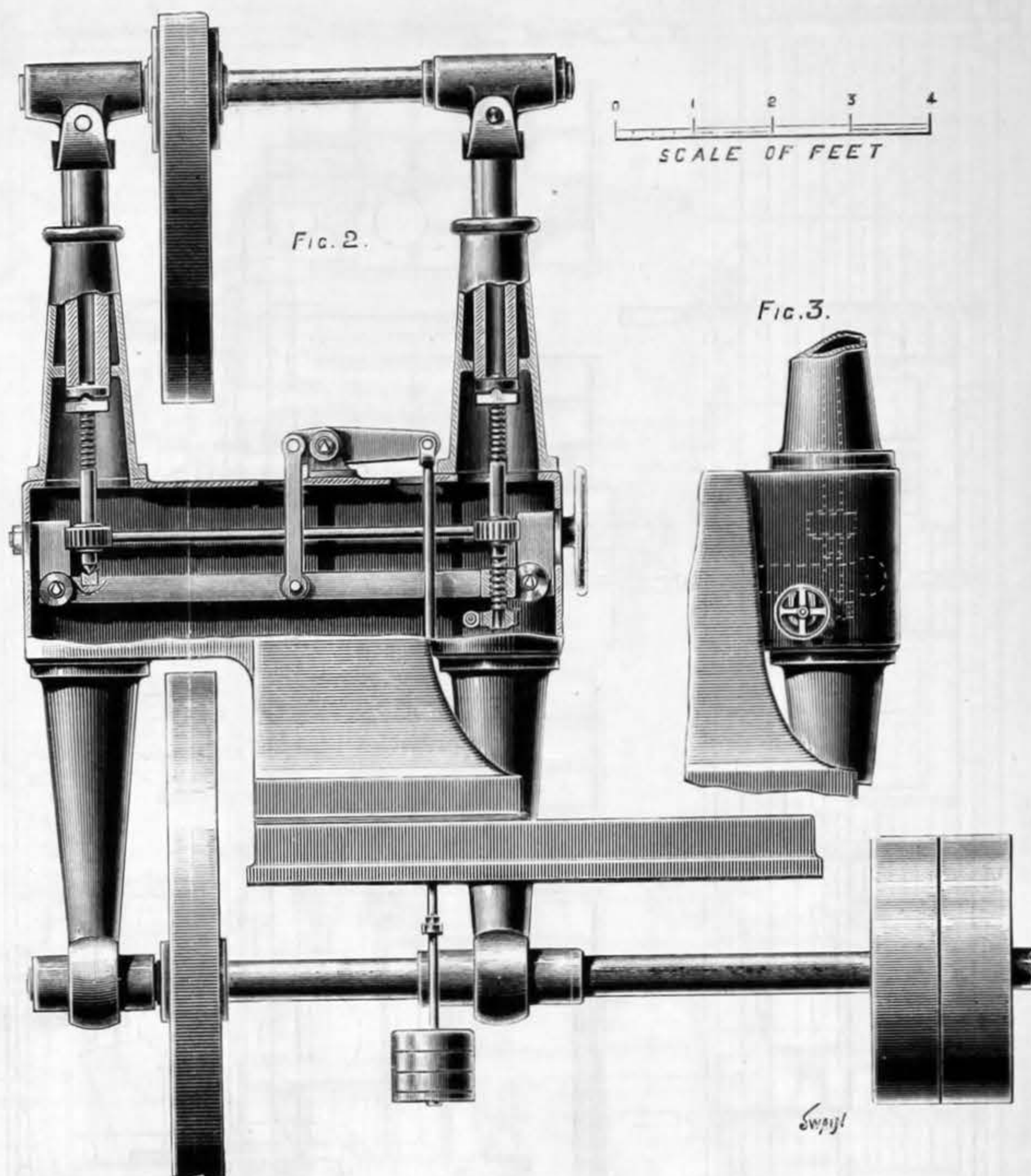
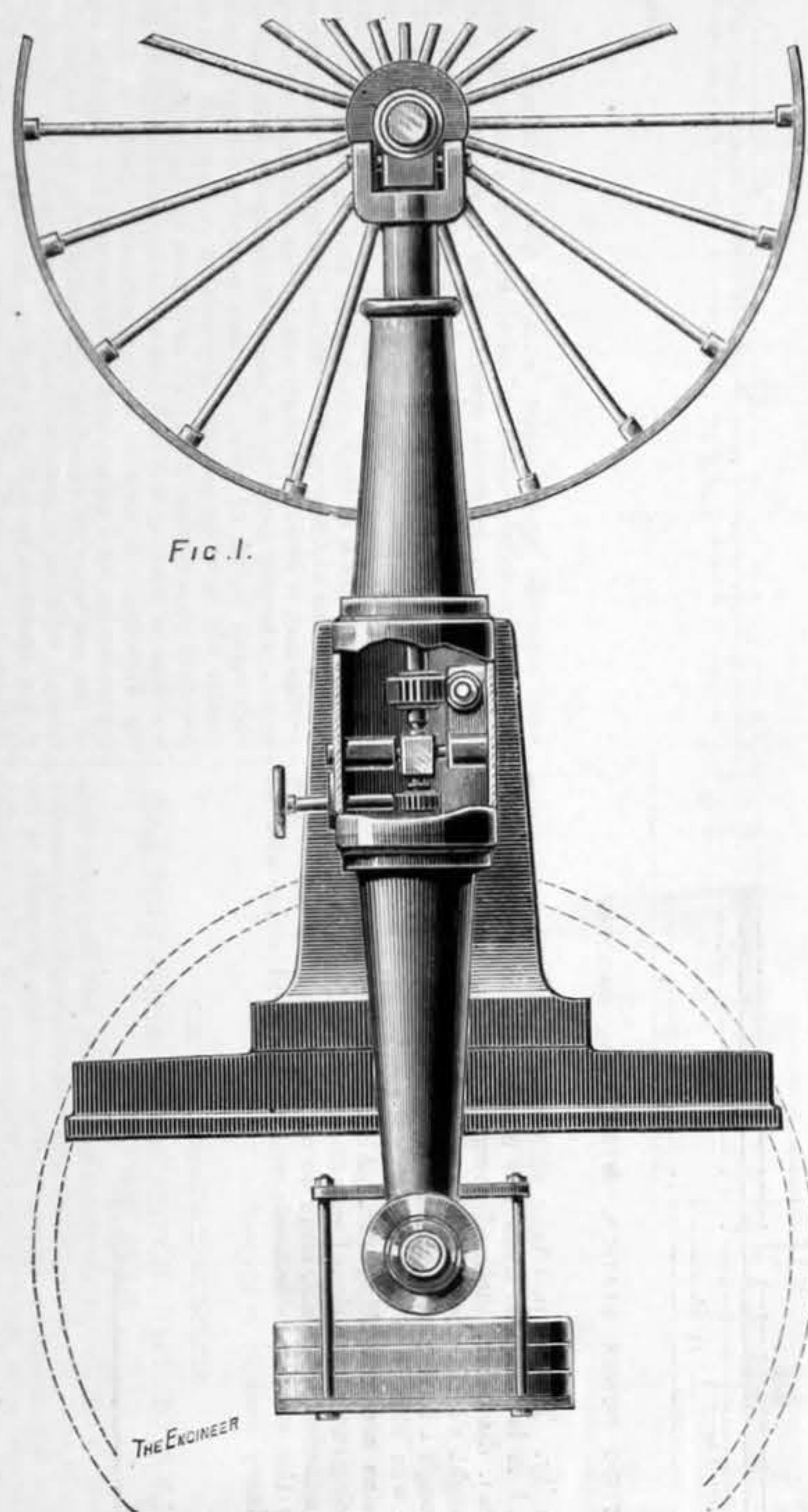
JUBILEE OF THE ROTHAMSTED AGRICULTURAL EXPERIMENTS.

A FUNCTION not only of considerable interest, but also from force of circumstances unique in character, was celebrated on Saturday last, when a remarkably representative assembly gathered in the vicinity of the quiet little village of Harpenden, in Hertfordshire, to do honour to Sir John Lawes and Dr. J. H. Gilbert, those emi-

nent scientific agriculturists who for fifty years have successfully laboured in collaboration in enriching our knowledge concerning many of those intricate operations of nature which control the growth of crops and other farm produce. The results of these labours have been given to the world in a multitude of papers, articles, and monographs, contributed to various learned societies, and to the press at home and abroad; moreover, an epitome showing the character of the current work and its relation to past work, as well as the average results obtained during the whole period of investigation, is circulated every year. The contents of these publications are largely made up of matter of highly scientific interest from very many points of view, but also comprise a large proportion of matter which, when properly appreciated and applied, is of immense practical importance, inasmuch as it puts in the hands of the farmer a means of making the very best of the natural conditions placed at his disposal. A visit to the experimental fields at Rothamsted demonstrates at a glance that, however well the physical condition of the soil may be cared for, and the sowing and cultivation performed, whether by manual labour or mechanical contrivances, yet, if due attention be not paid to those invisible influences which the Rothamsted experiments have done so much towards disclosing, the crops which are brought forth are poor, sickly, altogether

LOG BAND SAW, WITH EIGHT-FOOT WHEELS.—DETAILS

MESSRS. J. SAGAR AND CO., HALIFAX, ENGINEERS



inferior, and unprofitable. The matters dealt with in Rothamsted memoirs are so wide-reaching as to be indispensable to all in any way connected with agriculture, whilst some are of absorbing interest to chemists, physiologists, meteorologists, statisticians and economists, and others of paramount importance to the sanitary engineer. When, too, it is remembered that the whole of this work has been conducted entirely at the private expense of Sir John Lawes, who, moreover, has founded and liberally endowed the Lawes Agricultural Trust to insure the continuation of the experiments after his death, whilst Dr. Gilbert has devoted the whole of his life to these investigations, it is not difficult to realise the fervour and sincerity of the oration accorded to Sir John Lawes and Dr. Gilbert when at the celebration of the jubilee of the Rothamsted experiments on Saturday last, they were the recipients of innumerable congratulatory addresses from learned bodies, both British and foreign, and were presented—Sir John with his portrait, Dr. Gilbert with a silver salver; whilst a granite memorial, erected in front of the Rothamsted Laboratory, and bearing the inscription, "To commemorate the completion of fifty years of continuous experiments in agriculture, conducted at Rothamsted by Sir John Bennet Lawes and Joseph Henry Gilbert, A.D. MDCCCXIII," was dedicated by the Right Hon. Herbert Gardner, M.P. The proceedings on Saturday were the result of a movement initiated by the Prince of Wales, who, in March last, set on foot the Rothamsted Jubilee Fund, which has provided the memorial and gifts just enumerated, and the accompanying addresses from the subscribers to the fund, to Sir John and Dr. Gilbert, signed by the Prince of Wales, and presented by the Duke of Westminster. Amongst the other addresses, the Duke of Devonshire presented those from the Royal Agricultural Society; Dr. Michael Foster, from the Royal Society; Dr. Armstrong, from the Chemical Society; Professor Stewart, from the Linnean Society; Professor Kinch, from the Cirencester College; whilst two were presented from French Agricultural Societies, and congratulatory messages arrived from the United States and Canada. Commemorative and congratulatory speeches were made with each presentation; and after graceful replies from Sir John and Dr. Gilbert, the brilliant and agreeable proceedings, appropriately conducted in the open, were terminated by the usual votes of thanks.

A LARGE LOG BAND SAW.

By the engravings above and on page 120 we illustrate a very large band saw recently put to work in the saw mills and joinery of Messrs. Illingworth and Co., Leeds, by Messrs. J. Sagar and Co. It is intended for rapid work, chiefly on large squared timber. It carries saws up to 9in. in width on pulleys 8ft. in diameter, the lower one being the driver, and being made very heavy, contrary to usual practice, and acting as a fly-wheel. This bottom pulley is cast iron, and designed with splayed spokes to withstand side strain when cutting, and to allow for unequal contraction in cooling. The top pulley is a built-up wheel of iron and steel with staggered spokes. The top and bottom pulley shafts are steel, 6in. in diameter in the centre, and they are carried in pivoted bearings as shown in detail in Figs. 1, 2, and 3. The speed of saw is 6500ft. per minute. The tension arrangement is patented, and is made very sensitive, the levers resting on steel knife edge bearings as shown. There is also provision, as seen at

Figs. 1 and 2, for canting the top saw pulley to give the saw more or less tension on the tooth edge. There is also a cross-line movement to make the saw run in any position on the wheel. The feed motion is driven by variable friction discs, and can be set to saw logs up to 5ft. diameter, at from nothing to forty lineal feet per minute. This feed gear is seen in the perspective view, Fig. 4 below, and the position of the driven roller on the discs is controlled from above by a hand lever near that which moves the belt, and also that which throws the feed into or out of gear, or gives a quick return motion, this being done by a paper roll running between two friction

being that to which the rack is connected. The frame is made of steel, "girder" section. There is a patent "off-set" motion to the carriage, which, by connected cams at the two ends, moves the tables on its axles, so that when running back the timber is entirely clear of the saw. The machine is provided with five uprights or brackets, to which the dogs for gripping the timber are attached. These uprights can be set forward simultaneously, or each or any of them can be set up separately, so that in sawing crooked timber each upright can be set dead to the stick, and then the whole set forward simultaneously as much as may be required. The

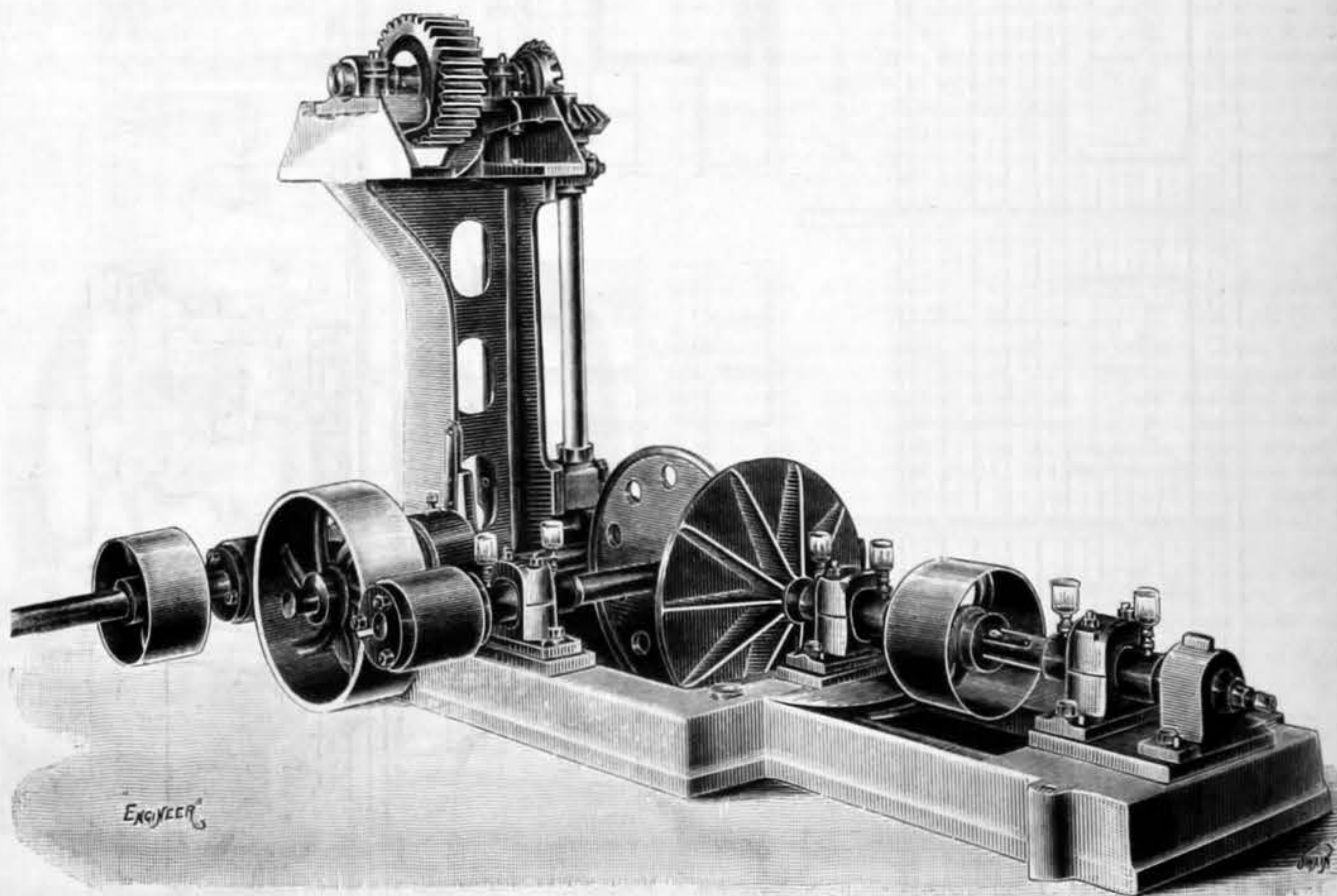


Fig. 4.—EIGHT-FOOT LOG BAND SAW.—FEED GEAR

rolls. The action appears to be quite certain, and experience with other machines in which these friction rollers have been used has not shown any deficiency in this respect. The saws at present running on the machine are No. 16 gauge, and the waste of wood over each cut is a shade over $\frac{1}{4}$ in. The saw pulleys have no flexible covering of any kind. The saws are working directly in connection with the metal face. A scraper is provided to clear the bottom saw pulley of any sawdust or other material which may adhere to it. The bearings are of great length, and lined with anti-friction metal. They are on the ball-and-socket principle. The saw guides are so constructed that the last board of the log need not be more than $1\frac{1}{2}$ in. thick. The carriage and table is made almost entirely of steel and iron, the only timber in it

set-up motion acts very exactly, the workman knowing to $\frac{3}{4}$ in. how much he has set the log forward. This is done by means of a ratchet lever which works between stops on a quadrant, each stroke of the lever giving $\frac{1}{4}$ in. move of the table. In shifting the log forward it does not slide on the same surface as the uprights. There is an arrangement by means of which the whole of the uprights can be quickly returned to the back of the table. The rails on which the carriage runs are planed. The setting-up gearing for the uprights is made of steel. The return motion of carriage may be arranged at any required speed up to 150ft. per minute. There are several points in this machine which make it specially worthy of notice, as will be seen from the engravings. We recently saw it at work cutting twenty-two

HAMMOND-WILLIAMS COMPOUND VERTICAL ENGINE AND DYNAMO—CHICAGO EXHIBITION

THE LAKE ERIE ENGINEERING COMPANY, ENGINEERS

(For description see page 112)

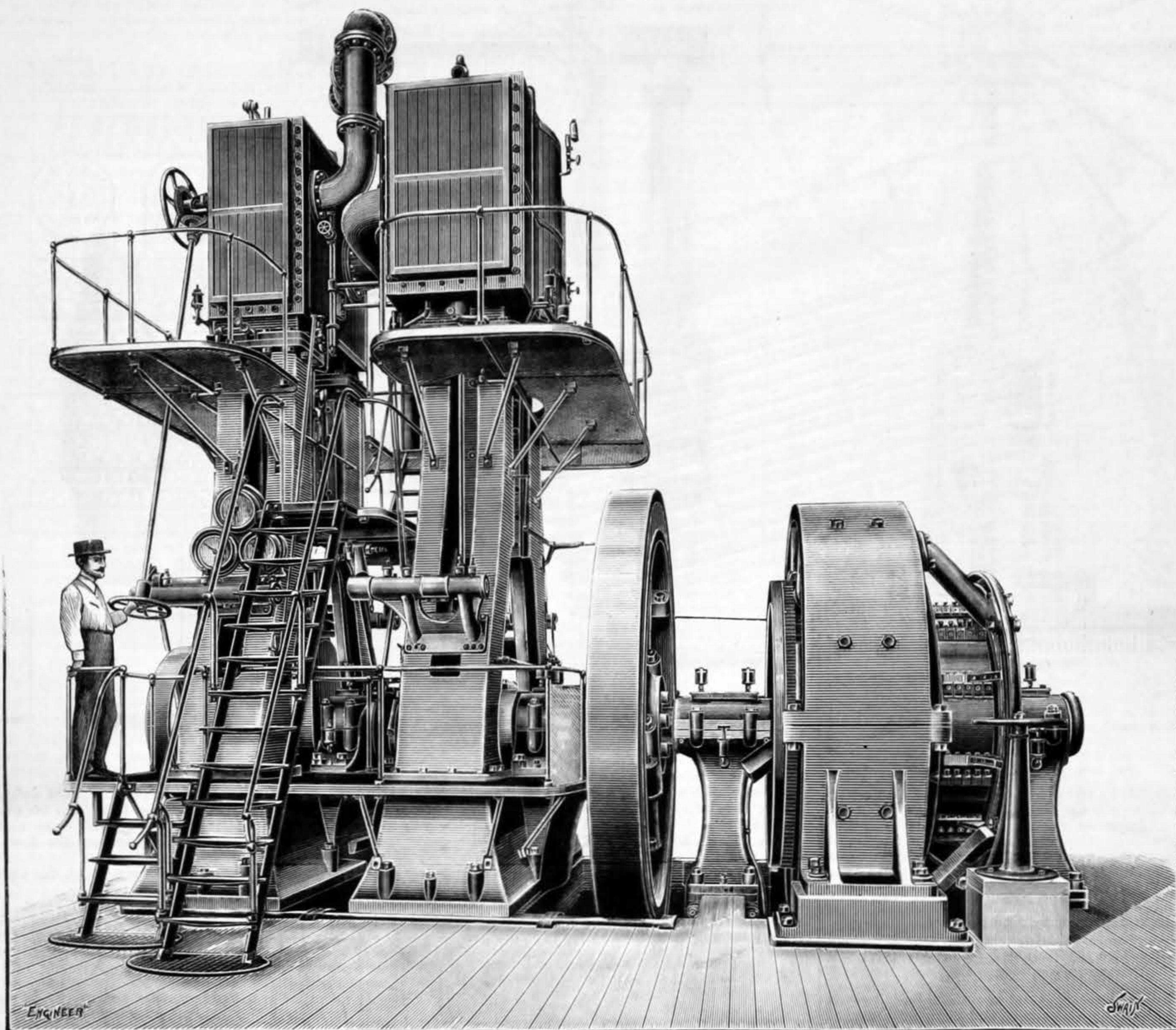


Fig. 7—COMPOUND VERTICAL ENGINE ON THE INTRAMURAL RAILWAY AND 550-KILOWATT DYNAMO

African mahogany logs into slabs, and giving a good surface at the rate of 15ft. per minute. A lower rate, however, becomes necessary when nearing the centre of some of these logs, where the wood is very woolly or stringy, and the saw likely to run. There is plenty of room for the ready removal of the slab cut off, and for the examination of the surface opened out. We believe this is the largest band-saw at work in this country. The total weight of the whole of the machine and its parts is over twenty tons.

SINKING AND DRIVING IN WATER-BEARING STRATA WITH THE AID OF CONGELATION.

THE Poetch method of freezing water-bearing measures and quicksand comprises the putting down of tubes into the soil to be frozen, and of causing to pass through them air or a liquid cooled down below freezing point. The former, however, has the disadvantage of low efficiency, and the latter of being necessarily incongelable. At the temperature at which it is made to circulate through the tubes it causes much trouble if the slightest crack in the tubes or want of tightness in the joints permits the liquid to escape into the soil and communicate thereto its incongelability.

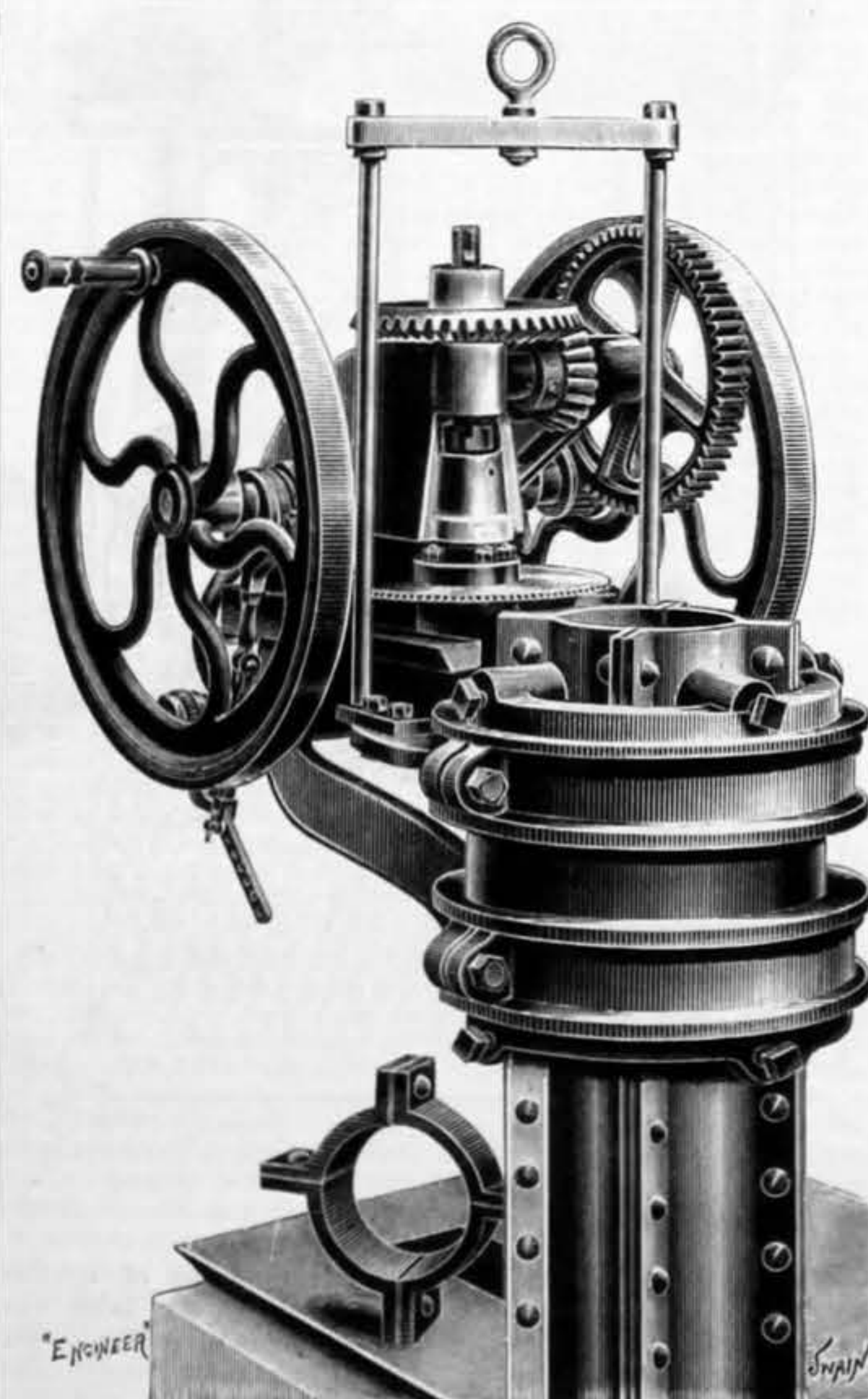
To avoid these difficulties, M. A. Gobert, Ingénieur Honoraire des Mines, of Brussels, who has put down some

that of the outside pressure due to the height of the liquid column. It has been found by experiment that a temperature of -35 deg. C. corresponds with a pressure of 0.9

By working with a temperature of -32 deg. C., the pressure of the gas is equal to that of the atmosphere, and there is, it is claimed, no fear, even in the event of a crack or want of tightness in the joints, of the ammonia oozing out into the soil. As it is easy to ascertain the level of the water round the tubes, the pressure inside them can be regulated in accordance.

The tubes are closed at the bottom and have two necks at the top, one for receiving the pipe which introduces the liquid ammonia, and the other that by which the gas is taken off to be again condensed into liquid. The joints have hitherto been made by screwing one length of tube into another—a practice which fails to secure tight joints, and also weakens the tube at the joint, so that they often break off there, when withdrawn from the soil after having served their purpose.

To obviate these defects, M. Gobert has devised the two forms of joint shown in the annexed sections. The ends of the tube lengths are threaded internally, so as to be screwed upon an internal ring, thus preserving almost the full thickness of metal, while at the same time leaving the outer surface uniform for easy withdrawal. The ends of the tubes are turned, not perpendicular to the sides, but bevelled or hollow curved like the gland of a stuffing-box; and for the larger sizes of tubes a flange of dovetail section is formed on the joint-ring. The effect of this arrangement is to produce two grooves, of internal dovetail section, between the dovetail flange of the ring and the ends of the tube lengths, to receive lead or other washers, which are compressed tightly by the screwing up, thus forming a perfectly tight joint. For the smaller sizes of tubes, the flange of the joint ring is dispensed with, the ends of the tubes, however, being turned with a bevel, or convex or concave bevel surface, thus forming a single dovetail groove for receiving the lead or other washer.



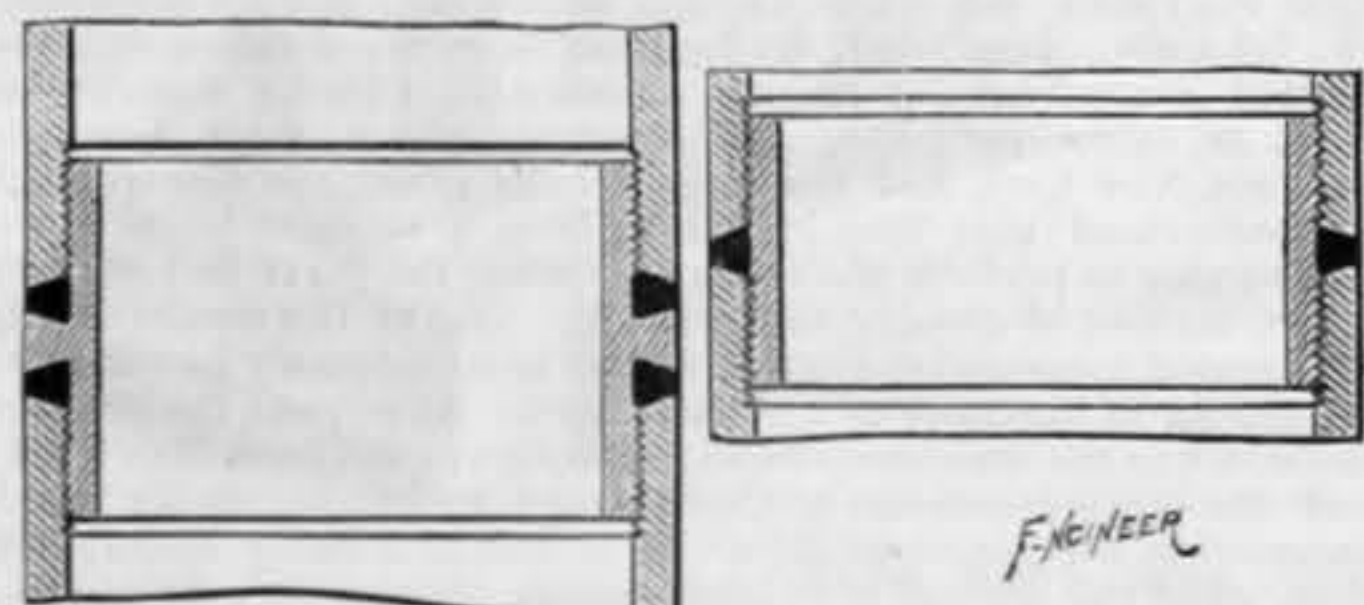
COLD IRON PILE HEAD SAW

atmosphere; -32 deg. C. with the atmospheric pressure; -30 deg. C. with 1.15 atmosphere; -25 deg. C. with 1.46 atmosphere, and -20 deg. C. with 1.84 atmosphere.

MACHINE FOR CUTTING OFF HEADS OF IRON PILES.

ANOTHER advance in sawing cold metals has been made in connection with the piles for Dover Pier, now in the course of construction by Messrs. Head, Wrightson, and Co., Thornaby. The machine, of which we give an illustration, is one designed for the above firm by Messrs. Isaac Hill and Son, Derby, and is built to suit the peculiar requirements of the undertaking. It is necessary, in the first place, that the tops of the piles should be cut off square, and all to the same level.

The machine is attached to each separate pile to be cut by a belt or clamp, adjusted to the pile by means of setting-up screws. On this belt or clamp the machine swivels to any required position, and is then locked. The saw travels towards the centre of the pile, and cuts one-third part away at each operation, so that each pile requires three cuts to level the top of it. It is built for manual power, and is

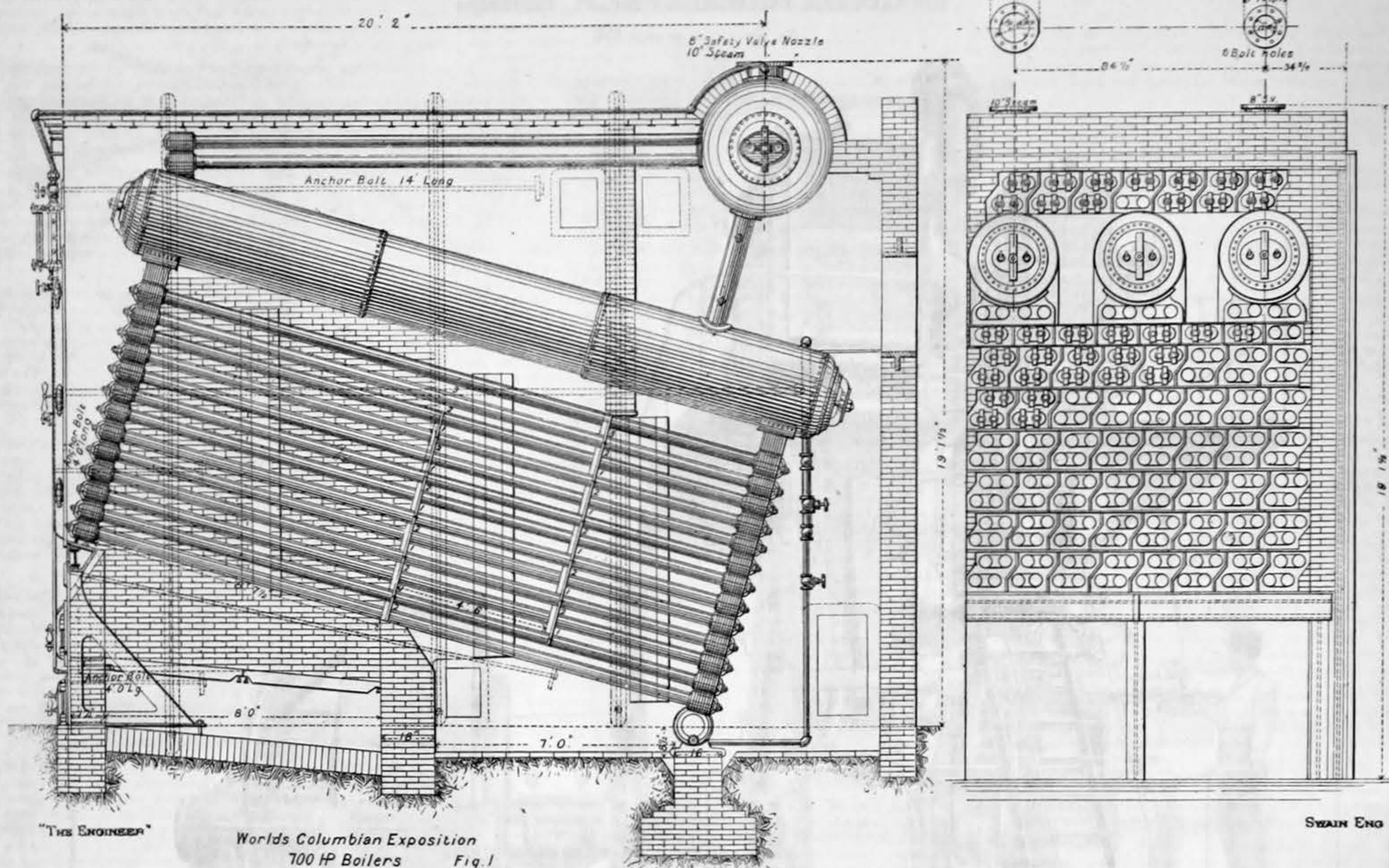


shafts in water-bearing strata at the Lens Colliery in the north of France, substitutes for the incongelable liquid, cooled down below freezing point, liquid ammonia, anhydrous or nearly so, which is sent into the tubes at a temperature above freezing point. The liquid ammonia vaporises in the tubes, producing an intense cold, which freezes the water-bearing measures or quicksand outside.

The same ammonia is used indefinitely, being made to circulate through the tubes by a forcing and compressing pump, which therefore constitutes with the tubes a complete refrigerator, thus leading to a considerable saving in plant; and the cold produced is more intense than that obtained with an incongelable liquid cooled down below freezing point.

A great advantage claimed for this method is that the pressure inside the tubes can be varied so as to slightly exceed

THE ZELL WATER-TUBE BOILER, CHICAGO EXHIBITION



provided with fly-wheels and double handles, also with lifting bar for removal from place to place.

The machine illustrated was selected from designs asked for by the contractors. The teeth of the saws are sharpened by Hill's patent automatic sharpener, a most useful tool, of which great numbers are in use. Our illustration shows the main features of this.

THE ZELL BOILER AT THE CHICAGO EXHIBITION.

Of the Zell boiler there are placed in the Exhibition seven boilers rated at 350-horse power each, and two others rated at 200-horse power each, making in all 2850-horse power. The boiler is made by the firm of Campbell and Zell, at Locust Point, Baltimore. Fig. 1 is a longitudinal section, Fig. 2 a front elevation, and Fig. 3 a rear elevation of a pair of 350-horse power boilers, the latter two drawings having the front plates and back wall removed to show the tubes, &c. The section shows an ordinary firebar grate for solid fuel, but at the Exhibition this is removed, and crude oil is burnt by help of burners supplied by the Chicago National Supply Company. The brick or "tile" partitions run transversely across the tubes, so that the flame and hot gases first ascend, are then drawn downwards, and once more ascend to escape to the chimney through the breach seen in the section placed at a level above that of the back end of the water drum. The flow of mixed water and steam is delivered into the front end of the water drums, of which there are three in each boiler, each 2ft. 6in. diameter, and 21ft. long. The feed is supplied to the back end of these drums, and the water level is kept up to two-thirds or three-quarters of the drum diameter at its front end. As these drums slope at the same inclination as the tubes, nearly the whole of their volume is filled with water, leaving only a small steam space in the top front corner. Here the separation of water and steam occurs, the steam rising into the header boxes for the two rows of tubes which lie horizontally above this drum. These tubes are superheaters, or more probably in actual action heaters which evaporate the priming water and dry the steam. They deliver the steam to the steam drum, which is 3ft. 9in. in diameter, and 24ft. long, and which is placed transversely across the back ends of the water drums and at a level 7ft. above them. This steam drum is connected to the rear end of each water drum by a 4in. external diameter wrought iron tube placed inside a cast iron flanged pipe. In the pair of 350-horse power boilers set together in one battery, the steam drum stretches over both boilers, and it is thus supported by six of these cast iron pipes. The object of enclosing the 4in. wrought iron tubes in the cast iron pipes is twofold: firstly, to avoid any of the load being transmitted through the wrought iron tubes and their joints; and in the second place, to protect these latter from being played over by the hot gases. These tubes are filled with water to near their upper ends, but their top joints with the steam drum are in steam alone, and therefore require this protection from contact with the hot gases. The mud drum at the foot of the rear water leg is 1ft. in diameter, and is not continuous over the two boilers as is the steam drum.

The generator tubes are of wrought iron, 4in. outside diameter, and 18ft. long inside the headers. In the 350-horse power boiler there are 224 of these below the water drums, besides 28 horizontal superheating tubes overhead 15ft. 8in. long. In the 200-horse power boiler, 120 of the generating tubes, of the same dimensions, are provided, along with a corresponding number of superheating tubes.

The back water leg rests on the mud drum directly and solely, and thus the whole weight of the steam drum and more than half the weight of the rest of the boiler is transmitted to the foundation through this mud drum transversely.

This seems to be a curiously bad arrangement. A cast iron bearing plate shaped to under surface of drum delivers the pressure to the brickwork. At the front end the water leg rests on rollers and a machined cast iron bearing plate, so as to give freedom for expansion. This bearing plate is inclined parallel to the tubes. It would seem that a horizontal plate would be more suitable, as the inclined support throws a back thrust on the bearing at the rear water leg, and besides necessitates the lifting against gravity of the whole front half of the total weight whenever expansion occurs.

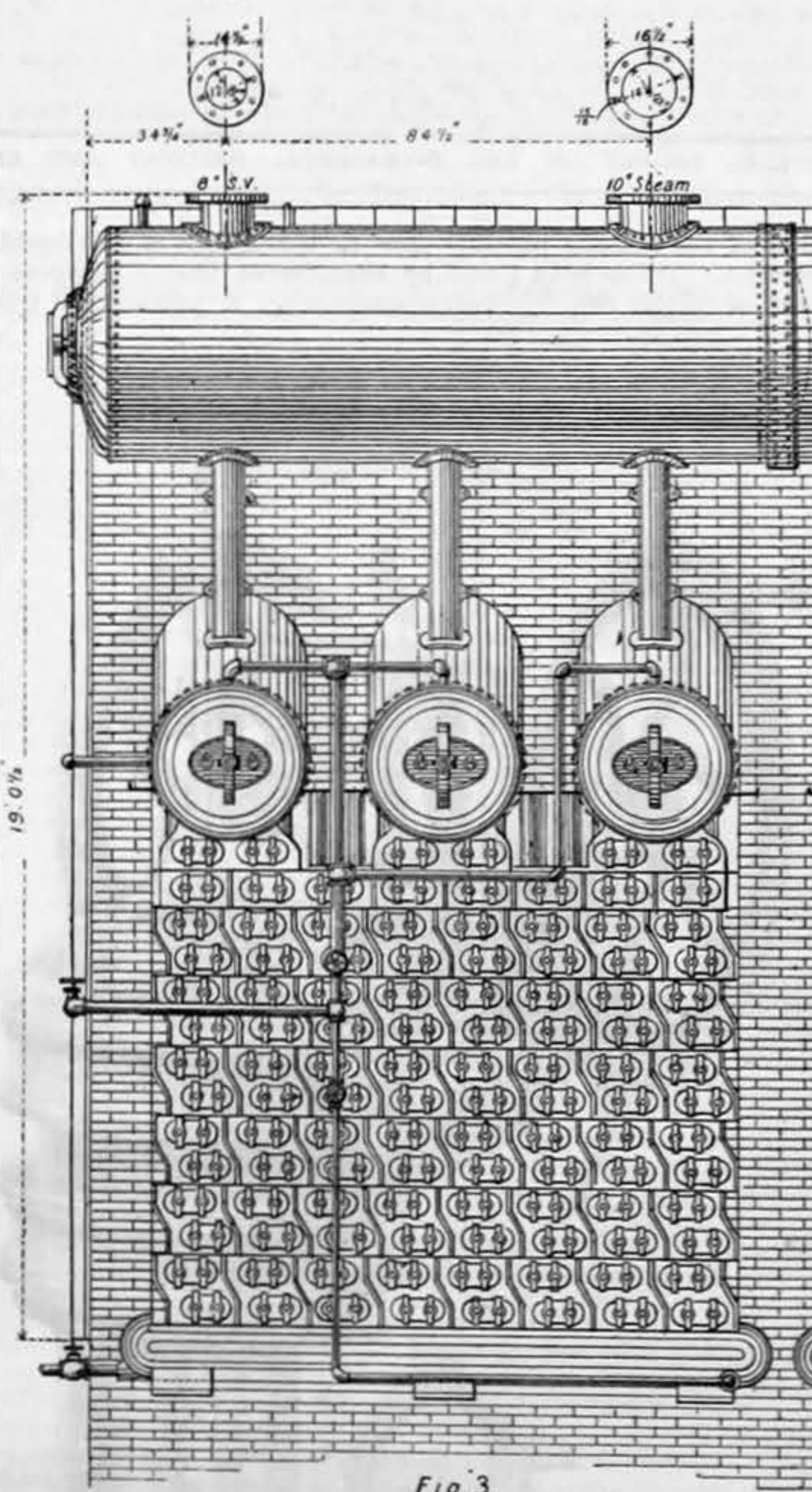


Fig. 3.

The water leg of the Zell boiler is made up of similar sections or boxes, illustrated in Fig. 4. Each box takes the ends of four tubes, and opposite these ends in pairs are two hand holes of oblong shape. These hand holes have inside-jointed corners—the joint surfaces being milled—and the bolts are dovetailed in the metal of the covers, and do not pass through it. The boxes are connected with each other vertically by short lengths of 4in. wrought iron tube, which are roller expanded into the holes drilled for their reception

in the boxes. This connection appears deficient in area; near the top row we find the flow from 96 generator tubes 4in. diameter passing up through only eight tubes, also of 4in. diameter. The escape of steam and the flow of the water must be here seriously throttled.

The main steam valve is mounted on the top drum, as are

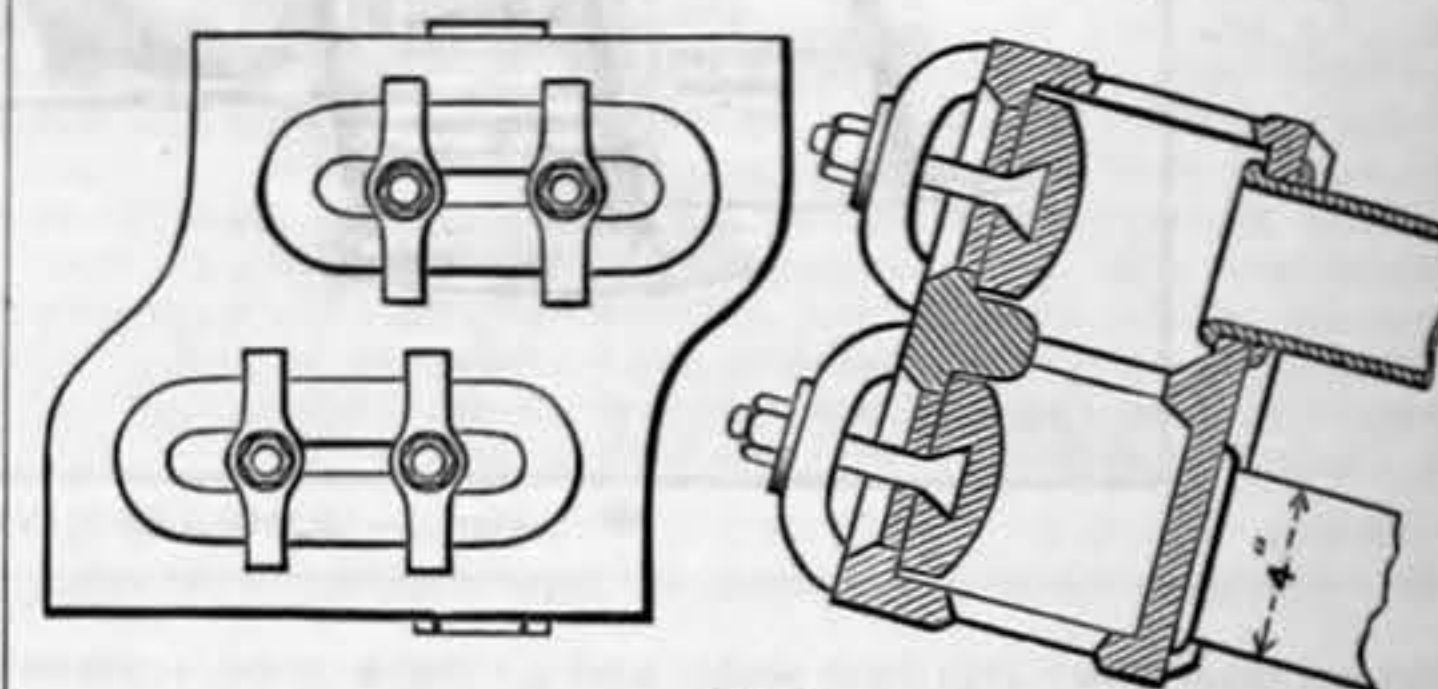


FIG. 4.

also the safety valves. On the 350-horse power boiler two 4½in. safety valves are provided; on the 200-horse power boiler one valve only 5½in. diameter.

BERMUDA.—From a report just issued by the Colonial Secretary of "the still vexed Bermoothes," it is satisfactory to find that the settlement is in a prosperous condition. We must not expect a great deal in the way of expenditure on public works in so comparatively small a dependency, but an increase of over eleven hundred pounds has been incurred in the matter of roads. With the exception of one thousand pounds, the amount of the original liability of the causeway debentures of nearly twenty thousand pounds has been refunded, while fourteen thousand pounds has been spent in the construction of a new Government house. As regards future undertakings of a public character, intended for the general improvement and benefit of the Colony, the local Legislature has lately authorised the Government to borrow forty thousand pounds in connection with a proposed improvement of certain of the West End ship channels, leading into Hamilton Harbour. It is proposed to raise the money either in the settlement or at home, and to make provision for the creation of a sinking fund by the investment of an annual sum of a thousand pounds, the first instalment to become payable in London three and a-half years from the date of the issue of the stock. The importance—in fact it may be stated, the necessity—for improving the local navigation may be inferred from the circumstance that so soon as the contract for deepening the channels is concluded, the facilities for communication with the United States will be greatly enhanced. Directly this public work is fairly launched, the company whose ships now ply between New York and the Colony have given the Government to understand that they intend to have a steamer built which will be able to perform the voyage between the ports in forty-five hours, instead of seventy as at present. One of the results of this accelerated intercommunication will be to considerably increase the popularity of Bermuda as a winter resort. At present the greatest drawback is the time occupied in the voyage to and from New York, and the unpleasantness of the passage in comparatively small steamers in the winter months. It is also reasonably anticipated that, when the channel improvements are completed, a direct communication may be established between the Colony and the mother country—at any rate in the winter season. Such an established route would not only be advantageous to our settlement, but to many people of delicate constitution, to whom the English climate in winter is exceedingly trying. The author of the report states that, in his opinion, the climate of Bermuda would prove more beneficial to invalids than that of the Madeiras. The cause of the prosperity of last year indicated by the revenue returns, according to the same authority, is due to the increasing popularity of the islands among the inhabitants of North America, together with the recent tariff legislation in the States, which appears to induce the citizens of that country—when visiting such places as Bermuda—to take the opportunity of replenishing their wardrobes. The general condition of the Colony may be summed up in the words of the report: that while on the one hand there is little realised wealth, on the other there is no practical poverty in it.

RAILWAY MATTERS.

THE receipts from the New South Wales Government railways and tramways show a net profit for the year of £1,250,000.

THE Tunisians are greatly exercised in their minds that the convention has not been voted for their new system of railways. Great indignation has been expressed, and it has been determined to organise public meetings and send delegates to Paris.

THE Japanese railways have 206 locomotives, of which 200 are of English construction, four of German, and two of American. The variety of design is already very great, there being no less than twenty-four classes in these 206 engines, or an average of less than ten locomotives to a class.

A PROPOSAL to construct a railway from Delhi to Bhatinda, and thence to Bahawalpore, was made some time since. A careful survey of the first portion of the proposed route, from Delhi to Bhatinda, is now almost completed, and, *Indian Engineering* says, a London firm has asked the Government for a concession.

A SERIOUS railway collision occurred in Paris on Wednesday evening. A passenger train from the Courcelles Station was making the circuit of Paris on the Ceinture line, when it came into collision, near the Charonne tunnel, with another train that had left the Gare du Nord and was proceeding in an opposite direction. Fifty-nine persons received contusions or were otherwise injured.

A SUM of half a million, according to Russian accounts, has been assigned by the Minister of War for the construction of a railway, which is intended to connect the station of Moulta Kara, on the transcasian railway, with the port of Knasnovousk. In future, therefore, the terminus of this line will be changed, and the port of Ouzoun-Ada will be no longer used, as it has been proved to be inconvenient and even dangerous at times.

THE London and North-Western Railway Company announce that, beginning on the 1st inst., refreshment and dining cars for first and third-class passengers will be run in the corridor train leaving London, Glasgow, and Edinburgh at 2 p.m. each week day, and between London and Edinburgh, in addition to those now in use between London and Glasgow. Corridor vehicles connected with these dining saloons at Preston will also be run between Liverpool and Edinburgh and Glasgow, and between Manchester and Edinburgh and Glasgow.

THE South-Eastern Railway Company has obtained Parliamentary powers enabling the directors to advance money to persons of all ranks in the company's service to assist them to purchase their dwelling-houses, whether freehold or long leasehold. The rate of interest payable by the borrower is to be 4 per cent. per annum, and the time for repayment is to spread over a sufficient number of years to meet the convenience of the borrower. No fees whatever are to be charged beyond the actual costs out of pocket, not exceeding two guineas, exclusive of stamp duty.

SOME newly-designed third-class carriages have just commenced running on the extensive railway system of the Compagnie Paris-Lyon-Méditerranée. They are 38ft. in length and 6ft. 6in. in height, and are provided with slightly sloping seats, which are upholstered in horsehair. All the carriages are divided into seven compartments, of which one is reserved for the use of ladies, and another for smokers. They are furnished with compressed air brakes, lighted with gas, and are mounted on three axles in order to diminish as much as possible all jar and vibration.

WE regret to record the death, at the age of fifty-eight years, of Mr. John Edward Macnay, who, for the last seven years, has been treasurer of the North-Eastern Railway. He was connected with the old Stockton and Darlington Railway, which was absorbed by the North-Eastern, and of which his father—the late Thomas Macnay—was the well-known secretary. Mr. J. E. Macnay was, after the amalgamation of the companies, assistant secretary of the Darlington Committee of the North-Eastern Railway, and afterwards secretary, there being for a number of years after the amalgamation a separate working arrangement of the Darlington section.

In his report to the Board of Trade on the collision which occurred on the 27th of May at the north end of Darlington—Back Top—station, on the North-Eastern Railway, Major-General Hutchinson says:—"As the North-Eastern Company have never applied for or received any exemption from block working as regards Darlington Station, they have been habitually disobeying the order, issued in January, 1891, with regard to the present mode of working a large number of trains running into that station, and to this disregard of the order their very serious attention should be drawn. To guard against the occurrence of a mistake such as led to the present collision, it is very desirable to give the signalman in the east cabin electrical or mechanical control of the southernmost up home-signal worked from the north cabin. Had such control existed, this signal could not have been lowered without the co-action of the east cabin signalman, who, being aware that the Tebay train was standing at the platform, would have kept the signal at danger."

FROM the experiments which have been going on for the last ten years in the Forest School in Dehra, it appears that the Himalayan cypress is one of the most durable of Indian timbers. Specimens of various kinds of wood, each the size and shape of a metre-gauge railway sleeper, were planted perpendicularly, with half their length under ground and the upper portion exposed to the atmosphere. Most of them were put down in 1881, and a few subsequently at different times. One by one the softer and weaker woods disappeared under the attack of rot and white ants, and a short time ago, when the surviving posts were dug up, it was found that out of thirty-nine common Indian timbers three only were still sound. These were Himalayan cypress, teak and anjan, which had been exposed for ten, nine, and seven years respectively. So far as the experiment went, therefore, Himalayan cypress showed the best result. The *Indian Engineering* reports that of the remaining timbers mango gave way in three years, while chir and hill oak only lasted for six. It is evident, therefore, that the conditions under which the experiment was conducted were anything but favourable for preservation.

WHEN the Blackpool, St. Anne's, and Lytham Tramways Bill came before the Earl of Morley's Committee on the 27th ult., in the House of Lords, considerable discussion arose on the proposal of the chairman to insert the new model clauses drafted by the joint committee of the two Houses which sat recently to inquire into and report upon the question whether the grant of statutory powers to use electricity ought to be qualified by any prohibition as to earth return circuits or by any provisions as to leakage or induction. The representatives of the National Telephone Company asked that there should be certain modifications in the clauses if adopted, and the representatives of the London and North-Western and Lancashire and Yorkshire Railway Companies, who had "agreed" clauses in the Bill protecting their present electrical systems of signalling, protested against being deprived of those "agreed" clauses, and being left to the sole protection of the Board of Trade. In the result the railway companies' "agreed" clauses were struck out, and the model clauses recommended by the committee inserted with the modification, the result of which was to give power to the Board of Trade to extend, if they thought it expedient and reasonable to do so, the three years fixed as the time within which every electricity-using company should be required to insulate their systems by the adoption of the metallic return before being able to take proceedings in respect of interference against the promoters of a Bill.

NOTES AND MEMORANDA.

THE Bombay officer of health protests against the decision of that corporation to adopt means for the utter destruction of the crocodiles. He says they are the best and only scavengers possible of the water reservoirs in which they dwell; as they clear away all decomposing animal and vegetable matter, all obnoxious substances which there are no human means of removing.

ONE of the most remarkable illustrations of progress in electrical appliances is electrolytic painting. Hitherto, if copper or other metal had to be deposited electrically, a bath of solution was needed. Now all this is changed, and *Electricity* says a ship's hull can be plated as easily as a spoon or teapot. Instead of a bath, insoluble salts, ground to a fine powder and mixed with water, are used. This mixture is painted on the metal to be plated by a fine wire brush, to which one pole of a dynamo conductor is attached, the other pole being connected with a plate. Not only pure metal but all sorts of alloys can be used.

M. RAFFARD, writing to the Société de Physique with reference to the recent proposal for making glass for arc lanterns corrugated on both sides, mentions that in 1879 Bréguet supplied thirty large lamps for the Havre Harbour works. At first the lantern glass was painted white; but as this obscured the light too much, he had the idea of replacing the glass by two sheets of the ordinary corrugated glass of commerce, placed with the corrugations at right angles. The *Electrical Engineer* says this had the desired effect; the lantern became luminous over its whole surface, and the deep shadows were softened. The only objection is that the ground and object present a slightly mottled appearance, but this inconvenience was of no importance with the heavy work done in the shops.

SEVERAL novel features of construction will appear in the new building of the Manhattan Life Insurance Company, in the course of erection in Lower Broadway, New York. The great structure, as described in the *Scientific American*, will have a steel skeleton frame, and will tower aloft to an elevation of 300ft. above the curb line. The supporting piers of the building are to be sunk to bedrock by what is known as the pneumatic process. The reason for the employment of this plan is that the soil is a fine sand for a depth of about 50ft. overlying the rock. It would be a great risk to build so heavy a structure on the sand, and to excavate to such a depth would very likely result in undermining neighbouring buildings, especially as the soil is very wet. The difficulty is to be overcome by sinking pneumatic steel caissons, fifteen in number, by the same means that are often employed in laying the foundation for bridges, and which was used in connection with both towers of Brooklyn Bridge. When the caissons reach bedrock, the workmen inside level the rock, so as to give a firm bearing, and then fill in with concrete, so that the space from the top to the bottom of the caissons is solidly filled, and upon these piers in turn will be placed huge cantilevers, from which will be built up the skeleton steel structure of the building.

THE metric measures are in general use in Russia in scientific literature. They have also been adopted by the Mining Administration in all its publications, while the practical and commercial world, the railway and water communications engineers are using the decimal divisions of the Russian sagène—7 English feet. Professor Petrushevskiy, who has advocated since 1868 the adoption of metric measures, has published a scheme of metric measures, as near as possible to the present Russian measures, so as to make them easily acceptable to the population. The change is facilitated by the fact that the Russian sagène is very nearly equal to 2 m., and the versta is nearly equal to the kilometre, and the desiastina differs but little from the hectare. The system proposed by Professor Petrushevskiy is both plain and at once intelligible. It is, *Nature* says, that the new sagène shall be equal to the double metre—0.9374 of the present measure—and that a half sagène, equal to 1 m., shall be divided into 20 vershoks—5 cm. are equal to 1.1248 of the present vershok. Also that the new versta shall be equal to the kilometre—0.9374 of the present versta—the small desiastina to the hectare and to 0.9153 of the present desiastina; the big cube to 10 cubic metres and to 1.0296 cubic sagènes; the small vedro to 10 litres and to nearly four-fifths—0.8131—of the present vedro; the big measure—1000 litres—to nearly 5—4.795—tebet-veriks; and finally, the big pound—500 grammes—equal to 1.221 Russian pounds.

In a note on the marvellous accuracy of a battleship's movements, Admiral Colomb mentions the ship *Edinburgh*, one of the Mediterranean fleet, and says:—"Her turning powers were measured so as to fix her position at the moment the helm began to move, and when she had turned an eighth, a quarter, three-eighths, and half a circle. She was turned three times to the right and three times to the left, under the same conditions, at a normal speed of about twelve knots. The result was that, including all errors of observation, chords drawn from the point of starting to the points given above did not vary in length for the eighth of a circle turn more than 22 yards in 335; for the quarter-circle, more than 25 yards in 565; for the three-eighths of a circle, more than 25 yards in 687; and for the half-circle, more than 64 yards in 716. The angles that the chords formed with the original course of the ship did not vary, for the first chord, more than one degree in 13; for the second chord, more than two degrees in 33; for the third chord, more than two degrees in 53; and for the fourth chord, more than two degrees in 75. As to the times occupied, the accuracy is, perhaps, still more remarkable. The ship turned the eighth of a circle in 66 seconds, with a variation of only three seconds; she turned the quarter of a circle in two minutes and one second, with a variation not exceeding five seconds; she turned the three-eighths of a circle in 2 minutes and 58 seconds, with a variation not exceeding seven seconds; and she finished the turn of half a circle in 3 minutes and 54 seconds, with a variation not exceeding eight seconds of time. I have never known this accuracy of movement controverted by any experiment. It is equally present in the battleship and in the steam pinnace which she carries on her deck."

At a recent meeting of the Edinburgh Royal Society, Dr. H. R. Mill communicated a paper on the physical geography of the Clyde sea area. He considered specially the question of the distribution of temperature, discussing the observations made by the Scottish Marine Station staff on the West Coast of Scotland for March, 1886, to October, 1888, along with some other earlier and later observations made by Mr. J. Y. Buchanan and the Fishery Board for Scotland. In the North Channel, between Scotland and Ireland, the temperature was uniform from the surface to the bottom because of the action of the tides in mixing the water. The yearly average of the temperature of the Channel water was 2 deg. higher than that of the air of the Mull of Cantyre. The air temperature reached its maximum in the end of July, while the water temperature was greatest in the middle of September. The temperature varied greatly from surface to bottom on the broad shallow which stretches from Cantyre to Galloway, except at the time of the annual minimum, when it became uniform. The Channel water mixes there with the water from the great Arran basin. In that basin the temperature is the same from the surface to the bottom at the spring minimum in March, the lower layers being only slightly affected during the year—most so at the autumn maximum. The surface layers heat and cool rapidly; but the average temperature of the whole is always lower than that of the Channel, except for a month at the spring minimum. The maximum temperature in the basin occurs in October. In the more isolated sea lochs, such as Loch Fyne and Loch Goil, the absence of oceanic influence is more marked. Thus in Loch Fyne, though the temperature is nearly the same as at other places at the minimum period, it is colder during the rest of the year, and the difference between the surface and bottom temperatures is more marked.

MISCELLANEA.

THE Cleveland Bridge and Engineering Co. has been formed into a limited concern, with a capital of £25,000 in £10 shares. They will carry on the business of engineers and contractors for and manufacturers of iron and other bridges, and also the trade of iron manufacturers.

AMONG the papers to be read during the next session of the Institution of Electrical Engineers, will be one on "The Electrical Transmission and Distribution of Power at Niagara Falls," by Professor George Forbes, F.R.S.; and a paper upon "The Electric Lighting of the City of London," has also been promised by Sir David Salomons, Bart., Vice-president.

AN interesting and important report to the Hornsey Local Board has been prepared by Mr. T. De Courcy Meade, M. Inst. C.E., on the compulsory provision of intercepting traps to house and other drains, and on the testing of new drains by water test, and subsequently by smoke test. The report is accompanied by engravings, which illustrate the question in a manner useful to the members of the Board.

AFTER negotiations, which have been in progress since November last, a Special Committee of the Portsmouth Town Council have decided to recommend the purchase of the local water supply by the town. The directors of the company have reduced the amount of purchase from £1,100,000 to £1,005,000, which they have agreed to take in Corporation 3 per cent. stock. The Committee propose that, with the consent of the Local Government Board, the money should be borrowed and its payment extend from ninety to 100 years.

THE first-class protected cruiser *Theseus*, noticed in this column in our last issue as being ready for delivery from the works of the Thames Ironworks at Blackwall, is to be taken over by a navigating party from H.M.S. *Pembroke* on the 12th inst. for transport to Chatham Dockyard, where she is to be armed and completed for commission, £10,000 having been provided for that purpose in the Naval Estimates for the current year. The *Theseus* is the last of the cruisers of her class to be delivered under the provisions of the Naval Defence Act of 1889.

THE reconstruction of her Majesty's battleship *Monarch*, the oldest armoured vessel in the Navy, is proceeding apace at Chatham Dockyard. As she is to be fitted with new and powerful engines by Messrs. Maudslay, Sons, and Field, of Lambeth, this will involve the pulling to pieces of the stern portion, but when completed she will be one of the most powerful armoured ships of her class. The cost of the alterations to be made in her will be close upon £100,000. The *Monarch* was built at Chatham Dockyard twenty years ago, and took part in the bombardment of Alexandria in 1882.

ON the 23rd of last month the official inauguration of the Maritime Canal of the Basse Loire took place. This work was commenced just eleven years ago; but very little progress was made—except a brisk start—until 1886, as the funds were not over-abundant. For the two following years after that date, the undertaking was vigorously pushed forward. It was during that period that the hardest part of the task was accomplished, which was the construction of the great Migron dam. The length of this work was close upon three miles, and it was a matter of some difficulty to make it staunch. An advance of £180,000 from the Chamber of Commerce of Nantes in 1889 paved the way for the speedy and successful termination of the enterprise.

AN oil launch has recently been sent by Messrs. Vosper and Co. to Sir James Calquhoun, of Loch Lomond. She is a handsome 30ft. boat, built of teak, has a nice cabin 6ft. long, and this is continued over the engines, which are placed aft. This not only gives a good cabin, but a 7ft. cockpit also. There is 6ft. of deck, on which the steering wheel is placed, with voice-tube to the engine-room. The boat is also fitted so that one man can both drive and steer. The engine is six brake horse-power, and drives her over seven miles per hour. The firm has now, we are informed, a similar boat under construction, and several engines for boats being built in various parts of the world, the engines being of the Roots type.

In their half-yearly engineering trades report, Messrs. Matheson and Grant say:—"The decline in trade during 1892 culminated in the spring of this year, but since that time there have been signs of recovery in many branches, and this improvement seems likely to continue and extend. The falling off in the demand for all kinds of engineering material has been the more marked, because of the peculiar combination of causes. Enterprise in South America had already been arrested by the failures of 1891-2, when the financial difficulties of Australasia reduced greatly the purchasing power of all the Colonies and developed into the bank failures of the present year. Since then Eastern trade has been embarrassed by the uncertainties of the silver question, which cloud the future. The metal markets have been, and still are, more unsettled than for many years past."

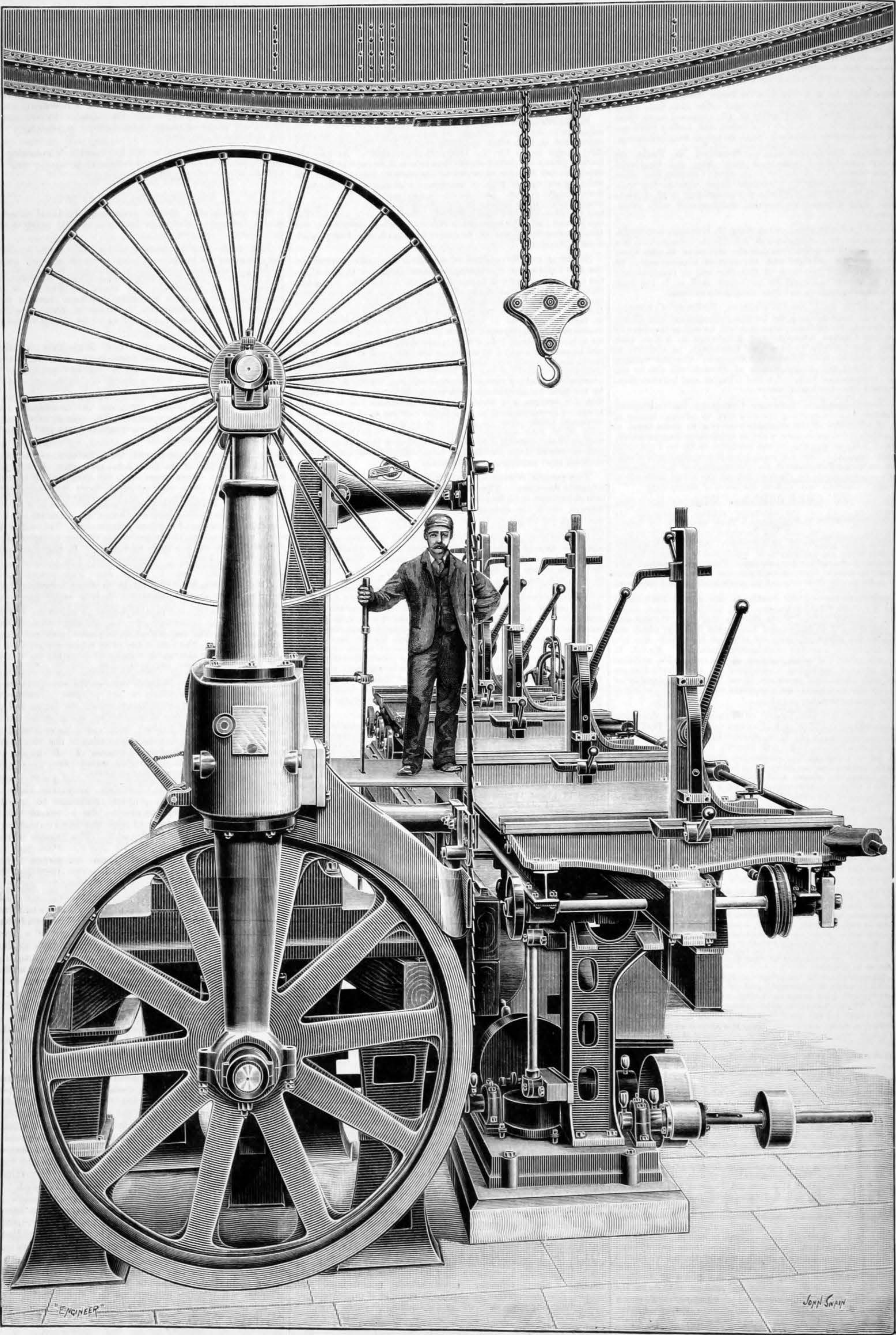
ARRANGEMENTS have now been completed for the Royal Agricultural Society's fifty-fifth annual country meeting, which will be held at Cambridge, on Monday, June 25th, 1894, and four following days. The implement yard and dairy will be open on the previous Saturday, June 23rd. The final dates for the receipt of entries for this meeting will be as under:—Implement, &c.: Saturday, March 31st, 1894; post entries, Saturday, April 7th. Live stock, poultry, and produce: Tuesday, May 1st; post entries, Saturday, May 12th. The detailed regulations as to the exhibition—not for competition—of implements, machinery, seeds, roots, manures, and other articles, and as to the prize sheet for live stock, poultry, and produce, will not be settled until after the recess. The following among other prizes for competition at the Cambridge meeting have already been settled by the Council:—Fixed oil engines, of 4 to 8 brake horse-power, £50 and £25; portable oil engines, of 9 to 16 brake horse-power, £50 and £25; horse-power machine for distributing *Bouillie Bordelaise* or other mixture on potatoes, £10; machine for distributing insecticides and fungicides upon fruit trees and bushes, £10; sheep-dipping apparatus, £5. The regulations for the trials of oil engines are now ready, and a copy will be sent on application to the secretary.

A COMPREHENSIVE scheme for street improvements in London, accompanied by maps and sketches, illustrating the principles on which the scheme has been prepared and the reasons for their adoption, by Mr. Arthur Cawston, A.R.I.B.A., has been published by Mr. Edward Stanford, Charing Cross. Mr. Cawston's central idea is this:—"That a comprehensive scheme, not necessarily his own scheme, for the improvement of the streets of London, should be devised, and that immediately; that in its elaboration the advice of experts most competent to give it should be retained, so that the plan should not only be the most practically convenient possible, but that it should secure our existing architecture being seen to the greatest advantage, as well as affording well-considered sites for future public buildings; that in carrying out this comprehensive plan, whenever a new street dislodges any considerable number of our working population, means should be simultaneously taken for their being housed elsewhere in health and comfort; that the cost of these works should be spread over many years, and that we should not run into further debt for their execution, but only spend each year what has been raised for this purpose during the past twelve months." Mr. A. Waterhouse, R.A., past-president R.I.B.A., says his idea seems eminently practical and sensible, and one which will sooner or later find favour. It is to be hoped sooner, rather than later, for every year lost in inaction will increase the difficulties of the great problem and the cost of its ultimate solution.

LOG BAND SAW, WITH EIGHT-FEET WHEELS

MESSRS. J. SAGAR AND CO., HALIFAX, ENGINEERS

(For description see page 116)



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CONTENTS.

THE ENGINEER, August 4th, 1893.		PAGE
HEAT TRANSMISSION THROUGH METAL PLATES. (Illustrated.)	107	107
BIRRIZ VIADUCT—COSTA RICA RAILWAY. (Illustrated.)	109	109
THE STIRLING BOILER AT THE CHICAGO EXHIBITION. (Illus.)	110	110
ON RECENT DEVELOPMENTS IN THE CLEVELAND IRON AND STEEL INDUSTRIES	111	111
ELECTRICAL ENGINEERING AT THE CHICAGO EXHIBITION. (Illus.)	112	112
JUBILEE OF THE ROTHAMSTED AGRICULTURAL EXPERIMENTS	115	115
A LARGE LOG BAND-SAW. (Illustrated.)	116	116
SINKING AND DRIVING IN WATER-BEARING STRATA WITH THE AID OF CONGELATION	117	117
MACHINE FOR CUTTING-OFF HEADS OF IRON PILES. (Illustrated.)	117	117
THE ZELL BOILER AT CHICAGO EXHIBITION. (Illustrated.)	118	118
RAILWAY MATTERS—NOTES AND MEMORANDA—MISCELLANEA	119	119
LEADING ARTICLES—Some Maritime Questions—The Principles of Combustion	121	121
The Late Admiralty Circular—The Expiry of the Lamp Patents—The First Transatlantic Steamer—Tunnel under the Great Belt	122	122
Taxation of Foreign Machinery—The R.A.S. Reaper Trials—Abridgment of Patent Specifications	123	123
LITERATURE	123	123
BOOKS RECEIVED	123	123
BLITHE'S HAY AND STRAW PRESS. (Illustrated.)	124	124
THE ORIEL LUBRICATOR. (Illustrated.)	124	124
WICKSTEED'S TUBE EXPANDER, TUBE CUTTERS, AND BEADERS. (Illus.)	124	124
ELECTRIC LIGHTING IN HUDDERSFIELD	124	124
THE NAVAL MANŒUVRES	125	125
INSTITUTION OF MECHANICAL ENGINEERS AT MIDDLESBROUGH	125	125
THE COAL CRISIS AND THE IRON TRADE	126	126
LETTERS TO THE EDITOR—On Carnot's Function of the Temperature—Tube-frame Trucks on Irish Railways—Thermodynamics—The Japanese Cruiser Yoshino	126	126
AN ACCOUNT OF SOME EXPERIMENTS ON THE TRANSMISSION OF HEAT THROUGH STEEL PLATES, FROM HEATED GAS AT THE ONE SIDE TO WATER AT THE OTHER. (Illustrated.)	127	127
LOG FRAME WITH TRAVELLING RACK. (Illustrated.)	128	128
TIGER PIPE WRENCH. (Illustrated.)	128	128
S.S. LUCANIA	128	128
THE BATTLESHIP MASSACHUSETTS, UNITED STATES NAVY. (Illus.)	129	129
AMERICAN ENGINEERING NEWS	130	130
LETTERS FROM THE PROVINCES, &c.—The Iron, Coal, and General Trades of Birmingham, Wolverhampton, and other Districts—Notes from Lancashire—The Sheffield District—The North of England	131	131
Notes from Scotland—Wales and Adjoining Counties—Notes from Germany	132	132
AMERICAN NOTES	133	133
LAUNCHES AND TRIAL TRIPS	133	133
THE PATENT JOURNAL	133	133
SELECTED AMERICAN PATENTS	134	134

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MEETINGS NEXT WEEK.

THE JUNIOR ENGINEERS.—Nine days' summer excursion in Wiltshire, Devonshire, and Cornwall, August 11th to 19th. The programme includes visits to the works of the Great Western Railway Company, Messrs. Harvey and Co., and Messrs. John Freeman, Sons, and Co., and to Keyham Steamyard, Devonport Dockyard, Stonehouse Victualling Yard, the Botallack Mine, Camborne Museum, the Dolcoath tin and copper mines, &c. Arrangements have also been made for excursions to Land's End, Truro Cathedral, and Exeter Cathedral and Palace Gardens; and for picnic parties and steamboat trips.

THE ENGINEER.

AUGUST 4, 1893.

SOME MARITIME QUESTIONS.

THE importance of the subjects under discussion at the recent Maritime Congress, and the advantage to the maritime commerce of this country of bringing together representatives of harbour authorities from all parts of the world, for the purpose of comparing notes, was clearly brought out by the President of the Board of Trade, Mr. Mundella,

in his speech at the opening meeting, when he called attention to the fact that the British Empire, including the Colonies, possessed six million tons of steam shipping, and four and a-quarter million tons of sailing vessels; and that our shipping had increased seventeen million tons during the last twenty years.

The provision of docks and harbours for berthing, and for loading and unloading the vessels which trade to and from Great Britain, has, almost without exception, been provided by private enterprise, in this respect bearing a great contrast to the method of procedure in France, Italy, and other Continental ports, and even in America, where all the great maritime works are under the charge of the State. This fact, especially as regards France and Italy, was prominently brought out in the various papers that were contributed by foreign engineers on docks and their equipment. On the other hand, the British Legislature, while thus leaving the provision for the development of the commerce of the country to private enterprise, has held a very tight control over the manner in which these enterprises shall be carried out. The promoters of docks and harbours are handicapped by heavy preliminary expenses in obtaining parliamentary powers before they can commence the works; and shipbuilders and shipowners are equally handicapped by stringent and embarrassing regulations which place them at a great disadvantage with those of other countries. Professor Biles, in his speech on Mr. Seaton's paper on "Steam Communication with the Continent," stated as an instance of this that the Brighton Company had a project for building a vessel of great speed to put on the Newhaven and Dieppe route, but it was found that the limitations of the Board of Trade being more stringent than those of France, it would not pay to build such a vessel here; and with regard to the type of boilers proposed to be used, there was also a danger that when the vessel was ready for sea she would be refused her certificate. In attempting to design new departures in this country, shipbuilders always have the fear before them that their vessels when completed will not be passed by the officers of the Board of Trade.

As between the two great sections into which the Maritime Congress may be said to have been divided—the shipbuilders and the constructors of docks and harbours—the former are moving more rapidly than the latter. Mr. Daynard, speaking from his experience of the Compagnie Transatlantique, impressed on the members representing the other sections the necessity of deepening those ports frequented by passenger ships, in order that fresh progress might be made in the construction of well-proportioned vessels. It was also pointed out by other speakers that the question of depth was becoming a matter of vital importance. Mr. W. H. White, speaking at the discussion on the paper on the Mersey Bar, said that unless dock and harbour engineers gave increased depth of water, naval architects and marine engineers would be soon brought almost to a standstill in the designing of vessels. At present the draught of water is below the standard required for ships of the largest dimensions, and navigation must, therefore, wait on the civil engineers unless most undesirable proportions of vessels were had recourse to. At present the limit on the Liverpool and New York line is 26½ ft. It was contended that if this could be extended to 30 ft., it would be equivalent to enabling a shipbuilder to add another 100 ft. to the length of the vessels now in use, and consequently to the attaining of a greater speed. At Southampton a commencement has already been made towards providing the required 30 ft. No doubt, if this is done on this side, the same depth will be given by the Americans at New York. In summing up the discussion on this matter, Mr. White remarked that it was true that ships could be built more quickly than docks, and had shorter lives; but he advised that engineers should look ahead. At Birkenhead, docks had been planned and executed a quarter of a century ago with a foresight that enabled them to hold a prominent position at the present day. He almost felt inclined to suggest that a resolution should be passed by the section over which he was presiding calling on the other sections, who had charge of such matters, to give greater depth of water in docks and harbours.

Another matter which gave rise to considerable discussion was the relative value of paddles as against screws for the boats engaged on the Continental traffic, more especially as affected by this question of depth. The general opinion appeared to be that twin-screws had an advantage over paddle-wheels in giving a better average performance in all weathers, the rough weather steaming approaching very closely to that in smoother water, supposing that sufficient draught was given; but that below a certain limit of draught the better results obtained by paddle-wheels in fair weather raise their average. In paddle steamers there is not experienced so much rolling in a heavy sea, but such vessels are subject to a very unpleasant action when driving into a head sea, owing to the shock of the waves striking the paddle-boxes. The twin-screws also derive an advantage from the duplication of the machinery, and from the fact that the saloon can be placed in the best part of the vessel. Mr. Doxford, while admitting these advantages for the twin-screws, said it must be remembered that to progress in this direction it was necessary to have deeper water accommodation. This was the key of the situation. If the engineer would provide this, the shipbuilder would not be long in rising to the occasion.

Bearing further on this question of deep water was the paper by Mr. Lyster on the "Deepening of the Mersey Bar." It is unnecessary to refer in any detail to this, as we have so recently given a full account of the operation. The discussion added very little light on the matter. Mr. Conrad, the engineer of the Maas, gave it as his opinion that it is possible to make a channel in this way, but the question arose whether it could be maintained in rough weather. The conclusion drawn by the French engineer in charge of the works on the river Loire, from experience obtained in dredging 2,000,000 tons of sand from that river, was that the accumulation at

the mouth of a river being once removed the future maintenance would be small. The opinion expressed by Mr. P. de Mey, in his paper on the "Maintenance of Ports on Sandy Shores," from experience gained in his dredging operations in opening a channel through the sandy banks obstructing the approach to Ostend, bears to the same effect.

The general impression left by the papers and discussion is, that in maritime engineering there is no condition of "rest and be thankful." The continued demand is for greater quickness of despatch, both in transit and in loading and unloading. To accomplish this vessels must be made of greater length and deeper draught; and for their accommodation deeper channels must be dredged, the size of locks must be increased, and the depth of water on their sills increased. Docks must be equipped with efficient machinery, particularly of a movable or floating type, for dealing with cargoes rapidly and economically, and as far as possible dispensing with that most uncertain and unreliable agent the dock labourer, and his master the agitator.

THE PRINCIPLES OF COMBUSTION.

THE conversion of the potential chemical energy of fuel into heat, and thence into mechanical work, being a process of primary importance to the engineer, to whatever branch of the profession he may belong, all new light thrown upon the *rationale* of that process must be of interest to him, and capable of practicable application, immediate or ultimate. We therefore hasten to make known to an English-speaking audience certain of the results of an investigation by Herr R. Ernst, published as an inaugural dissertation at the University of Giessen, which bear directly on this subject.

It is a matter of common knowledge that carbon, the chief constituent of most fuel, forms two oxides possessing the systematic names, carbon monoxide and carbon dioxide. When carbon or carbonaceous fuel burns in air, both oxides are commonly produced, the proportion of each depending upon the conditions under which combustion takes place. The nature of these conditions has been hitherto a matter of doubt. The cut-and-dried explanation—to be found, for example, in the baser sort of text-book—is that carbon monoxide is formed when the air is in defect, and carbon dioxide when it is in excess. This is just one of those neat, plausible statements which square so nicely with the preconceived ideas of the superficial inquirer, that to rob him of them would be a cruelty. Robbed, however, he must be, if the substitution of fact for pious opinion may be called robbery. What actually occurs when carbon is oxidised is a good deal less simple than he thinks. In the first place, oxidation begins at a comparatively low temperature—e.g., about 400 deg. C. (752 deg. Fah.)—and carbon dioxide is formed as the main product, whether the air be in large or small quantity. Only a small amount of carbon monoxide is simultaneously produced. The rate of combustion increases as the temperature rises to 700 deg. C. (= 1292 deg. Fah.), but the chief product of combustion is still carbon dioxide, even when the air is so far from being in excess as to make it possible for the exit gases to contain 20 per cent. by volume of carbon dioxide, which is almost the theoretical maximum—proving the consumption of the whole of the oxygen. Therefore it appears that under conditions which, as far as the proportion of air to carbon is concerned, are most favourable to the formation of carbon monoxide, mere traces are produced. When it is considered that in the combustion of solid fuel in industrial furnaces of all kinds, the absence of a large excess of air—which often amounts to 50 per cent. of the total volume of the exit gases—inevitably means the presence of carbon monoxide alone, or accompanied by soot in quantity sufficient to horrify a factory inspector, the existence for a reason for the discrepancy between the real and the ideal oxidation of carbon may be readily foreseen. The reason is this:—Above the temperature of 700 deg. C.—1292 deg. Fah.—the proportion of carbon monoxide to carbon dioxide rapidly increases, until when 995 deg. C.—1823 deg. Fah.—is reached, the former gas is exclusively produced. Mere length of column of heated carbon will not suffice to induce the formation of carbon monoxide—a minimum temperature has to be attained. It may be incidentally remarked that these observations throw light on a phenomenon which has hitherto received no adequate explanation. When carbon is oxidised at a moderate temperature, e.g., about 700 deg. C.—1292 deg. Fah.—it burns without flame, whereas when the temperature is higher, as, for example, 1000 deg. C.—1832 deg. Fah.—a flame accompanies its combustion. In the former case it burns direct to carbon dioxide, itself an incombustible gas, and in the latter to carbon monoxide, which, on getting beyond the zone of highest temperature, burns with a further supply of oxygen with its characteristic blue flame.

Some deductions of considerable practical significance are easily drawn from these results. In the first place the complete combustion of the carbon of carbonaceous fuel—always assuming that the other constituents of ordinary fuel were shown not to interfere with the course of the reactions which we have described—could be effected with the theoretical amount of air if the temperature of combustion could be kept so low that the maximum temperature at which the exclusive formation of carbon dioxide takes place were not exceeded. To effect this, it would either be necessary to allow the rate of combustion to be small, or to take steps for the rapid transference of heat from the combustion chamber to the material to be heated. There are considerable difficulties to be encountered in either course. Slow combustion—that is, small consumption of fuel per unit of time—involves loss by the enhanced influence of those factors, such as escape of heat by conduction and radiation, which vary directly as the time during which they operate. Rapid transference of heat can only be achieved by intimate contact of the fuel and the substance to be heated, or by the interposition of the

thinnest possible layers of the best possible conductors between them, and these postulates involve the consideration of questions of chemical action and mechanical strength, differing with each case, and far too complex to be now discussed. Nevertheless, taking the accuracy of Herr Ernst's work for granted, the fact remains, and its utilisation is only a matter of time and opportunity. The obtaining of the most perfect combustion of fuel with the theoretical minimum of air, must not be confused for a moment with the production of the highest possible temperature. The conditions for the two results, so far from being identical, are actually antagonistic, if not mutually exclusive. This will be clearer from the consideration of the second deduction that may be made from the same data. Seeing that the oxidation of carbon at temperatures above 995 deg. C.—1823 Fah.—results in the formation of carbon monoxide, and that it is therefore impracticable to burn it at such temperature direct to carbon dioxide, the best method of obtaining very high temperatures industrially is to consume the carbon monoxide as fast as it is formed by the admission to a point beyond the solid fuel of a further supply of air, the combustion of the carbon monoxide being thus effected, while it yet retains the sensible heat imparted to it by the reaction to which it owes its origin. But this is nothing more nor less than the principle of the producer. There the fuel is gasified in one vessel and finally burnt in another. The whole question of the principles underlying its working, and the best mode of utilising the sensible heat of a producer worked solely with air, have been treated by us at length in a recent article, and need not be repeated here. It is enough to point out that the truth of our second deduction has been long recognised in practice, and that the producer is *par excellence* the means now commonly employed for the attainment of high temperatures in manufacturing processes. Practice is as much ahead of theory in this instance as it is behind it in the former. It is interesting to note that as solid carbon has to be converted into gaseous products of combustion, a certain quantity of heat is absorbed in the work of gasification, and the maximum temperature that can be reached by its means is thereby diminished. Could carbon be gasified and then burnt, a considerable increase would be gained. The nearest approach to this is, as has recently been pointed out, the combustion of some gaseous compound of carbon, such as cyanogen, in the formation of which work equivalent to the heat of gasification has already been done. The third and last deduction of utility that can be drawn is that the temperature of a producer should not fall appreciably below 1000 deg. C.—1832 deg. Fah.—as otherwise an undue proportion of carbon dioxide will be formed. No doubt the skilled workman in charge of producers has long ago settled what is the proper "heat" at which they should be run, and shows excellent judgment in regulating the temperature merely by his trained instinct, but he would be no worse off if aided in his task by the use of a thermo-electric pyrometer, so as to insure the maintenance of the best working conditions, even should his senses momentarily mislead him. In any case it would be interesting to ascertain the temperature of a typical producer running at its best in the opinion of its attendant, and compare it with that deduced from these investigations. The researches that have served as our text afford a striking instance of the advantage to be derived from the investigation of principles for their own sake, a dictum always accurate even when the utilitarian character of the deductions that may be made from them is less obvious than in the case of the present experiments, the full fruit of which will be gathered when they are extended to commercial fuels, and the modifying influence of less prominent constituents determined, so that generalisations capable of immediate and extended application may be based upon them.

THE LATE ADMIRALTY CIRCULAR.

OUR Naval engineer readers will not need reminding of the persistency with which we have, from time to time, advocated a change for the better in the matter of an increase of engineers, and in the ratings of engineer artificers, and others on board her Majesty's ships. The long-promised Admiralty Circular dealing with these subjects has at length appeared, and has been promulgated at the principal Naval ports within the past month. This Circular, after stating that the Lords Commissioners of the Admiralty have had under consideration the provisions necessary to meet the increased requirements of the engine-room departments in her Majesty's ships consequent on the completion of the vessels built under the Naval Defence Act of 1889, goes on to state that the following changes approved by her Majesty's Order in Council of the 15th of March, 1890, have been decided on:—The number of fleet, staff, and chief engineers will be gradually increased, and that of engineers and assistant engineers correspondingly reduced, during the next three years; the former from 250 to 280, and the latter from 487 to 457. The engine-room complements of her Majesty's ships have been revised, and the new scheme—shown in Mobilisation Return No. 1—will come into force as ships are commissioned, but will not affect ships in commission at its date without special orders from the Admiralty in each case. The total number of engine-room artificers' ratings in the fleet will not be altered, but the proportion of chief engine-room artificers will be increased by one-fourth of the total number borne, instead of one-fifth, as at present. The number of chief stokers borne in the fleet will be increased, and a new class, to be known as second-class leading stokers, will be established to meet the requirements of the revised complements. The changes in the rank and pay for the various ratings are as follows:—To qualify for chief engine-room artificer, engine-room assistants must have served not less than eight years, five of which must have been actual service afloat, and they must possess in all cases a certificate, signed by the captain and engineer officer of the last ship served in, to the effect that they are considered fit for advancement to the rating, and pass the prescribed examination. In the case of engine-room artificers now serving who are desirous of being advanced to the rating of chief engine-room artificer, this examination is to be necessary in the case of all who have less than six years' service at the date of this order. To

qualify for chief stoker a man must be a leading first-class stoker of ten years' service and a stoker mechanic; but in very exceptional cases, to meet service requirements, the commander-in-chief may rate men—not having these qualifications, but in every other way considered suitable—acting chief stokers, he reporting having done so in each case. Such men must pass a qualifying examination before an inspector of machinery, or, where no inspector of machinery is borne on the station, the chief engineer of the flagship, being first passed provisionally before the engineer officer of the ship in which they are serving. Chief stokers, in consequence of the more important duties to be performed by them, and the extra qualifications which will be required of them, will receive as continuous service pay 3s. per day on advancement to the rating, to be increased every third year by 6d. a day, to a maximum of 5s. a day. Those now serving will receive the new rate of pay from April 1st, 1893, according to their length of service in the rating. To qualify for the rating of first-class leading stoker a man must have served as leading stoker of the second class for one year. For continuous service the pay is to be 2s. 6d. per day. All leading stokers now serving are to be rated as first-class leading stokers, and to receive the new rate of pay from April 1st, 1893. Continuous service stokers of four years' service, or of three years' service if stoker mechanics, are to be eligible for the rating of second-class leading stoker. They must pass a test examination by the engineer officer of the ship in which they are serving, and their pay is to be 2s. 3d. per day. Such are the changes, made after long expectancy on the part of some of the hardest-worked of her Majesty's loyal and faithful subjects and servants in their pay and position. We suppose they must, like many another, be thankful for small mercies received; but we hope the day is not far distant when their status and remuneration will be still further improved, and brought more into accord with that due to those whose duties are very trying, and at times more than dangerous to perform.

THE EXPIRY OF THE LAMP PATENTS.

It will, perhaps, both be interesting and appropriate at the moment to refer to a subject which has long engaged the attention of the electric light industry, and which is now receiving even greater consideration. We refer to the expiry, in November next, of the incandescent lamp patents owned by the Edison and Swan United Electric Light Company. This company, it is scarcely necessary to mention, have a monopoly of the manufacture of incandescent lamps in the United Kingdom, and that monopoly has been rigidly maintained, even when its enforcement has resulted in the shutting down of other lamp works in the country. What, it may be asked, will take place in November? Will the market be flooded with cheap lamps of home and foreign manufacture? and will they be as good or have as long a life as those now obtainable? These are important points. It is understood that arrangements have for some time past been in progress in different quarters for the production of glow lamps immediately on the lapse of the company's patents, and it may reasonably be expected that large numbers of cheap English-made lamps will be put on the market, whilst foreign firms are practically ready at the present to deluge us with their lamps. It must be borne in mind that the process of manufacturing incandescent lamps is not an easy one; it cannot be learned in a day, a week or a month—it requires a considerable period to teach workmen to make good and efficient lamps. Users of the electric light do not want the cheap and nasty lamps—they require efficient lamps. They would prefer to pay, say, 3s. 6d. for a good lamp having a life of from 500 to 800 hours, rather than purchase two lamps for the same amount, and having, say, only a combined life of 600 hours. No doubt when the patents expire there will in many cases be a rush for the cheap lamps, and for that matter such a proceeding will be perfectly justified. The price of 3s. 6d. or 4s. for a lamp costing, according to Mr. J. Staats Forbes, the chairman of the Edison and Swan United Company, only 9d. to produce, seems an extraordinary figure; but such a charge will not be enforced much longer. As Mr. Forbes mentioned on Friday last, when the company emerged from protection, they would be prepared for competition. The prices will be reduced, although to what extent does not yet seem clear; but as the company can manufacture as cheaply as any one in Europe, they should be able to sell as low as any other makers. However this may be, a diminution in price will be welcomed, though this would not happen were it not for the expiry of the patents and the consequent competition in the business. There will be competition, perhaps very severe, from home firms; but the prospects of the latter would not be regarded as satisfactory unless they produced lamps equally as good as those in use, and at the same price to which the latter will be reduced; but it will take some time to turn out efficient lamps, and the lamp which proves to be the best in actual use will predominate. As far as foreign competition is concerned, we do not think there is much reason for assuming that it will be considerable. Some American firms are preparing to introduce lamps in this country in a few months, and they have some new simple forms, but the lamp business in the United States is not in a very happy condition just now. The new lamps being introduced have yet to be perfected before they can stand practical usage and be considered efficient, and for that reason alone some time must elapse before competition from that quarter need be seriously considered. Perhaps of European countries, Germany is the one from which much rivalry may be at once anticipated; but the possible opportunity of Germany is so clearly represented by the following statement as to need no comment. The statement is from a German electrical engineer in London, and was made to the *Elektrotechnische Zeitschrift* of Berlin some six weeks ago. He concludes "that German makers cannot place much hope in the throwing open of the English market, and that in most cases, on account of the great home competition of the already good makes of lamps and the protection of English goods on the part of the authorities, difficulties would be encountered which would require considerable sacrifices." To sum up, it may be concluded that foreign competition will not be of much importance, that lamps will be cheaper, although probably having a shorter life, and that the lamp business will considerably improve; but it will not yet bring us the fulfilment of Mr. Preece's dream of the "poor man's light."

THE FIRST TRANSATLANTIC STEAMER.

FOR a considerable number of years an object of profound veneration in the rooms of the Literary and Historical Society of Quebec has been the model of the Royal William, a steamer built at Quebec in 1830-31, and which crossed the Atlantic

under steam in 1833. A duplicate of this model forms part of the Canadian exhibit in the World's Fair at Chicago, and, following up the prominence thus afforded to the subject, the people of Quebec and Halifax are at the present time urging upon the Canadian Government the propriety of issuing an official publication making clear the vessel's claims to be considered the pioneer steamer on the Atlantic, or "the first transatlantic steamer," and of taking steps to appropriately celebrate the sixtieth anniversary of the first crossing, which falls due this month. In view of the confusion which seems still to prevail in many quarters with regard to the conflicting claims put forward for the distinction of having produced "the first transatlantic steamer," there does seem to be some call for a decisive deliverance on the subject and commemoration of the event. In connection with this subject Americans never fail to put forward the Savannah; Canadians urge the Royal William, and Britons swear by the Curacoa, or the Sirius, and the Great Western. Loosely worded statements regarding the introduction of steam vessels make out the Savannah as the first steamer to cross the Atlantic. It is true that in 1819 this vessel made the voyage from Savannah in Georgia to Liverpool in twenty-five days, but she was not a steamship in any true sense, but a full-rigged packet ship on whose deck a small steam engine was fitted, actuating portable paddle wheels, which were used only in smooth water and when the wind failed. The wheels were taken on deck frequently in the course of the voyage, and were only in use during eighteen of the twenty-five days the voyage lasted. This clearly enough disposes of the Savannah's claim to being the first steamer to cross the Atlantic, although doubtless the first vessel to use steam as an auxiliary agent of propulsion in crossing. A more formidable rival for the distinction presents itself in the English built, but Dutch owned, steamer Curacoa, of 350 tons and 100-horse power, which in 1829 made several successful voyages between Holland and the Dutch West Indies. As an event in the introduction of steam navigation, this is certainly quite as notable as the achievement of the Royal William, which we will now refer to, but it does not partake of the interest which naturally attaches to the crossing of that part of the Atlantic between the old and the new world, which has in the present day become so renowned an arena for the development of the steamship. The Royal William was built in Quebec by a Scotchman named James Goudie, who had served his time and learned his art in Greenock. The keel was laid in the autumn of 1830, and she was launched in the following May before a large and distinguished concourse of spectators, amongst whom were the Governor-General, Lord Aylmer, and his wife, the latter giving the vessel her name. After her launch she was taken to Montreal and there received her engines which had been made in Britain. The vessel, propelled by steam alone, traded for about a year between Quebec and Halifax; but owing to the general paralysis of business attending the cholera epidemic of 1832, it was resolved to send her to Britain to be sold. Accordingly, in 1833 the eventful voyage was made successfully without any mishap of any kind. She left Quebec on the morning of August 4th, 1833, commanded by Captain John McDougall, and including a detention of two days at Pictou, Nova Scotia, she arrived at London after a voyage of twenty-five days. Her captain wrote:—"She is justly entitled to be considered the first steamer that crossed the Atlantic by steam, having steamed the whole way across." In 1833 the Royal William was disposed of for £10,000, and chartered to the Portuguese Government. In September, 1834, she was acquired by the Spanish Government, and after alterations, fitting her for warlike service, and under the new name of Yesabel Segunder, was employed on the north coast of Spain against Don Carlos. In 1838, the hull being surveyed at Bordeaux, it was found that the timbers were so much decayed that it was decided to build a new hull to receive the engines, which had been kept in good repair. This was done, and the hull of the pioneer steamer on the Atlantic was converted, or degraded, into a hulk at Bordeaux. When all is said, however, the Royal William can hardly claim to be "the first transatlantic steamer," in the sense of having been specially built for, and of having continued on the service after the initial voyage. The first transatlantic steamers in this sense were the Great Western and the Sirius, both of which vessels arrived at New York from the old world on Monday, April 23rd, 1838, and returned again within a week of each other. The Sirius did not again cross the Atlantic, but the Great Western continued to cross and re-cross, her subsequent voyages being greater triumphs than the first. The place of the Sirius was taken by a vessel also called the Royal William, but not to be confounded with the Canadian-built vessel. This second Royal William belonged to the City of Dublin Steam Packet Company, and she was despatched for New York by a syndicate of Liverpool merchants on July 6th, 1838, her performances being much like those of the Sirius, and less satisfactory than those of the Great Western.

TUNNEL UNDER THE GREAT BELT.

COPENHAGEN, owing to its isolated position in the Isle of Zealand, is cut off, not only from a portion of Danish territory, but from the shores of Schleswig-Holstein and from the Continent generally, by the waters of the Baltic, and the two inlets of that sea known respectively as the Great and Little Belts. In fact, during winter time the water communication is seriously interfered with by the gathering of the ice in the frozen north. Zealand is separated from the island of Funen by the Great Belt, and Funen in its turn is divided from the mainland by the Little Belt, which towards the northern part of that island assumes very contracted dimensions. In order to overcome these natural barriers to a direct land communication between the Danish capital and the rest of the world, a project has been started of a somewhat extensive and important character which is now exercising the minds of the engineers, authorities, and capitalists at Copenhagen. It has for its object the establishment of a direct land communication between Zealand and the Continent of Europe. So far as the smaller of these tributary seas is concerned, the scheme presents no particular difficulty, as the transit across the Little Belt might be accomplished by means of a bridge on the cantilever principle. With the Great Belt, however, matters could not be managed in quite so simple a manner, as its width is far too great, notwithstanding the opportune existence of an island situated in mid-channel, to be spanned by any ordinary bridge of dimensions hitherto attempted. Under the circumstances, the Danish engineers consider the undertaking should assume the form of a tunnel in that portion of its length which concerns the passage of the Great Belt. It is stated that the configuration of the ground between the two islands is peculiarly favourable to the construction of such a work. The length of the tunnel would be a little over eleven miles, and now that the Channel Tunnel Bill has been

withdrawn, for this session at any rate, the new project will have a fair field to itself as a constructive experiment. Besides the obvious convenience and security of the proposed new route, it would shorten the distance between Copenhagen and the mainland very considerably, and also effect a saving of time in the transit of both goods and passengers. It has been estimated that the Little Belt bridge would cost nearly seven hundred thousand pounds, and the Great Belt tunnel not far from a million and a quarter. A couple of million pounds would probably see the whole affair through, which cannot be regarded as an exorbitant amount for a work of international interest and importance.

TAXATION OF FOREIGN MACHINERY.

WHAT may prove to be a valuable contribution to the rating of machinery question in this country has just been made by the Foreign-office. It takes the form of a series of reports from British Consuls abroad on exemptions from rating and taxation of manufactories and machinery outside England. The reports hardly make it clear that the Consuls have in all cases understood the precise nature of the questions addressed to them. But, in any event, the information is interesting and instructive, and it is likely to be employed by the Machinery Users' Association, and by the advocates in Parliament of the exemption of machinery measure in support of the relief movement. Hungary is a peculiar illustration of exemptions, which are of the nature of bounties, freedom from taxes on profits, from general income tax, and so on, having been granted to new manufactories for the production of articles not previously turned out in Hungary, and to the textile industries for their extension. In Belgium no exemptions are granted, and a similar state of things is reported by the British Consul in Berlin. But the Consul at Dusseldorf seems to have grasped the position more exactly, for he reports that he is unaware of any special taxation of machinery at all. From Hamburg the information is of much the same character. Neither manufactories nor machines are rated in Italy, but buildings used for industrial purposes and provided with fixed machinery are stated to be taxed by the central Government by two-thirds of their rental. Some of our Consuls in the United States report occasional special exemptions in particular States or counties for the local encouragement of additional industries. Nothing conclusive is said, however, as to any general exemption, or the application of any special principle of discrimination in the assessment of machinery. In France it appears that, upon the whole, there is no local rating of manufactories, the Government taxing works and factories, both for the national exchequer and for the departments and municipalities. In a sense, however, all machinery may be said to be taxed in one form or other, the so-called tax on patents being based on the number of machines in use, though the movable machinery escapes assessment.

THE ROYAL AGRICULTURAL SOCIETY'S REAPER TRIALS.

IN accordance with arrangements previously announced, the trials of sheaf-binding reaping machines for prizes offered by the Royal Agricultural Society took place last week near Chester. The trials on oats were made on the farm of Mr. Thomas Smith, at Blaen Point, and those on wheat and barley on the farm of Mr. Robert Podmore, at Dee Side. The machines entered included those of Messrs. R. Hornsby and Sons, Messrs. Massey Harris and Co., and eight other exhibitors, the total number of machines entered being twenty-three, and the trials were made in connection with the recent Chester meeting. The following is the award of the judges as a result of the trials of these self-binding harvesters. The first prize of £50 to exhibit No. 5172, Messrs. R. Hornsby and Sons' improved sheaf-binding harvester, No. B.; price £45. The second prize of £30, and the third prize of £20 were added together and divided between No. 4301, the Massey Harris Company's sheaf-binding harvester, open end, price £45, and No. 5171, Messrs. R. Hornsby and Sons' improved sheaf-binding harvester, No. A., price £45, which were of equal merit. This will probably close the competitive trials on this subject for some years, as although considerable improvements have been made since the last, no radical changes have been introduced. Messrs. Hornsby must find prize taking quite monotonous.

ABRIDGMENT OF PATENT SPECIFICATIONS.

THE Patent-office is now publishing a new series of illustrated abridgments for the period A.D. 1887-1893, the volumes being of the size of the "Journal," which is published weekly, and of considerable thickness. We have just received the volume relating to Class 122, namely, of steam engines, including details belonging to fluid-pressure engines generally. This, of course, covers other forms of engines, such as petroleum, so far as their details specially covered in the patents are referred to as equally applicable for steam engines. These abridgments will prove very useful, and are, to say the least, always sufficient to enable inventors to see whether it is necessary in any case to consult the original. We could, however, wish that they were somewhat better illustrated, or that such illustrations as there are were better printed. Under the direction of Sir H. Reader Lack, Comptroller, lists are also issued showing on what subject these abridgments are now being published or in preparation. The uniform price of the volumes is ninepence.

LITERATURE.

The Naval Annual for 1893.

[FINAL NOTICE.]

THE chapter on "Ordnance" is most valuable. Cordite appears to have fulfilled nearly all the anticipations which were expected of it. Consisting, as it does, of gun-cotton dissolved in acetone, with nitro-glycerine and mineral jelly, the two principal components, gun-cotton and nitro-glycerine, though eminently treacherous in themselves, prove when combined to be a singularly safe explosive; and hitherto the experiments which have been made with it, especially to ascertain its stability under the most extreme variations of temperature, have been attended with satisfactory results, although it must be admitted that great heat is a more severe test to it than cold. This must, of course, be exhaustively investigated before cordite takes the place of ordinary powder, but there is no doubt that both the Admiralty and the War-office are fully alive to the importance of sifting the matter thoroughly. Another point presents

itself; that cordite is more violent in its action than gunpowder is an ascertained fact. France, Germany, and Great Britain have all found difficulties with it, and it is generally admitted that nearly three times as much space is required to be left for expansion in the chamber, in proportion to the bulk of charge employed. Moreover, when fired in ordinary breech-loading guns, the vents show rapidly the effects of its action, and require constant renewal. It is also said that the effects upon small arms with this propellant have proved to be somewhat disturbing. Rumours are rife that the breech action, after quite a limited number of rounds, begins to work loosely, and appears to receive a considerable jar at the shock of discharge. The smoke, too, is most unpleasant to the eyes when blown into them. It is probable that a great many, if not all, of these difficulties will be overcome by modifications in the making up of this explosive; but we cannot at present consider that cordite, as it stands, is quite in a position to take the place definitely of gunpowder as a service propellant. Some interesting experiments were made by Captain Sir Andrew Noble, K.C.B., with service pebble, amide powder, smokeless ballistite, and cordite, and communicated to the Royal Society. A 4.7in. quick-firing gun was employed. The results of pressures, units of heat, velocity and muzzle energy were as follows:—

Nature of powder.	Charge in lbs.	Mean pressure in tons.	Velocity. Foot-seconds.	Muzzle energy. Foot-tons.	Gramme-units of heat to 1 gramme of explosive.
Service pebble ...	12	15.9	1839	1055	720
Semi-smokeless amide	10.5	15.3	2036	1293	821
Smokeless ballistite...	5.5	14.3	2140	1429	1365
" cordite ...	5.6	13.3	2146	1437	1260

One cannot fail to observe, on examining this table, that cordite produces over ordinary powder enormously improved velocity and increased muzzle energy, whilst the pressures are greatly reduced, and the heat developed—considered in proportion to the charge employed—is not so great. Hence it is a little difficult to understand how the "violence of action" before alluded to takes place, unless it originates in the greater rapidity of combustion of the propellant. For the maximum pressure, as well as the mean pressure, is less with cordite than with powder. When, however, it is considered that any difficulties which result from the employment of this new smokeless compound may be got over by the adoption of the Elswick quick-firing breech and metal cylinder for the cartridge, it seems indispensable that the ordinary breech-loading guns up to 6in. calibre should be replaced at the earliest possible moment. A question has, it is true, been raised as to the weight of such ammunition for field guns, but we have little doubt that the great reduction which would be effected in the numbers of gunners required to manipulate the pieces would more than counterbalance the extra weight in the metal cases, to say nothing of the reduction of weight in the propellant itself.

Chapter III., on "Quick-firing Guns," cannot fail to arouse interest at a time when both Canet and Krupp are endeavouring to rival the Elswick firm in their particular speciality. For convenience of reference rather than for comparison we append a statement of some of the ballistics of M. Canet's 80-calibre gun and those of a lengthened 6in. gun which was tried at Elswick in January of this year:—

Gun.	Weight of shot.	Charge.	Nature of powder.	Muzzle vol.	Muzzle energy.	Mean pressure.
	lbs.	lbs.		ft.-t.	Tons.	
Canet, 10cm. 3.9", 80 cal. ...	43.7	20.7	Brown pris. Smokeless.	2211	1481	16.4
Do. do. do.	28.7	12.1	"	3307	2176	18.3
Do. do. do.	28.7	12.4	"	3366	2255	19.6
Do. do. do.	28.7	14.1	"	3287	2150	16.6
Elswick lengthened 6" Q.F. ...	100.0	17.0	†	3231	7238	{ Not known
Do. do. do.	70.0	17.0	†	3711	6685	

* Assumed to be 17 lb.

† Believed to be smokeless.

It will be observed that the effect of screwing on a piece to the muzzle of the Elswick 6in. quick-firer, has been to raise the velocity from 2694 foot-seconds to 3711 foot-seconds, and the energy of the 100 lb. projectile from 5033 foot-tons to 7238 foot-tons. Krupp's formula for penetration at these high velocities, which appears to be more correct than the English one, gives 27.1in. as the perforation of wrought iron for this amount of energy. Not so bad for a 6in. gun! As we can never believe that M. Canet is serious in his attempt to thrust upon us a gun of eighty calibres, a weapon which is more fit for a museum of scientific toys than for the exigencies of service, we merely give the results obtained with it, presuming at the same time that its life would be a short and merry one if it were often fired with a charge of 14.1 lb. of smokeless powder. His ordinary 15-centimetre quick-firing gun, which exactly corresponds with the Elswick 6in., has only a muzzle velocity of 2460 foot-seconds, against the 2694 of the ordinary English gun, and an energy of only 3704 foot-tons to compare with the 5033 produced by the latter. How in the face of these figures Canet's guns can be said to equal or surpass those of Sir W. Armstrong, Mitchell and Company, is difficult to conceive. The sole advantage which the former can be thought to have possessed was the arrangement for opening the breech by a single movement, which certainly is done, but by a mechanical

contrivance which leaves much to be desired. The latest improvement at Elswick has, however, dealt with this matter most satisfactorily, and the more recent breech gear is being turned out with a most simple opening and closing handle, which shuts or opens the breech in one movement, at the same time automatically raising the striker to fire the gun. The new naval 12-pounder quick-firing guns will be thus fitted.

Part IV. of the *Annual* is, perhaps, as valuable as any other portion of the work, though, from its statistical character, it cannot be read with quite so much facility. The 12in. breech-loading steel and wire gun of a new design, intended for the armament of the new battleships, spoken of in the First Lord's Memorandum, is a weapon around which the greatest interest concentrates. Wire strapping or taping, as at first practised, was a rough expedient, and the coils were so imperfectly laid that it is doubtful whether the radial strength given to the breech was not more than counterbalanced by the longitudinal strength lost. Now, however, the apparatus for strapping is so far perfected that the wire becomes part and parcel of the material of the gun, and the covering jacket has a secure bed upon which it can be shrunk. The tape, which is of the finest ductile steel, with a longitudinal strength sufficient to resist a strain of ninety tons to the square inch, is fed through a gripping machine, which, by means of a long lever and weight, exercises a pressure of forty-five to fifty tons per square inch to prevent its passing through. The gun over which it is led is, however, revolving slowly between bearings, hence the wire is drawn round it at a strain of about 45 or 50 tons to the square inch. This, it is needless to say, tightens the wire or tape perfectly, and the edges are driven together as the process goes on with a mallet. The wire or tape is flat, about $\frac{3}{16}$ in. thick, and $\frac{1}{4}$ in. wide. An enormous quantity of it is now being constantly used at the Arsenal, Woolwich, and piles of little circular bundles of this singular-looking material surround the gun factories. A 12in. gun requires, we understand, many dozens of miles of this wire to be laid around it, so the labour of putting it on can be imagined.

The comparative tables of British, French, and Russian ships—a résumé of which appeared in our previous notice, and which has been brought up to May, 1893—is not the least instructive item of Part IV. By an oversight we omitted to include in our list of 175 battleships and cruisers, nineteen look-out vessels, including the Iris and Mercury, Blanche, Blonde, Archer, and Bellona classes. Against all these most important adjuncts to a fleet, the French have only six ships, and the Russians none at all.

In conclusion, a few words as to our present position. That it is satisfactory, except in so far as armoured cruisers and torpedo vessels are concerned, will scarcely be contested. We consider that Lord Brassey has, however, acted loyally to his country in emphasising our wants in these two respects. We have already drawn attention to the possibility that in a prospective naval war, "quality might exercise a more potent influence than quantity" in deciding the issues of engagements that would be proceeding simultaneously in all quarters of the globe. Under these circumstances it is an unpleasant reflection that we should have no cruisers which could compete—severally—on equal terms with the Russian Rurik or American New York, either as regards armament or protection; with the French Dupuy de Lôme, as regards immunity from high-explosive shells; or with the Argentine Neuve de Julio, or Japanese Yoshino as regards speed. In point of fact, either of these vessels, in their own peculiar element, could crush with overwhelming gun-power, destroy with high-explosive shells, or steam around and tickle at their pleasure, either single vessels or small combinations of similar classes in our fleet. The days have gone by when twenty different battleships or frigates set sail in company at a speed which scarcely varied half a knot in each, provided they had all the same force of wind. It is incredible that such a tremendous powerful steaming, fighting, and destroying machine as the Rurik, with its four 8in., sixteen 6in., and six 4.7in. guns, its 10in. armour, and 18½ knots—or, indeed, in the latest design 20 knots—of speed, should be handicapped by the company of half-a-dozen inferior vessels in taking up a position on active service. Clearly other tactics will be adopted. As the knights of old, superbly mounted, and clad in a complete panoply of armour, often individually decided the issues of a battle by riding amongst and cutting down the common horse and foot soldiers of the enemy, so will the swift and terrible armoured cruisers be employed. Avoiding action with a fleet, they will hover upon the flanks of the enemy, sinking his cruisers, and destroying, with superior armament and manœuvring power, individual vessels which may be overtaken. We cannot too importunately urge upon our Government a reconsideration of our requirements, both as regards swift armoured cruisers and torpedo vessels. With this homily we conclude our notice of a work the value of which cannot be over-estimated.

BOOKS RECEIVED.

Heat. By Mark R. Wright. London: Longmans, Green, and Co. 1893.

Steamships and their Machinery, from First to Last. By J. W. C. Haldane. With many plates and other illustrations. London: E. and F. N. Spon. 1893.

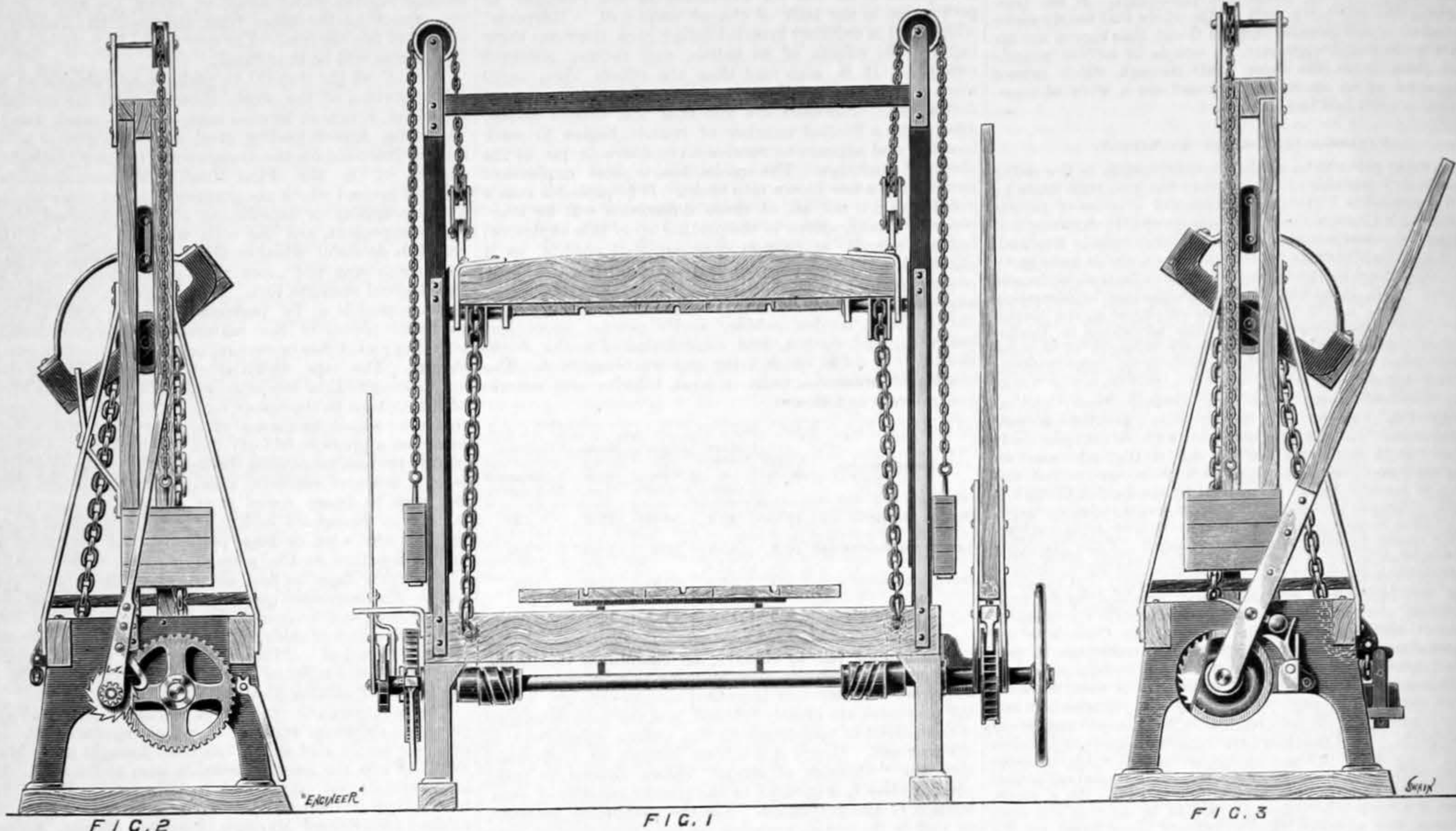
Lloyd's Register of British and Foreign Shipping. Particulars of the Warships of the World. Extracted from Lloyd's Register Book, 1893-94. London: 2, White Lion-court, E.C. 1893.

Labour-saving Machinery. An Essay on the Effect of Mechanical Appliances in the Displacement of Manual Labour in Various Industries. By Jas. Samuelson, of the Middle Temple, Barrister-at-Law. With illustrations. London: Kegan Paul, Trench, Trübner, and Co.

Pumping Machinery. A Practical Handbook relating to the Construction and Management of Steam and Power Pumping Machines. By William M. Barr. With upwards of 260 engravings, covering every essential detail in pump construction. London: J. B. Lippincott Company. 1893.

BLYTHE'S HAY AND STRAW PRESS

MR. S. W. BLYTHE, INGATESTONE, MAKER

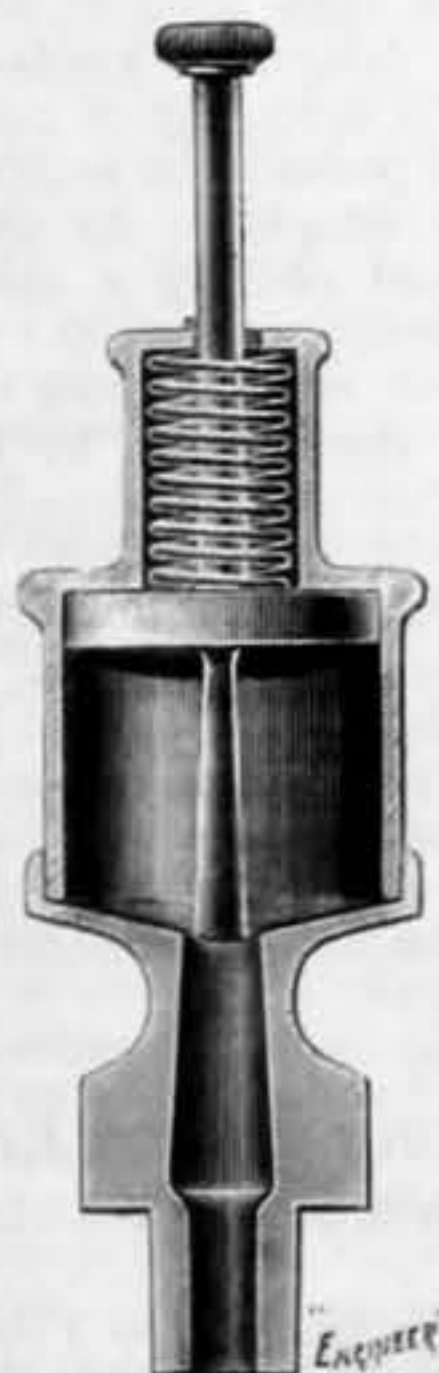


BLYTHE'S HAY AND STRAW PRESS.

The press illustrated by the engraving above was exhibited at the Chester meeting of the Royal Agricultural Society. The framework is a combination of ironwork and wood supporting a wood base and operating a wood platen. The platen is balanced by weights on chains running over pulleys on the top of the frame. The platen is operated by stronger frames, which are fixed at one end, as shown in Fig. 1, and one at the other end on screw rollers. The platen is rapidly hauled down by means of the hand-wheel shown in Fig. 1. Then the first and lightest part of the compression is performed by the hand lever, shown in Figs. 1 and 3, and a final compression under greater stress by the hand ratchet lever wheel and pinion, shown in Figs. 1 and 2. Pivoted close to the wheel is a lever, shown in Fig. 2, by means of which a pull on the chain can be made, when the bale is tied just sufficient to raise the pawl to allow the chain to unwind from the screw rollers and the platen to move upwards under the pull of the balanced weights. When in its upper position the platen tilts to the position shown automatically. Beneath the bed or lower platen is an equipoise weighing apparatus, which can be used for other purposes.

THE ORIEL LUBRICATOR.

The lubricator for semi-solid or viscous lubricants of the vaseline order, illustrated by the accompanying engraving, is being made by Messrs. J. G. Neville and Company, Liverpool. Numerous forms of lubricators for this sort of lubricant have been made with the object of getting over the difficulty connected with uniform flow of the lubricant with

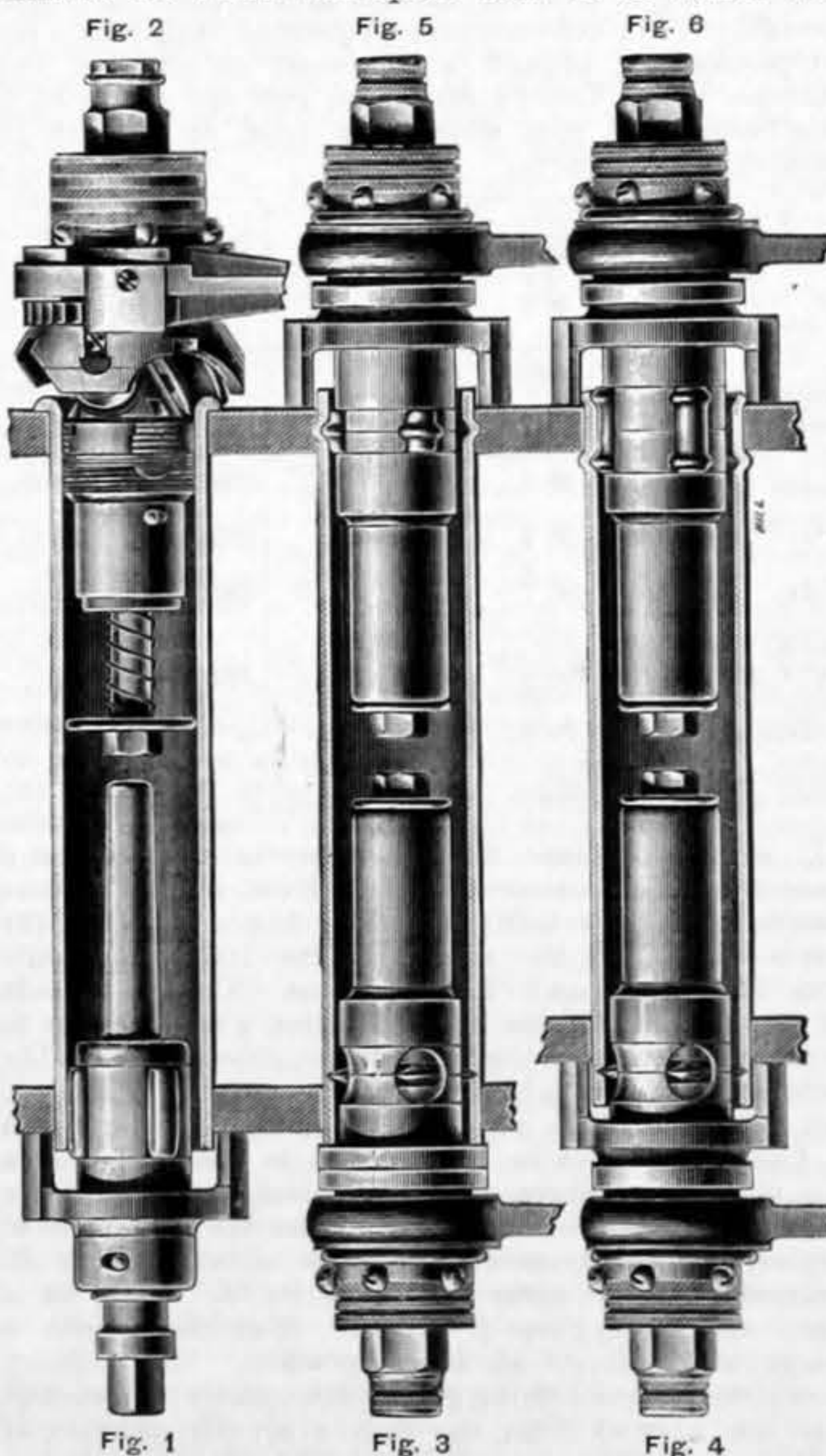


varying pressure upon it. In the lubricator illustrated the pressure upon the lubricant is obtained from a spring, the gradually decreasing pressure from which is balanced or is continuously made sufficient by the inverted taper plug, which, in descending, reduces the resistance to flow, and thereby the work the spring has to do. It is a very simple, and may be expected to remain, an efficient means of getting over the difficulty.

MADRID is to be the scene of an International Exhibition from May to October, 1894. The exhibition will be divided into fourteen groups. Chemicals and their manufacture, and electricity are both separate groups.

WICKSTEED'S TUBE EXPANDERS, TUBE CUTTERS, AND BEADERS.

The annexed engravings illustrate six forms or applications of Wicksteed's solid body self-feeding and releasing tube expanders and cutters. This tool is self-feeding, as the action of turning the mandril one way tightens it up, while turning it back instantly releases it. The whole body or roller case is cut out of one solid piece of steel, thus entirely doing away with the loose collar and screws at the end, which have caused trouble. The rollers are put in their places from the inside and prevented from falling back when the mandril is removed by removable wires securely placed behind the rollers at one side of the slot. These wires have no strain on them whatever, the mandril taking the rollers entirely off when at work. The wear and thrust of the rollers at the ends of the slots is taken by plugs of hardened cast steel. The mandrils are made with square ends—to be worked with



ratchets, which is the best way—or with the ordinary round head with holes in it. In the engravings the plain expander for ordinary work is shown at Fig. 1. The machine or tool for beading the end over and rolling it up tight to the plate when cut off is shown at Fig. 2. At Figs. 3 and 4 is shown the action of the internal tube cutter cutting the tube off inside and outside the tube plate. At Figs. 5 and 6 are shown expanders fitted with beaded rollers for internal and external fullering. These tools are largely used, and are made by Messrs. C. Wicksteed and Co., Kettering.

ELECTRIC LIGHTING IN HUDDERSFIELD.

On Saturday evening the Huddersfield Corporation's Electric Supply Station was officially opened and the supply of the electric light commenced. The Brush Electrical Engineering Company's contract for plant and underground mains was £20,640, and others brought this up to a total of £29,693. The buildings, which are now completed, have a frontage on St. Andrew's-road of 117ft., and extend back 108ft., the engine-room being 105ft. long by 50ft. wide, and the boiler-house 105ft. by 54ft.; the chimney, which is 200ft. high, has an inside diameter of 6ft. The station has been built to contain machinery for supplying light equivalent to 40,000 eight-candle power incandescent lamps, and the office accommodation and storage room is ample to meet the demands of future extensions.

The machinery already put in will provide for 9000 eight-candle lights, but so great has been the demand for the supply of electric lighting in the town that it has been necessary to double the capacity of the machinery. The electric generating machinery consists of three high-tension alternating current plants having a total output of 250 units. Four boilers of the Babcock and Wilcox type have been fixed, equal in the aggregate to 800-horse power. These supply steam to three fine compound vertical condensing high-speed engines, made by the Brush Company, at their Falcon Works, which drive three Morley Victoria alternators, and the latter generates electricity at a pressure of 2000 volts. The additional productive power is to be provided by one large engine and alternator generating 250 units, and equal to the whole of the present plant. This will also be supplied by the Brush Electrical Engineering Company. The steam and feed pipes are arranged upon the ring system, all the valves being of Hopkinson's make, and the exhaust pipes are arranged so that the condensing plant may be used, or the engine exhaust direct to the atmosphere.

The switches and apparatus for regulating the supply of electrical energy are fixed upon a balcony running along the front and end of the engine-room, and the connections are arranged so that the alternators are supplying the energy at the pressure of 2000 volts in parallel, the quantity being measured by Shallenberger meters as it is conducted from the station. Four conduits have been laid from the station to a transformer chamber at the corner of Northumberland and John William-streets, and into these conduits up to the present have been drawn two primary concentric mains, manufactured by Messrs. Siemens Brothers and Co., of London. These mains supply four transformer stations, which have been erected in central positions with the alternating current at a pressure of 2000 volts, and from the chambers situated in the Market-place, Market Hall, and Town Hall, the supply is distributed at the low pressure of 100 volts by the low-tension mains in the principal streets of the town, from which the consumers are supplied. The length of the primary mains laid is 3495 yards; length of conduits for carrying the mains, 14,526 yards; and the length of low-tension mains, 9500 yards.

With regard to the cost of the electric light, the charge made by the Corporation for the supply of electricity will be at the rate of 6d. per Board of Trade unit.

At about six o'clock on Saturday evening the members of the Electric Lighting Committee and a few others assembled in the engine-room at the supply station, and after the machinery had been inspected, the Mayor—Alderman R. Hirst—Alderman Brigg, and Alderman Haigh each started an engine.

The ceremony over, the company returned to the committee room, where the toast list was gone through during a convivial evening. Councillor Garton presided, and those also present were the Mayor; Aldermen Brigg, Glendinning, Haigh, Heppenstall, J. J. Brook, and Stocks; Councillors Marshall, Holland, T. Brook, Longbottom, Sterry, Munroe, J. W. Sykes, E. Mellor, and J. L. Brierley; Mr. H. Barber, town clerk; Mr. A. B. Mountain, borough electrical engineer; Mr. William Owen, deputy town clerk; Mr. W. R. Herring, gas engineer and manager; Mr. A. Garton, Mr. W. M. Morley, chief electrician to the Brush Electrical Engineering Company and inventor of the Morley Victoria alternator; and Mr. S. A. Mahood, engineer-in-charge during the erection of the plant.

CHICAGO is now being invaded by people in want of work. On the 31st ult. a thousand of the miners who were reduced to idleness by the closing of the silver mines in Colorado arrived. Labourers from the Chicago factories are daily being added to the ranks of the unemployed.

THE NAVAL MANŒUVRES.

AFTER the preliminary week's cruise, the contending forces put into their respective ports and completed with coal. The time for this operation varied, but by Wednesday, July 26th, the four fleets were practically ready for action. Permission was then ready for cruisers to observe the movements of the enemy, and vessels of this class from each side were despatched to the vicinity of the ports where their opponents were collected. On Thursday, the 27th, information was received that hostilities were to commence at 10 p.m. on that day. From what followed it is evident that the primary object with each side was to effect a junction of its two fleets, and then, if possible, to fall upon the other side before it had completed a similar operation. We have already indicated that such was a very probable course to be adopted by one, if not both, of the contending Admirals. It was pointed out by us that with squadrons at Berehaven and Torbay, having practically equal speeds, and leaving these ports at the same hour, should each shape a course for the Irish Channel, the Berehaven contingent would approximately be sixty miles ahead of the other. Thus the Blue Admiral would have a chance of meeting the Lamash squadron should it be directed to proceed south to meet the Torbay Fleet, and having defeated it by superiority of numbers, could then amalgamate with his other squadron from Blacksod. Thus reinforced, he was powerful enough to turn and meet the Torbay Fleet with every prospect of success. But if he missed the Lamash force the Blue side would be confronted with the whole of the Red side, which, unless reduced by successful attack by the torpedo flotilla, would be superior to his own. From what occurred it is evident that the Red Admiral counted on preventing this junction, and trusted on coming up with his adversary before such a combination could take place. As the Blue Admiral desired to be sure of what his opponent would do, it was important to ascertain whether the Lamash squadron would proceed south, or remain to prevent the passage of the Blacksod force round the north end of Ireland. To obtain this information was the duty of the Blue cruisers. They were sufficiently numerous to watch closely the neighbourhood of Lamash Bay, and then, if the squadron within took a south course, could by command of speed proceed in front and warn the Blue Admiral of its approach, while one of their number could assure the Blacksod fleet that the sea was clear for its passage. Though the Lamash squadron did proceed south, it got away without being seen, and hence was not encountered by the Berehaven fleet. This made its way north, skirting the Irish coast, until it stretched away to the Isle of Man in order to meet the D fleet. This was successfully accomplished about two a.m. on Saturday morning. In the meantime the Torbay and Lamash squadrons had already met, and were proceeding north, hoping to fall upon the Blue Admiral before he was thus reinforced. Such was the rapidity of the Red Admiral's movements, that although originally sixty miles astern of his adversary, he came up with him only two hours after the Blue side had amalgamated their forces. Each observed the other about three a.m. by their lights, as it was still dark. The Red side was bent on attack; the Blue could hardly avoid one. In fact, the latter had only just completed forming their amalgamated fleet when the enemy was upon them. He approached from the Irish coast, and was therefore on the starboard beam of the Blue fleet, then heading south. Such was the position of affairs when the day broke on Saturday morning, and disclosed to each side that the full forces of both were collected at this spot, not far from the southern extremity of the Isle of Man. Each at once made up his mind to engage. There was practically no disparity of force. In battle-ships the numbers were equal, as one had gone from the Red side. Blue had more cruisers, while Red possessed a flotilla of torpedo catchers, which the other side was without. Though Admiral Fairfax had twenty-six vessels to twenty-one commanded by Admiral Fitzroy, the superiority of the latter's cruisers counterbalanced the greater numerical value of the Reds. Thus there was no reason for either side to refuse a conflict. To avoid being taken at a disadvantage, and meet the onslaught of Red, Admiral Fitzroy turned towards his adversary, who at that moment opened fire from his leading ships. Both were in divisions line ahead. The result of this evolution on the part of Blue was that the contending fleets passed parallel to each other at a distance of about 3000 yards, and the engagement became general. It was a magnificent spectacle, the meeting of nearly fifty warships engaging in mimic warfare, though only a certain number of guns were fired from each vessel to represent this part of the battle. Having passed each other, the Red Fleet turned to the southward, and the Blue side altered its course in the same direction, forming at the same time single line ahead. Both fleets were by these evolutions again brought on a parallel course, but the Blue being in one line full advantage could be taken of the guns of every ship, whereas the Reds, being in two divisions, had some of their gun-fire impeded as regards the outer ships. Moreover, the single line ahead could quickly be turned into line abreast, when the ships would be in a position to utilise the ram. Observing this, Admiral Fitzroy signalled to his fleet to turn eight points to port together, which brought them in this formation, and had they continued while in this position, the Blues must have rammed some of the ships in the Red rear. Under the circumstances the movement would not be permitted, and the Blues again turned in a safe direction and continued the previous course. The Red Fleet had now forged ahead so much that only its rear ships were in action. As these consisted chiefly of cruisers they must have suffered severely. Shortly afterwards the distance between the two fleets increased, and the engagement was discontinued. Though the cruisers took part in the battle they were not advantageously placed. Such vessels should be clear of the line of battle, and beyond

the range of craft so much heavier than themselves. But on both sides in this action they were sufficiently close to impede the free movement of the battleships. On the Blue side a cruiser got between the lines, while in the Red Fleet their attached cruisers were at one period of the action nearer to the enemy than the battleships. Previous to hostile fleets coming in contact scouts should be dispersed on the horizon, performing the functions which their name implies, and then, when this duty ceases, owing to the enemy being in sight from the main body, they should be stationed well clear on the off side or rear in a previously arranged formation. From such a position they would be ready to act against the light vessels opposed to them or assist a disabled battleship. After the action, both sides put into ports belonging to territory allotted to them and prepared for a renewal of the operations. This will enable the umpires to settle certain claims that have been made. The torpedo boats appear to have acted with vigour, in some cases even getting so close that torpedoes passed under the ships. So far, we hear, the Thunderer and two or three cruisers on the Red side were actually struck, which gives a great advantage to the Blue Fleet; but details of these operations must be reserved for a future occasion.

INSTITUTION OF MECHANICAL ENGINEERS AT MIDDLESBROUGH.

THE Institution of Mechanical Engineers commenced its summer meeting at Middlesbrough on the 1st inst. At ten a.m. some 200 members had assembled in the Town Hall to witness the reception of the President, Dr. William Anderson, and Members of Council, by the Mayor of Middlesbrough, Mr. Charles Lothian Bell, and the Chairman of the Reception Committee, Mr. Jeremiah Head, Past President of the Institution of Mechanical Engineers.

After a short speech from the Mayor, in which he said that Middlesbrough, though one of England's youngest children, was already using its brains in endeavouring to develop the resources of nature, Mr. Jeremiah Head gave some account of the Reception Committee's labours. He informed the meeting that the names of 172 of the leading men of the Cleveland district would be found on the Reception Committee, and that these gentlemen had been working for the last eight months in preparing the programme of visits, and in making arrangements for the comfort and gratification of the members who had visited Middlesbrough. He concluded by assuring them that they would find it "cold, smoky, but not altogether inhospitable."

Dr. Anderson, in returning thanks to the Mayor and Mr. Head for their welcome, said that Middlesbrough men had done much for the advancement of metallurgical science, that several works in this district—for instance, the Clarence Works—were known wherever metallurgy existed, and that the best proof that Middlesbrough was intimately associated with the Institution of Mechanical Engineers, might be gathered from the fact that on that platform were four Past-Presidents of the Institution of Mechanical Engineers, all Middlesbrough men.

After the usual formal business, and the notice of election of new members, Mr. Jeremiah Head read the paper on "Recent Developments in the Cleveland Iron and Steel Industries," an abstract of the first part of which will be found on page 111. Mr. Head took an hour and twenty minutes to read his paper, and the discussion on it was not finished at one p.m., when the meeting was adjourned. Considering that every member who desires it has a copy of the paper sent him a week or ten days before the meeting, and that these papers are presumably read by all who take an interest in the subject, it is a pity that all papers at the summer meetings, or at any rate, those which do not require illustration, cannot be "taken as read."

The discussion on Mr. Head's paper was opened by Sir Lowthian Bell, who said that it was a most complete account of the iron and steel industries of Middlesbrough. He added that some makers had a fixed idea that certain irons were fitted for certain purposes. Amongst others, the late Mr. Kitson always had that opinion. The fact, however, was that all irons were alike, though the ores from which they were extracted differed from the impurities which they contained.

Mr. Dawson, of Low Moor, had at one time thought the same, and commenced an investigation with the view of ascertaining the peculiar characteristics of Low Moor iron. The result of his research was to convince him that all iron was alike, and that the difference in quality must be attributed to the presence of metalloids—often in minute quantities. He thought that all iron would eventually be made by the pneumatic, i.e., open hearth or Bessemer process, and that nine-tenths of the so-called steel was really only homogeneous iron. With regard to the alleged greater liability of steel to corrode, Sir Lowthian said that they now were using steel entirely for the locomotive boilers of the North-Eastern Railway, and might have added that some thousands of portable engines have been made with it. It was true that occasionally a boiler would corrode rapidly and unaccountably; but, for one that would do so a hundred would not. He considered that inferiority of quality was due to the presence in the steel of some particular material which interfered either with the tenacity or the durability; and that it was their business to find out what this material was, and eliminate it.

Mr. E. Windsor Richards said that possibly steel might be made as good as iron in the future, but that at present the very mildest steel would not compare with the best Yorkshire iron. All additions of metalloids made steel brittle, and there was no fibre in steel, unless you added a large quantity of sulphur, which was not desirable.

Mr. Cochrane disagreed with what the author said about the power of production of blast furnaces being affected by their internal shape. He considered friction against the sides took up most of the strain, and compared the pressure of a charge in a furnace to that of a

man climbing down a chimney. He admitted that Messrs. Hawdon and Howson had made an improvement at the Newport Ironworks, but denied that it was caused by the change in the shape of the furnace. He then gave details of the wear of a furnace which had been in blast for eighteen years, and said that the members would see it when they visited the Ormesby Works on the following afternoon. He warned the members that they should judge of the wear and tear of a furnace by dimensions taken whilst it was actually at work, and not after it had been blown out.

Several speakers disagreed with Mr. Cochrane's theory of the angle of repose of the charge in the inside of a blast furnace, amongst others Messrs. Hawdon and Howson.

Mr. Hawdon described the change which they had introduced into the furnace linings at Newport Ironworks. In their furnace there are really three boshes instead of one, the upper being much the largest. This is high up above the melting zone of the furnace, and they claim that the material passes regularly to the intermediate or reducing, and bottom or melting zone, and that it has no tendency to clog.

Mr. Howson said that with the new furnace they could do 40 per cent. more work than with a smaller furnace, use 1 cwt. less coke per ton, and make a better iron.

Mr. Cecil inquired what the performance of the Newport furnaces had been before the new plan was tried, as if they were not equal to others, for instance to the Ormesby, something must be taken off the 40 per cent. saving.

Mr. White said they were using steel at the Admiralty, and that they did so because they could obtain a suitable material. It was, to a great extent, a question of cost. The Admiralty had encouraged manufacturers to supply them with steel made by the open-hearth basic process, and from native ores, but they found they could buy acid open-hearth steel cheaper. They had now been using mild steel in the dockyards for nearly twenty years. At first the smiths thought they could not weld it, and wanted to be allowed to use iron filling pieces, but now they could manage it very well, especially the younger men. They had ships eighteen years old, whose bottom plating was of steel $\frac{1}{2}$ in. thick, still working, and in good condition. The chief source of corrosion was manufacturers' scale; this they had to remove by an acid bath, and he thought manufacturers would soon get into the way of dipping their sheets. It was also necessary to take more trouble in painting, on account of the extra smoothness of the surface. With regard to fracture, he said it was true that you could break steel more easily than you could iron, but he reminded the members that at the Naval Exhibition two plates had been shown, one of iron, the other of steel. A charge of gun-cotton had been exploded against each. This completely shattered the iron, but only dished the steel.

Mr. Wicksteed said that his firm always had their racks full of best Yorkshire iron, costing 17s. or 18s. a cwt., and they had to continue to use it because they always found it reliable, whereas steel was not. It was impossible from the same quality of steel to make a shaft which would run in a cast iron bearing, and resist abrasion; and a piece like a chuck for a lathe, which could be welded and case-hardened. Therefore, unless iron were used, it would always be necessary to keep two qualities of steel.

Mr. Shaw said the reasons some steels rusted much more rapidly than others was that they probably contained a slight excess of manganese, which had a great affinity for oxygen.

In the afternoon the members visited the Newport Ironworks, the Newport Rolling Mills, the Britannia Works of Messrs. Dorman, Long, and Co., the Aysome Ironworks, and the North-Eastern Steel Works. We shall give further details of this visit next week.

The discussion on Mr. Jeremiah Head's paper was resumed on Wednesday morning by Mr. Aspinall, who said that on the Lancashire and Yorkshire Railway they used steel almost entirely for locomotive work. They found basic steel answer exceedingly well, and were able to caseharden all wearing parts. They had recently made boilers and crank axles from basic steel, and so far they seem to do well. Stays had also been tried from basic steel, when copper became so dear a few years ago; but these did not answer, and they had been obliged to revert to copper. He had since heard that the same had happened with other English railways, and with at least one in Belgium.

Sir Lowthian Bell asked permission to speak again. He wished to point out to Mr. Cochrane that with coal bunkers having only a 2ft. 6in. aperture, there was no difficulty about regularity of flow, and that the same thing happened in bins of iron ore. He considered that the fused matter would act as a lubricant.

Mr. Jeremiah Head stated that he had very little to say in reply. With regard to the controversial matter, speakers had practically answered one another. No one could say exactly what was happening to the material at the top of a blast furnace; we could only say what we thought happened. Messrs. Hawdon and Howson not only claimed that their plan ought to succeed, but that it had succeeded.

After a cordial vote of thanks to the author, the President called on Mr. Richard Grigg to read his paper on the "Middlesbrough Salt Industry." There was an interesting discussion, of which we must reserve the account till next week; and then Mr. A. L. Steavenson's paper on "Electric Rock-drilling Machinery," and Mr. George J. Clarke's paper on "Engineering Improvements of the River Tees," were read and discussed.

The President announced that Messrs. Dobson and Borodin's papers would have to be postponed till the autumn meeting. In the afternoon iron works east of Middlesbrough were visited, and in the evening the Institution dinner took place at the Royal Exchange.

(To be continued.)

THE COAL CRISIS AND THE IRON TRADE.

THE ATTEMPTED STOPPAGE OF THE MANUFACTURE OF COKE.

UNDOUBTEDLY the attempt to stop the manufacture of coke in Yorkshire is one of the most important features connected with the coal crisis. The blow intended to be dealt will, however, not be so heavily felt, inasmuch as many of the coke burners would have to give fourteen days' notice from Wednesday or Thursday last. In the meantime a large tonnage of coke will, doubtless, be manufactured at collieries and works where they have good supplies of slack and smudge on hand. Owners of blast furnaces will, it is expected, not be able to continue work for any lengthy period if prices increase.

The stoppage of the coke burners will have a serious effect on the iron trade of North Lincolnshire, Derbyshire, and Northamptonshire, most of the smelters drawing their supplies from South Yorkshire. Already there are not wanting indications of the effect of the stoppage on the Frodingham district. Messrs. Cliff and Co. are reported to be damping down three of their furnaces, and others are likely to follow. The Appleby Iron Company, which commenced operations in 1877, are reported to have several weeks' supply of fuel on hand, so that in all probability they will work on for some time. The general feeling is that the safest, and probably the cheapest course in the end, is to damp down the furnaces. This would undoubtedly have the effect of clearing stocks of pig iron, and would also improve prices. An important suggestion which is likely not to be lost sight of is, that in the event of the dispute being a lengthy one, and supplies of coke from South Yorkshire becoming scarce, the Manchester, Sheffield and Lincolnshire and North-Eastern Railway Companies should be appealed to, and ask to give a special rate from Durham, so as to enable smelters to use the coke from the North of England. If this is not done, and the furnaces are damped down, the railway companies will lose the traffic in pig iron and that arising from the transit of iron ore from North Lincolnshire, for the whole of the furnaces which are kept in blast will have to look to Durham for supplies of coke. It may be stated that the North-Eastern Railway Company have already met the Durham owners with respect to the carriage of coal, and circulars are now current in South Yorkshire soliciting orders of North of England coal.

One point in what is called "The Lancashire Reply" to the coalowners' manifesto, has attracted no little attention. It is the handiwork of Mr. Thomas Ashton, and runs thus:—"The workman's case is simple and clear. They did not reap their share of the profits on the high selling prices. They never asked for that. They struggled to establish a fair, just, and reasonable rate of wages, and having accomplished that, will fight campaign after campaign if need be to keep it." Considering that the high selling prices were caused by the 40 per cent. advances obtained by the workpeople, this statement is what the Americans call "steep." But perhaps what Mr. Ashton really means is that the coalowners put up prices out of all proportion to the increased wages given to the men. Even in that case the miners must be understood to have obtained their share, and no inconsiderable share, in the 40 per cent. The British public, as usual, was ground between the upper and the nether millstone. The colliers' 40 per cent. had to be paid by the public, and the extra profit the miners' leaders charge the owners with taking would have to come from the same pocket. It is in adversity as in prosperity. Now that the coal supplies are cut off, both coalowners and coal merchants make the householder pay all they can for their needs. Neither the one side nor the other appear to consider the customer. His business is to pay, and he is doing it now. There is every prospect, too, that he must continue to do it, for there seems little doubt of the determination of the Union leaders to fight. There never was a time in the history of Trades Unionism when the leaders had so firm a grip of their men, or when Federation was so widely spread and so deeply-rooted. The men have been thoroughly indoctrinated with this cardinal creed:—"The employers have thrown away their profits by senseless competition amongst themselves; that is no reason why you should throw away your labour. Stand out for a month or two, and the masters will be glad to give you work at the old wage." And thus the old evil game is played, and business goes from bad to worse, with the thoroughfare-congested centres of people who prefer to be unemployed rather than submit their grievances to arbitration. "No advances were ever got by arbitration," says one of the leaders, who is evidently of a mind with the South Yorkshire collier, who frankly confessed that the only sliding scale he believed in was the sliding scale that "always slid upward."

LETTERS TO THE EDITOR.

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

ON CARNOT'S FUNCTION OF THE TEMPERATURE.

SIR, If not honourable, certainly humorous, mention is often made of that unlucky playwright, matter for whose tragedy fell short of the quantity required for the customary number of divisions, owing to the awkward fact, in the early acts, all his characters were killed off; and, although a properly constituted drama was justified in assuming the co-operation of at least one energetic ghost, for the stage to be wholly occupied by "spooks" was felt to be a disregard of the unities, to which dramatic critics would, certainly, be bitterly hostile.

The difference between Mr. Donaldson and myself, as to Carnot's function, seems converging to a like dilemma. Mr. Donaldson's opinion being differences of opinion with himself, "are not worthy of serious consideration," and the thinking on the matter, of Carnot, Joule, Poisson, Thomson, &c., for their own credit would better have been "unthunk;" by strict mathematical methods he had demonstrated; the said function "was an utter absurdity." With parallel audacity I submit: the statements of Rankine, Clausius, Donaldson, &c., in the shape they are presented, ought never to have been advanced at all, as they are manifest unfounded misrepresentations and frivolous objections, which do not affect Carnot's reasoning. So here is a cleared space wherein to career on our respective hobbies, and administer sounding whacks to each other. Dry facts banged in mathematical bladders—scottish "blethers," which has another idiomatic and expressive meaning—make much noise without serious damage. Some one has asserted "there are mathematicians and mathematicians"—an oracular way of stating there are masters of mathematics, and also, persons mastered by their mathematics. The latter category, not unjustly, being charged with supplying illustrations of the apothegm, "great mathematicians are poor philosophers," and also held responsible for a current belief. The title, mathematician, is a synonyme for a "soft impeachment," such as being a poet, or having taken to drink. One symptom of this demoniac possession is, where we find the delusion: mathe-

matics are an effective substitute for brain; in point of fact, much superior for transacting our thinking. Whereas mathematics are a special process of reasoning, for making explicit the truth or nonsense involved in the assumptions with which, in large measure, instinctively, from former experience, mankind set out in their investigations. Hence, mathematical deductions are not necessarily consistent with common sense. Another shape of the delusion: a fact translated into abstract mathematical notation; this notation can be substituted for the fact. Whereas, the notation inadequately representing the fact, there may be points of view from which the assumption is quite erroneous. The possessed may even pass altogether out of the universe into the "fourth dimension," where he is not amenable to ordinary reasoning and speech; and, I believe, has then to be communicated with in "quaternions."

Long after the death of M. Sadi Carnot, an honest savant, M. Clapeyron, rescued the ideas of the former from oblivion by publishing a mathematical commentary thereon. In the introduction, is stated, "The idea taken for his researches appears to me fertile and incontestable; his demonstrations are founded on the absurdity which arises from admitting the possibility of producing absolutely either the motive power or the heat." Again, referring to a certain deduction, "a quantity of action (the French term for Newton's *actio agentis*, the *vis viva* of Leibnitz, or *mechanic power* of Smeaton)—would, therefore, be produced, which would be created, absolutely, and without consumption of heat—an absurd result which would imply the possibility of creating either force or heat in a gratuitous and indefinite manner." M. Clapeyron adds, "It appears to me that the impossibility of such a result might be accepted as a fundamental axiom in mechanics." I think in the Hebrew Bible M. Clapeyron might have found that age, before this axiom had been applied to things in general, and not to mechanics merely. But M. Clapeyron's practical instincts as a mining engineer and profound mathematical attainments, seem to have been alike, inadequate, to enable him to comprehend the notion. The foregoing simple and direct statements ought to have been exactly reversed, and that he ought to have written: Carnot's principle is, heat does work without being expended. At all events, Dr. Rankine and Professor Clausius, long after, asserted this to be the case. Not to wrangle over the failings of the dead, of one living and eminent man, Lord Kelvin, Professor Clausius positively asserts: "He still maintains the position of Carnot that heat may do work without any change of the quantity of heat taking place" ("Clausius on Heat," Brown's translation, page 333). On personal knowledge, I assert, the position of Carnot and teaching of Lord Kelvin are precisely alike, and to the effect: The idea of obtaining power without expending heat implies a physical impossibility, and the notions thereanent, imputed to them by Professor Clausius, are ludicrous absurdities, for which existed, neither now nor at any time, any basis of fact.

Next, as to Mr. Donaldson, refer to his paper, THE ENGINEER, May 5th, 1893, page 391. We find a correctly stated investigation:

"∴ area A B C D = $\frac{T - t}{T} p_2 v_2 \log. \frac{p_2}{p_1}$, as the resultant external work given out by Carnot's reversible engine, if the different stages of the cycle could be carried out as described by Maxwell, in accordance with Carnot's theory of heat." Next, refer to a paper entitled "Synthetical Investigation of the Duty of a Perfect Thermodynamic Engine, founded on the Expansion and Condensation of a Fluid, for which the gaseous laws hold, and the ratio (k) of the specific heat under constant pressure to the specific heat in constant volume is constant; and the modification of the result by the assumption of Mayer's hypothesis." ("Royal Society Transactions, 1852.") This result is given as, $M = \frac{E(S - T)}{1 + ES} = P V \log. \frac{V_1}{V_2}$ which, though written in a different notation, is exactly the same as quoted by Mr. Donaldson.

Thus $\frac{E(S - T)}{1 + ES} = \frac{S - T}{E + S} = \frac{T - t}{T}$ and $P V \log. \frac{V_1}{V_2} = p_2 v_2 \log. \frac{p_2}{p_1}$.

It is stated, "this result involves no hypothesis other than mentioned in the title. If we now add the assumption of Mayer's hypothesis, which for the actual circumstance is—

$P V \log. \frac{V_1}{V_2} = J H$, we have $M = J H \frac{E(S - T)}{1 + ES} = J H \frac{t_1 - t_2}{461 + t_1}$.

Note, here t_1 and t_2 are the Fahrenheit scale temperatures, and E the coefficient of expansion of a gas for the same scale—not the E of my former letter, which is here represented by M . This is the well-known form to which Carnot's reasoning is usually reduced, and is, equally, derivable from Carnot's cycle, or here, by Lord Kelvin, from the earlier independent investigations on gaseous action of M. Poisson.

These and like investigations, fully confirmed by experimental facts, are supposed as rendered absurd, on the strength of the rigmorale statements, by which is intruded into the problem a fictitious absurdity, which he names "heat substance," and a co-ordinate whimsicality "heat temperature," recognised by no one but himself; although, on his showing, the most important factors of the problem. Mr. Donaldson writes, "in accordance with this—Carnot's theory—mechanical work done upon the operative substance could not affect its temperature, if it were totally devoid of heat substance." This clotted nonsense, in no shape entered Carnot's theory! Observe: it assumes four things as dealt with, viz.:—(1) Mechanical work, (2) operative substance, (3) temperature of ditto, (4) heat substance. Consider Dr. Maxwell's statement:—"Heat may be transformed into something which is not heat—namely, mechanical work."

The late Dr. Clerk Maxwell, a profound thinker and consummate mathematician, well knew that one thing transformed into another, implied both to be precisely alike, in essence! This could only differ in quantity, and the one could always be stated in terms of the other. So that, instead of heat and work, two things, by determinable law of equivalence, we could write, heat or work, and have only one thing, not two, to deal with. Then, as to "heat substance." This is a fiction, intruded into the problem by a gentleman who shows himself cognisant of its utter absurdity! Yet, knowing its falsity, insists on its recognition: as an end towards invalidating certain reasoning, on the mistaken supposition of his ability to substantiate some kind of connection between it and the reasoning to which he objects. This is not science, but a reprehensible and stupid artifice. Instead of four things, we have only two:—(1) Operative substance, or the matter acted upon; (2) heat. Only, in the supposed case, this latter may exist in two forms—as temperature of the matter, or as mechanical work: at bottom, phenomena of distinct portions of the second definite existence, heat; when associated with the first definite existence, matter.

Note an explanation offered by Mr. Donaldson, in last week's issue:—"Heat transferred to the colder body will be expended partly in raising its temperature, and partly in creating *vis viva*. The *vis viva*, in the case of both bodies, will again be converted into heat, by molecular friction." Here Mr. Donaldson manages an explanation without separating the definite entity heat into his two imaginary factors, heat substance and heat temperature, only his confused modes of thought lead him immediately into another absurdity, a creation of *vis viva*. Now the only thing which he or I can create is amusement. The matter now in discussion ought to be, and really is, too simple to admit of juggling.

A transferred heat Q is expended and now forms the definite substans of the two phenomena, temperature and *vis viva* in matter. The quantity in the temperature, is given by the expression, $Q_1 = k t$, the quantity in the *vis viva* by $Q_2 = \frac{m}{2} V^2$.

Necessarily, $Q = Q_1 + Q_2$, and k, t, m , are determinable as the dynamic specific heat, absolute temperature, and mass of the operative substance, while V and 772 are the imparted velocity of the mass and Joule's coefficient of equivalence between capability to perform work, in foot-pounds, and the quantity of heat defined as the unit. From the $Q = k t$, as I have already shown, we

immediately derive, $E = J Q \frac{t_1 - t_2}{461 + t_1}$, Carnot's expression for the maximum power obtainable from the quantity Q of heat. The *vis viva* part, $Q_2 = \frac{m}{2} \frac{V^2}{772}$ is immediately re-transformed back again into heat, when we have expended that amount of power on molecular friction "nothing can be put to it nor anything taken from it . . . that which hath been is now, and that which is to be hath already been"—a fragment of old Chaldean philosophy on which, an axiom—as M. Clapeyron suggested—we are able to found the whole science of mechanics.

It were an endless task to track Mr. Donaldson through his jungle. I may point out his statement, " $\frac{1}{T}$ is called Carnot's function of the temperature" is a mistake for Dr. Joule's determination that this is $\frac{J}{T} = \frac{772}{T}$. In another place, he clears up a discrepancy between Carnot and Dr. Maxwell by utterly mystifying with heat substance relations explained by Mayer, Joule, and Thomson, and further overlook of the fact. An accurate-thinking scientist, the late Dr. James Thomson, forty-five years ago, had pointed out the origin as a verbal slip, so obvious as scarcely to require notice, except to those whose perception was somewhat dulled by the fact they themselves "had an axe to grind," and consequently, as is consistent with human nature, made the most possible of such oversights as are invariably associated, even with the most perfect of human efforts.

ROBERT MANSEL.

July 24th.

TUBE FRAME TRUCKS ON IRISH RAILWAYS.

SIR,—My attention has been called to Mr. Tratman's letter on "English and American Freight Wagons," published in the columns of your valued journal of the 7th inst., in which he says: "One of the Irish railways had some American type cars of 30 tons capacity, weighing only about 10½ tons, but I have no particulars as to their service, results of experience, or in repairs, but if experience with them has been satisfactory, they would seem to offer decided advantages for English railways." I have pleasure in handing you herewith copy of a letter, dated June 26th, 1893, from the general manager of the Great Northern Railway Company of Ireland upon this subject, from which you will see, that although that company were strongly advised against trying to use the Goodfellow and Cushman tubular frame wagons, they are so well pleased with them that they "have ordered a number more to be built," making the fifth order they have given the Tubular Frame Wagon Company, Limited, the last two orders having been for ten each. Friend Tratman, however, is altogether mistaken if he thinks that the reduction of working expenses by the use of American wagons on Irish railways to the extent of 60 to 70 per cent. will have the least effect on English railways. I have not yet met an English railway official and shown him the enclosed letter but who at once said, "It is different in Ireland from what it is in England." There are four Irish railways to-day using tubular frame cars, and every one of them will vouch for their superiority, but no Yankish tricks—trucks—for English railways if they can help it.

London, July 26th.

THERMODYNAMICS.

SIR,—I must confess that I have not, as Mr. Donaldson remarks, read the whole of the correspondence. I cannot, however, quite follow his reasoning. What ground is there for the belief that molecules expand and contract by heat? If they do not, it is obviously not possible for the mass of a body to be expanded by heat, and the molecules to be in a state of quiescence. In the supposititious instance referred to, with the two bodies in a perfectly adiabatic medium, granted that the same temperature will be attained by both, there is no reason that interchange of heat-motion should not take place. If the molecules are at rest contraction will take place in any case, as it is impossible to suppose that agitation of any sort can take place without giving rise to an increase of volume. Then we have a substance at the same temperature and under the same pressure occupying different volumes, according as it is surrounded or not by a perfectly adiabatic medium. In the case of gaseous matter, it is to be supposed that as soon as two portions of a gas attained the same temperature that there would be no diffusion? There seem to me to be many difficulties in the way of accepting this theory. Doubtless every known substance at definite temperatures will assume the solid, liquid, or gaseous state, and I see no reason why there should be any difference, except in magnitude, of the movement of the molecules.

J. R. COWELL.

Southampton, July 26th.

JAPANESE CRUISER THE YOSHINO.

SIR,—I have read with much interest your article on the "Trials of the Japanese Cruiser Yoshino," constructed for the Japanese Navy by Messrs. Sir W. G. Armstrong, Mitchell, and Co., which appeared in your last issue of July 28th.

You state that the Yoshino is the same class of vessel as the 9 de Julio and 25 de Mayo, constructed by the same firm for the Argentine Government, but exceeds either of them in size and speed.

I want to call your attention to your article on the 9 de Julio that appeared in your issue of February 17th, in which you stated that the 9 de Julio reached, during the six hours' trial, the mean speed of 21.943 knots.

The Yoshino in the same interval has reached the mean speed of 21.6 knots, which, according to your statement, gives 0.34 in favour of the 9 de Julio.

JACINTO Z. CAMINO,

Lieut. in the Argentine Navy.

94, Church-street, Birkenhead, Cheshire,
August 1st.

TRIALS OF THE JAPANESE CRUISER YOSHINO.—In the report of these trials in our last issue, the word "throughout" should follow the words "double-bottom" in the fourth line of the last paragraph.

CITY AND GUILDS OF LONDON INSTITUTE.—At a meeting of the Council, held on July 31st, the diploma of "Associate of the City and Guilds Institute" was awarded to the following third year students of the City and Guilds Central Institution:—Civil and Mechanical Engineering—K. W. Digby, G. A. Fry, G. H. Heelas, R. F. Krall, H. F. Robinson, A. E. H. Sonneborn, C. V. Drysdale, T. L. D. Hadwen, E. L. Joselin, H. C. Leake, R. D. T. Roe, and W. T. W. Sussman. Physics and Electrical Engineering—G. H. Ballie, W. A. Brodie, W. Casson, J. R. Dick, A. H. Finlay, E. E. Gunter, W. E. Miller, J. Barnard, R. B. Burrows, W. R. Cooper, W. H. Everett, E. G. Fleming, T. Hemmant, N. Ward, and C. H. C. Woodhouse. Applied Chemistry—O. F. Russell.

CHATHAM DOCKYARD.—An outlay of close upon £1000 has been sanctioned by the Lords of the Admiralty for the extension of the Alexandra building slip at Chatham Dockyard. The slip is to provide facilities for the construction of ships of 75ft. beam, or vessels of much greater breadth than any battleship now afloat. When the proposed alteration is completed, the slip will exceed in size that of any building slip in the service, and upon it will be constructed the newly-ordered first-class battleship Magnificent, which when completed will be the largest and most powerful warship in the world. She is to cost £960,000, inclusive of armament, which will include four of the latest improved 67-ton guns. The drawings of the vessel are expected to be received in Chatham in the course of a fortnight, and the building to be commenced forthwith.

AN ACCOUNT OF SOME EXPERIMENTS ON THE TRANSMISSION OF HEAT THROUGH STEEL PLATES, FROM HEATED GAS AT THE ONE SIDE TO WATER AT THE OTHER.*

By A. BLECHYNDEN, Member.
(Concluded from page 98.)

Results of the experiments.—These are given in figures in the Tables I. to XIII., and are likewise shown graphically for the plates A and B in the diagrams numbered 1 to 9, Figs. 3 to 11. The general results for all the plates are also shown relatively to each other in Diagram 10, Fig. 12. Diagrams 1 to 5, Figs. 2 to 7—Tables I. to

Table X. gives the results with the plate C .8125in. thick, with both sides rough. Table XI., the results of plate D, .5in. thick, with one side—that next the water, as in A and B—machined. In the experiments with this plate, the temperatures were also taken at the lower point D, just over the fire, and the results are given in the table referred to. Tables XII. and XIII. give the results of the trials with the plate E. This plate was machined on both sides; it was at first 1.1875in. thick, and was afterwards reduced to .1875. As with the plate D, the temperatures were measured at both the upper and lower points C and D. Only four experiments were made with the plate at each thickness.

Discussion of the results.—If an examination be made of any of the diagrams Nos. 1 to 13, or of Tables I. to XIII., the broad general fact is evident that the units of heat transmitted through

of waste was sufficient to influence the result detrimentally. There is also an apparent falling-off in the increased efficiency of the thinner plates when they are under three-eighths of an inch or so, which seemed as if it might possibly be accounted for on the assumption that the thinner plates yielded to the cutting tool, and thus came to have more smoothly machined surfaces than the thicker. That the smoothness of the surfaces was an important factor will be readily seen when the position of the points for the plate E are compared with others. The plates A and E were at first the same thickness, viz., 1.1875in., yet the modulus for A is .0155in., while that for E is only .01419in. Plates B and E were ultimately reduced to nearly the same thickness, viz., B to .15625in., and E to .1875in., while their moduli differ widely, viz., for B .02583in., and for E .019245in. The differences are due to A and B having the receiving surfaces as from the mill, while E was very smoothly machined on both sides. It may be worth while to compare the results for the various plates relatively to their carbon content:—

Plate.	Carbon.	Specific gravity.
A	.21	7.8176
C	.22	7.8082
D	.23	7.8401
B	.25	7.7420

Now, it will be observed that A, the lowest in carbon, is also the lowest in conductivity, while the others seem to follow in the order of the percentage; though, doubtless, the experiments should be extended to confirm this. The rate of conduction has hitherto within this paper almost entirely been referred to the terminal temperature of the gases. This is not, however, that to which they should be referred, as has already been stated, but to a function of the initial and terminal temperatures, viz., $D \cdot d$. In the cases of plates B, .15625in. thick, D, and E, these are given, and from these and others not here given it is evident that the values should be reduced to about .74 of those given for the ultimate differences of temperature.† The results of these experiments certainly point to the conclusion that the thinner the plates, forming part of the heating surface of a boiler, the higher should be the boiler's efficiency, always provided that the plates are clean; but it will be evident that, if the plates be coated with a covering of scale, or some bad conductor, then the less must be the influence of the thickness on the efficiency, while with a thick coat of oil the influence might become practically unimportant. The fact that the heat transmitted is proportional to the square of the difference of the temperatures of the two sides of the plate shows the importance of high furnace temperatures if efficiency is aimed at, and emphasises the importance of rapid combustion, either by means of air supplied by fans or by height of funnel.

Results of Experiments on the Transmission of Heat through Steel Plates.

No. 1. PLATE A.

Duration of trial.	Temperature in furnace.	Total lbs. of water evaporated.	Heat units transmitted per hour by heating and evaporation of water.	Heat units lost by radiation per hour.	Total units (with radiation) transmitted per hour per sq. ft. H.	Difference in temperature D.	Heat units transmitted per 1 deg. diff. per sq. ft. per hour H/D	H/D ²	Thickness of plate.
H. M.	Deg.								
1 51	1060	10.15	5,800	600	10,820	848	12.78	.01505	1.1875
1 49	1205	14.0	7,460	"	14,780	993	14.85	.01498	"
1 27	1225	8.11	7,845	"	15,500	1013	15.26	.01505	"
2 3	1425	25.1	11,800	"	22,750	1213	18.73	.01545	"
1 54	1440	25.1	12,750	"	24,450	1228	19.9	.01622	"
2 37	1490	38.05	13,950	"	26,750	1278	20.9	.01687	"
Mean ..								.01552	

No. 2. PLATE A.

1 4	838	3.44	3,120	600	6,820	626	10.89	.01741	.75
2 1	1000	11.27	5,380	"	10,950	788	13.9	.01765	"
2 14	1125	15.45	7,880	"	14,500	913	16.04	.01757	"
1 33	1270	16.79	10,480	"	20,300	1058	19.18	.01811	"
1 48	1445	26.45	14,150	"	27,100	1233	21.92	.01788	"
Mean ..								.01770	

No. 3. PLATE A.

2 6	775	6.65	3,058	600	6,705	563	11.90	.02110	.5625
1 57	920	9.97	4,950	"	10,180	708	14.37	.02030	"
1 84	1175	11.85	10,000	"	19,450	963	20.18	.02094	"
1 7	1360	17.98	15,500	"	29,550	1148	25.7	.02241	"
Mean ..								.02119	

No. 4. PLATE A.

1 51	715	5.06	2,645	600	5,950	503	11.81	.02350	.25
1 25	858	6.52	4,450	"	9,260	646	14.35	.02290	"
1 19	935	8.11	5,930	"	11,970	723	16.55	.02290	"
1 14	1040	9.97	7,820	"	15,450	828	18.65	.02255	"
1 7	1105	10.9	9,460	"	18,470	893	20.65	.02310	"
1 7	1190	13.61	11,750	"	22,650	97	23.15	.02365	"
Mean ..								.02300	

No. 5. PLATE A.

1 3	950	6.55	6,030	600	12,170	738	16.48	.02230	.125
1 1	1120	10.18	9,690	"	18,850	998	20.75	.02285	"
1 25	1210	18.27	12,500	"	24,030	998	24.1	.02415	"
1 6	1295	16.48	14,460	"	27,620	1083	25.48	.02352	"
1 24	1335	23.28	16,100	"	30,620	1123	27.25	.02426	"
1 13	1345	20.45	16,240	"	30,900	1133	27.27	.02410	"
1 13	1350	20.65	16,450	"	31,300	1138	27.48	.02410	"
1 3	1530	26.10	24,000	"	45,100	1318	34.21	.02595	"
Mean ..								.02390	

No. 10. PLATE C.

1 3	864	3.95	3,638	600	7,776	652	11.91	.01829	.8125
1 2	975	5.70	5,325	"	10,860	763	14.25	.01865	"
1 1	985	5.98	5,630	"	11,420	773	14.80	.01912	"
1 9	990	6.07	5,100	"	10,450	778	13.46	.01730	"
1 4	990	6.05	5,475	"	11,140	778	14.31	.01841	"
1 5	1060	6.95	6,200	"	12,475	848	14.70	.01735	"
Mean ..								.01819	

No. 6. PLATE B.

1 10	625	2.09	1,730	600	4,270	413	10.32	.02495	.46875
1 7	850	5.09	4,400	"	9,175	638	14.38	.02255	"
1 23	855	6.41	4,500	"	9,850	643	14.53	.02260	"
1 0	1205	12.68	12,235	"	23,550	993	23.70	.02385	"
1 80	1240	20.64	13,800	"	25,500	1028	24.80	.02410	"
1 8	1280	17.23	14,720	"	28,140	1068	26.30	.02462	"
1 19	1335	21.86	16,000	"	30,450	1123	27.10	.02410	"
1 0	1340	16.82	16,230	"	30,850	1128	27.84	.02425	"
1 3	1360	18.28	16,800	"	31,940	1148	27.80	.02420	"
1 0	1465	21.38	20,610	"	38,950	1253	31.10	.02474	"
Mean ..								.023996	

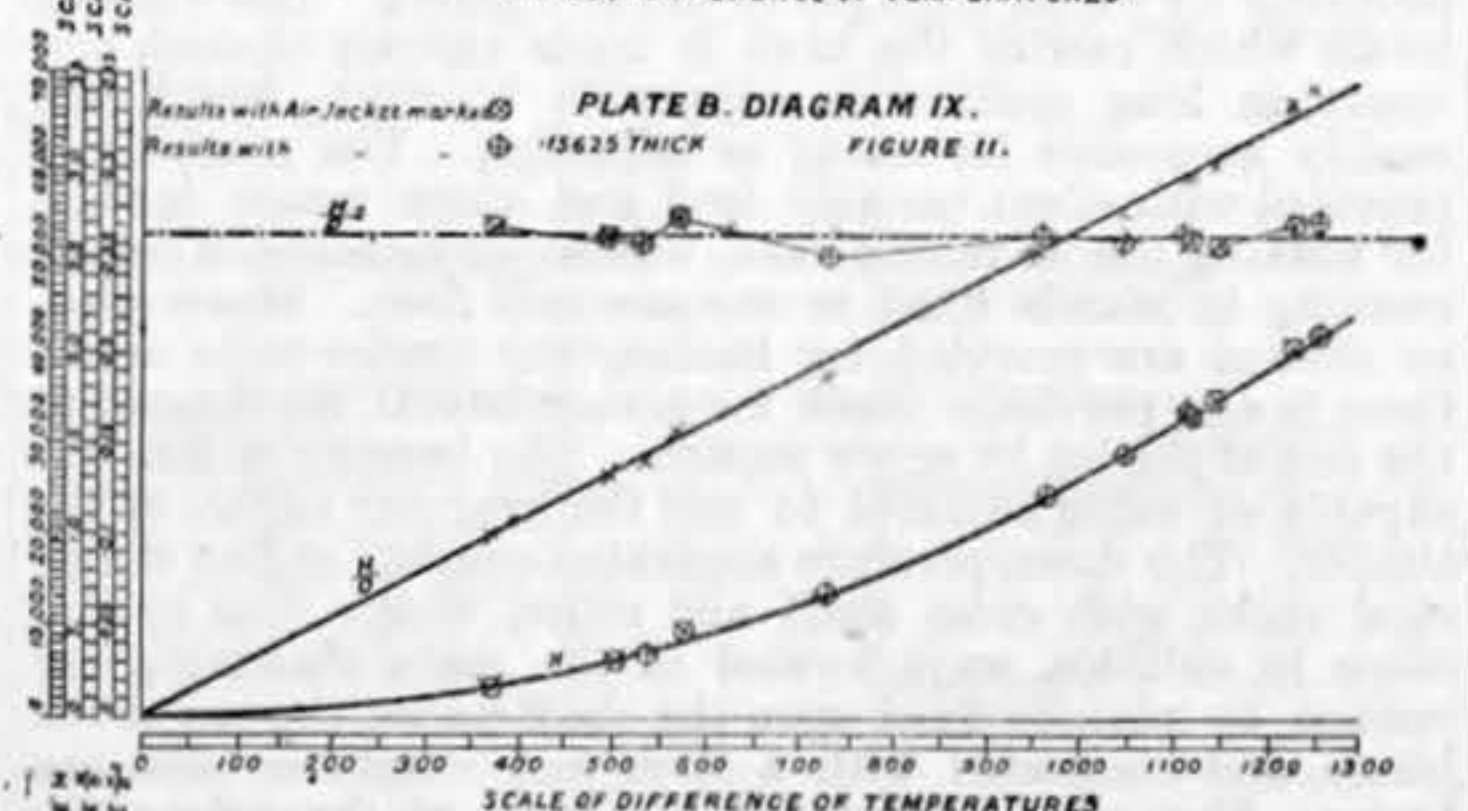
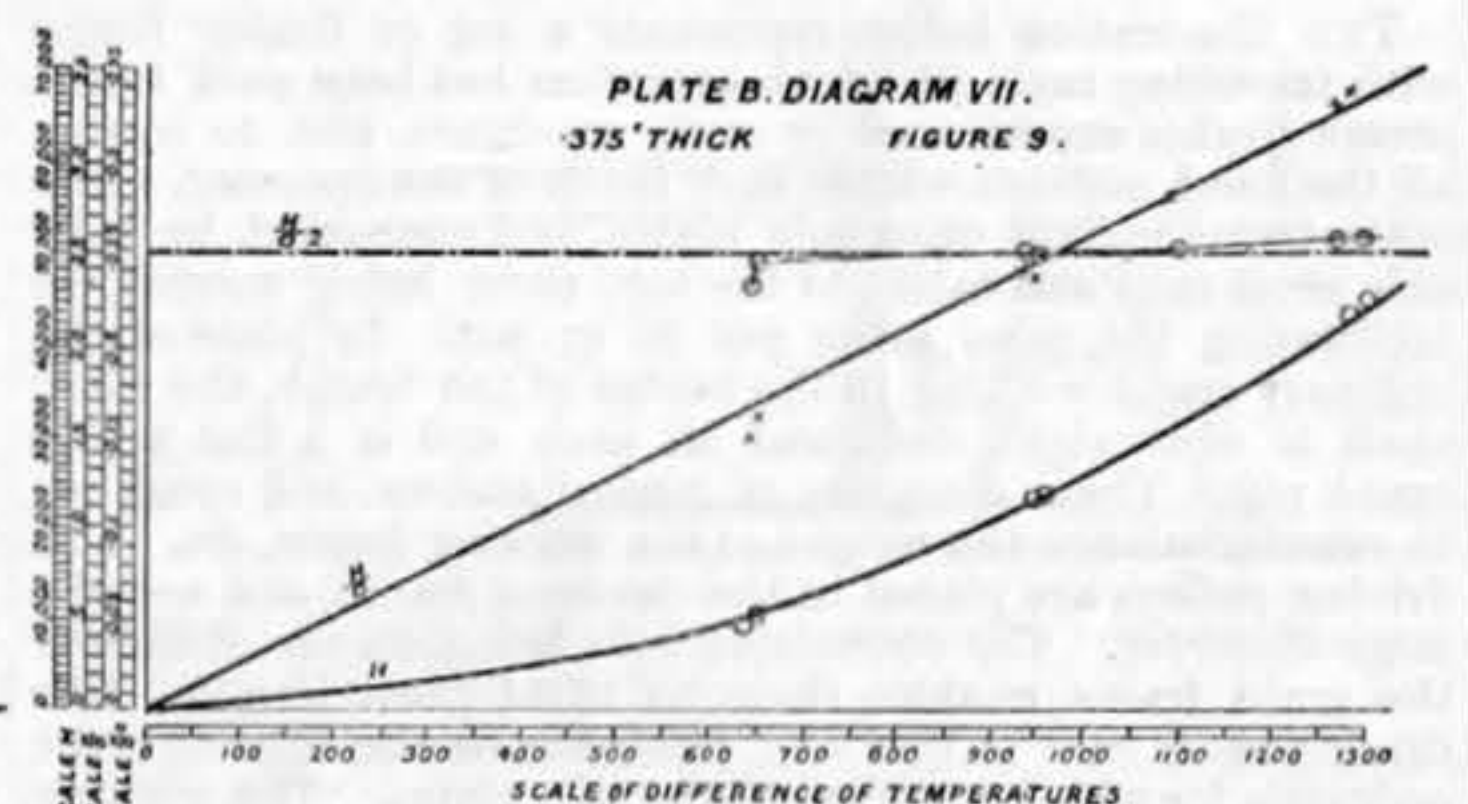
† The results for the plates D and E are given in Tables xi., xii., and xiii. Those for the plate B, at thickness .15625, in Table ix. A.

any of the plates per degree difference of temperature between the fire and the water are proportional to that difference, or, in other words, the heat transmitted is proportional to the square of the difference between the temperatures at the two sides of the plate, as will be seen from the fact that the ratio

$$\frac{\text{Heat transmitted per square foot}}{(\text{Difference of temperatures})^2}$$

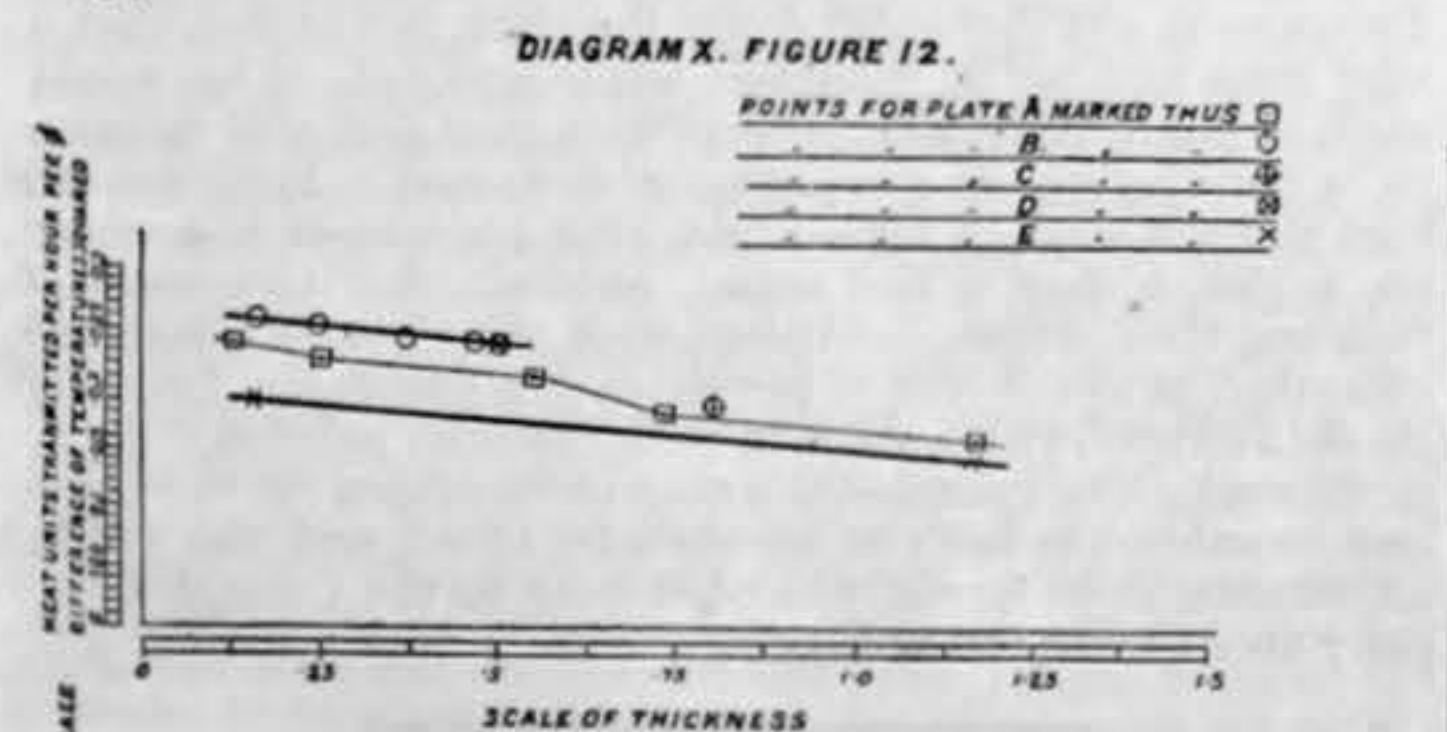
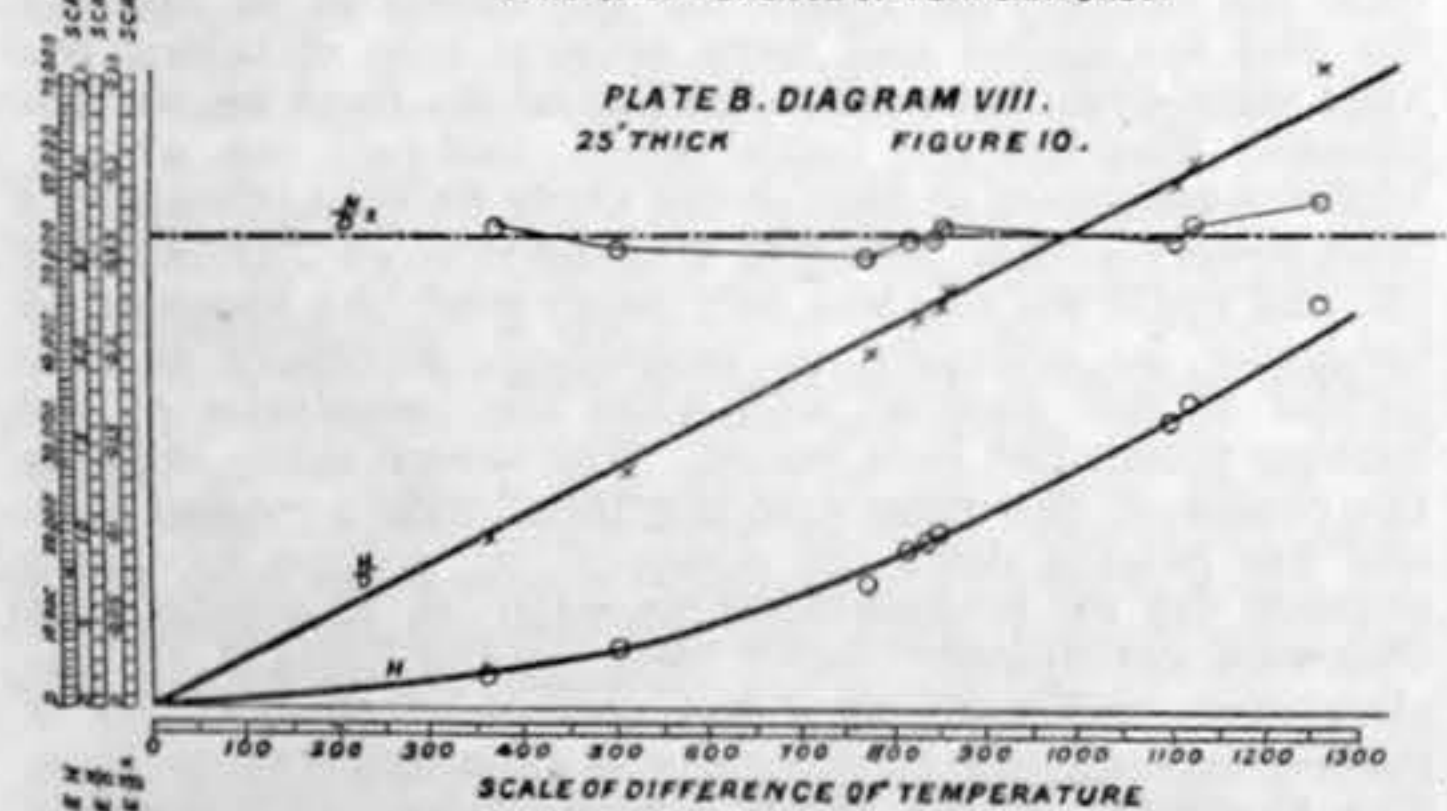
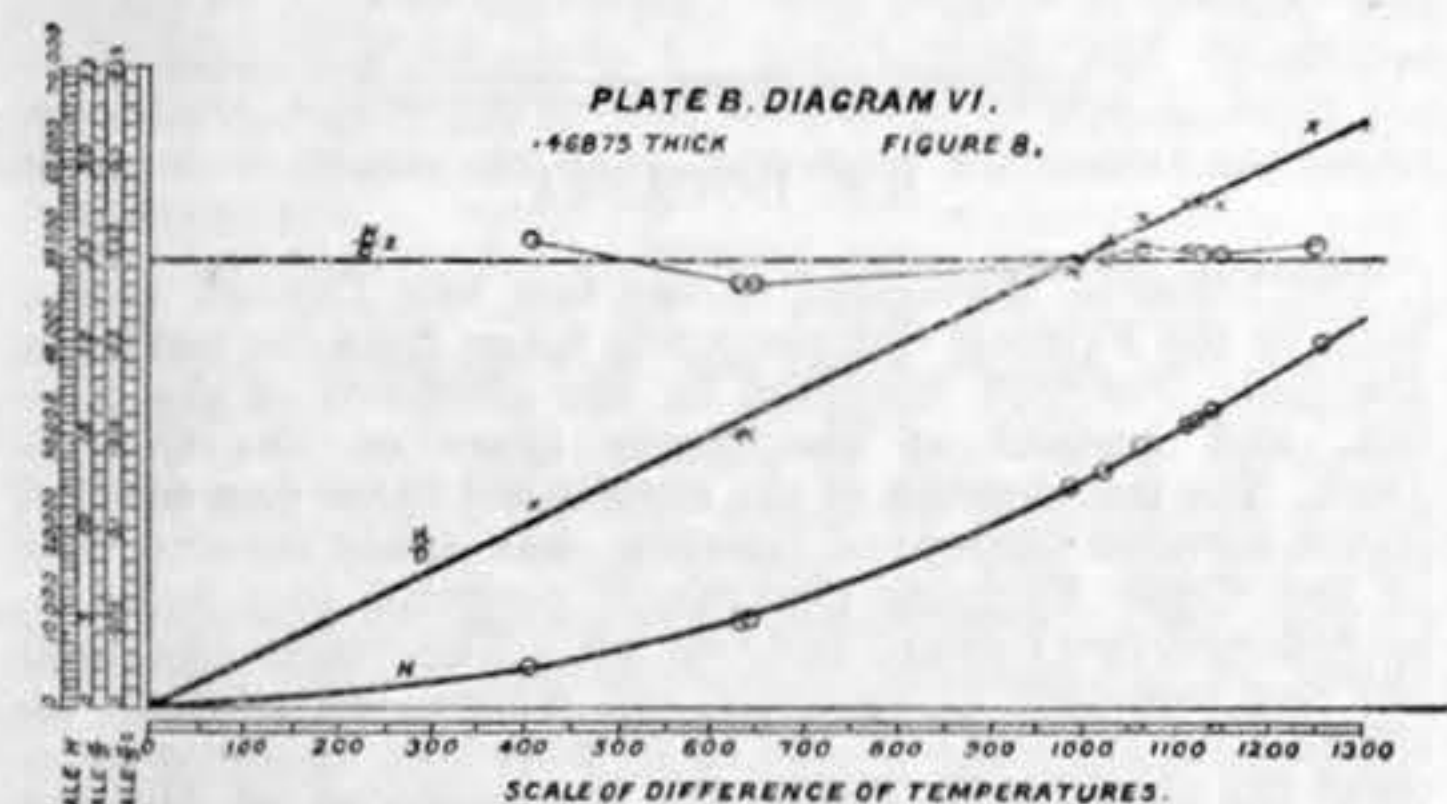
is a constant for each plate within the limits of the experiments, and the mean values of this ratio for the various plates are as follow:—

Plate.	Thickness— inches.	Modulus for temperatures at top station.	Modulus for temperatures at both upper and lower stations.
A	1.1875	.01550	—
A	.750	.01770	—
A	.5625	.02119	—
A	.25	.0230	—
A	.125	.02390	—
B	.46875	.023996	—
B	.3750	.02443	—
B	.250	.02568	—
B	.15625	.02611	.02064
C	.8125	.01819	—
D	.5000	.02367	.01747
E	1.1875	.014188	.00961
E	.1875	.019235	.01432



The figures for the moduli in the last column are calculated as for the mean of the squares of the differences of the temperatures on the assumption that the temperatures taken just over the fire, or point D, are the maxima which would be approximately true, and that those at the upper station were equal to those of the escaping gases, which, as has been shown, was actually correct. The mean of the squares of the differences of temperatures was taken as being $D \cdot d$, where D is the difference between the temperature at the upper station and the boiler, and d the difference between that at the lower station and that in the boiler. The table shows that there is a general rise in the value of the moduli with decrease of thickness; but if the diagram No. 10, which shows graphically the general relation of these moduli, be inspected, it will be seen that there are considerable irregularities in the curves joining the various points for each plate. This is, perhaps, no more than might be expected, because of the great difficulty of machining all the surfaces to the same degree of smoothness; and, notwithstanding the precautions taken, the difficulty of maintaining the surfaces uniformly clean. It was found that the very slightest trace of grease caused a very large fall in the rate of transmission; even wiping the outer surface of the plate with a piece of rag or

V., give the results of the experiments with plate A, which was at first 1.1875in. in thickness, and was afterwards reduced successively to .75in., .5625in., .25in., and .125in. in thickness, and tried at each thickness. The temperatures of the furnace, given in the records of the trials with this plate, are those measured at the point C, Fig. 2. Diagrams 6 to 9, Figs. 8 to 11 and Tables VI. to IX., show the results obtained with the plate B, which was at first .46875in. thick, and was successively reduced to .375in., .25in.,



and .15625in. thick, and tried at each thickness. For its first three thicknesses, as with plate A, no temperatures were measured at the lower point, D, Fig. 2; but in the latter experiments with it, at the smallest thickness, these temperatures were measured, and in these experiments the boiler was fitted with an air jacket.

* Institution of Naval Architects, Cardiff.

Results of Experiments on the Transmission of Heat through Steel Plates.

No. 7. PLATE B.

Duration of trial.	Temperature in furnace.	Total lbs. of water evaporated.	Heat units transmitted per hour by heating and evaporation of water.	Heat units lost by radiation per hour.	Total units (with radiation) transmitted per hour per sq. ft. H.	Difference in temperature D.	Heat units transmitted per 1 deg. diff. H per sq. ft. per hour D.	H D ²	Thickness of plate.
H. M.	Deg.								
1 3	862	5.0	4,610	600	9,570	650	14.74	.02270	.375
1 10	868	6.15	5,080	"	10,420	656	15.87	.02421	"
1 17	1170	15.60	11,800	"	22,750	958	23.74	.02479	"
1 8	1180	13.92	11,880	"	22,880	968	23.62	.02440	"
1 4	1320	17.02	16,000	"	30,400	1108	27.40	.02472	"
1 21	1500	30.7	22,000	"	41,450	1288	32.15	.02498	"
1 84	1520	27.0	22,910	"	43,150	1308	33.0	.02520	"
Mean ..								.02443	

No. 8. PLATE B.

1 4	585	1.5	1,360	600	3,595	373	9.63	.02584	.25
1 1	725	3.13	2,975	"	6,560	513	12.77	.02495	"
1 10	985	8.93	7,410	"	14,700	773	19.0	.02460	"
1 9	1035	10.45	8,780	"	17,220	823	20.94	.02544	"
0 57	1060	9.25	9,370	"	18,310	848	21.6	.02545	"
1 15	1067	12.66	9,770	"	19,020	855	22.28	.02600	"
1 4	1320	18.15	16,500	"	31,380	1108	28.3	.02550	"
1 12	1340	21.62	17,460	"	33,150	1128	29.39	.02604	"
1 6	1480	26.55	23,300	"	43,800	1268	34.6	.02730	"
Mean ..								.02568	

No. 9. PLATE B.

1 17	755	4.67	3,520	600	7,550	543	13.88	.02558	.15625
1 20	950	9.38	6,780	"	13,540	738	18.35	.02490	"
1 3	1185	14.0	12,850	"	24,650	973	25.3	.02600	"
1 7	1270	17.45	15,150	"	28,000	1058	27.3	.02583	"
1 6	1335	19.65	17,320	"	32,900	1123	29.28	.02604	"
1 10	1460	27.8	23,050	"	43,400	1248	34.8	.02790	"
1 5	1475	25.3	22,550	"	42,400	1263	33.58	.02658	"

With Air Jacket. No addition for Radiation.

3 21	588	6.99	2,010	0	3,700	376	9.86	.02625	Air jacket
1 86	717	5.96	3,595	0	6,600	505	13.06	.02500	"
2 0	794	10.28	4,979	0	9,140	582	15.67	.02600	"
1 46	1341	32.6	17,850	0	32,750	1129	29.10	.02570	"
1 21	1367	25.95	18,540	0	34,050	1155	29.48	.02550	"
1 32	1450	35.1	22,100	0	40,550	1238	32.78	.02650	"
Mean ..								.02611	

No. 11. PLATE D.

Duration of trial.	Temp. at top of furnace.	Temperature at bottom of furnace.	Heat units trans- mitted per hour by heating and evapora- tion of water.	Heat units trans- mitted per hour per sq. ft. H.	D diff. top.	d diff. bott.	$\frac{H}{D}$	$\frac{H}{D} \times d$	$\frac{H}{D^2}$	Thickness of plate.
H. M.	Deg.	Deg.								
1 30	651	743	2,318	4,250	439	531	9.66	.01820	.02200	
1 30	967	1279	7,180	13,200	755	1067	17.49	.01640	.02316	
1 31	950	1354	7,140	13,110	738	1142	17.75	.01560	.02428	
1 29	956	1177	7,400	13,580	744	965	18.23	.01892	.02455	
2 40	980	1280	7,620	13,980	768	1068	18.26	.01710	.02380	
1 41	1059	1396	8,820	16,200	847	1184	19.13	.01615	.02260	
1 40	1091	1347	10,200	18,730	879	1135	21.32	.01880	.02430	
1 33	1122	1422	11,120	20,410	910	1210	22.45	.01858	.02470	
Mean								.01747	.02367	

No. 9A. PLATE B.

With Air Jacket. No addition for Radiation.

1 36	717	867	3,595	6,000	505	655	13.06	.01995	.0259	.156
2 0	794	904	4,979	9,140	582	692	15.67	.02265	.0269	"
1 46	1341	1537	17,850	32,750	1129	1325	29.10	.02195	.0257	"
1 21	1367	1850	18,540	34,050	1155	1638	29.48	.01800	.0255	"
Mean								.02064		

No. 12. PLATE E.

Duration of trial.		Temp. top.		Temp. bott.		Heat units transmitted per hour by heating and evaporation of water.		Heat units transmitted per hour per sq. ft. H.		D diff. top.		d diff. bott.		$\frac{H}{D \times d}$		$\frac{H}{D^2}$		Thickness of plate.
H. M.	Deg.	Deg.																
1 38	513	735	774	1,420	301	523	.00901	.01560	1.1875									
1 53	652	896	1,520	2,790	440	684	.00927	.01442	"									
2 0	856	1125	2,855	5,230	644	913	.00890	.01264	"									
2 2	1285	1550	8,800	16,150	1073	1338	.01126	.01405	"									
Mean														.00961	.01418			

No. 13. PLATE E.

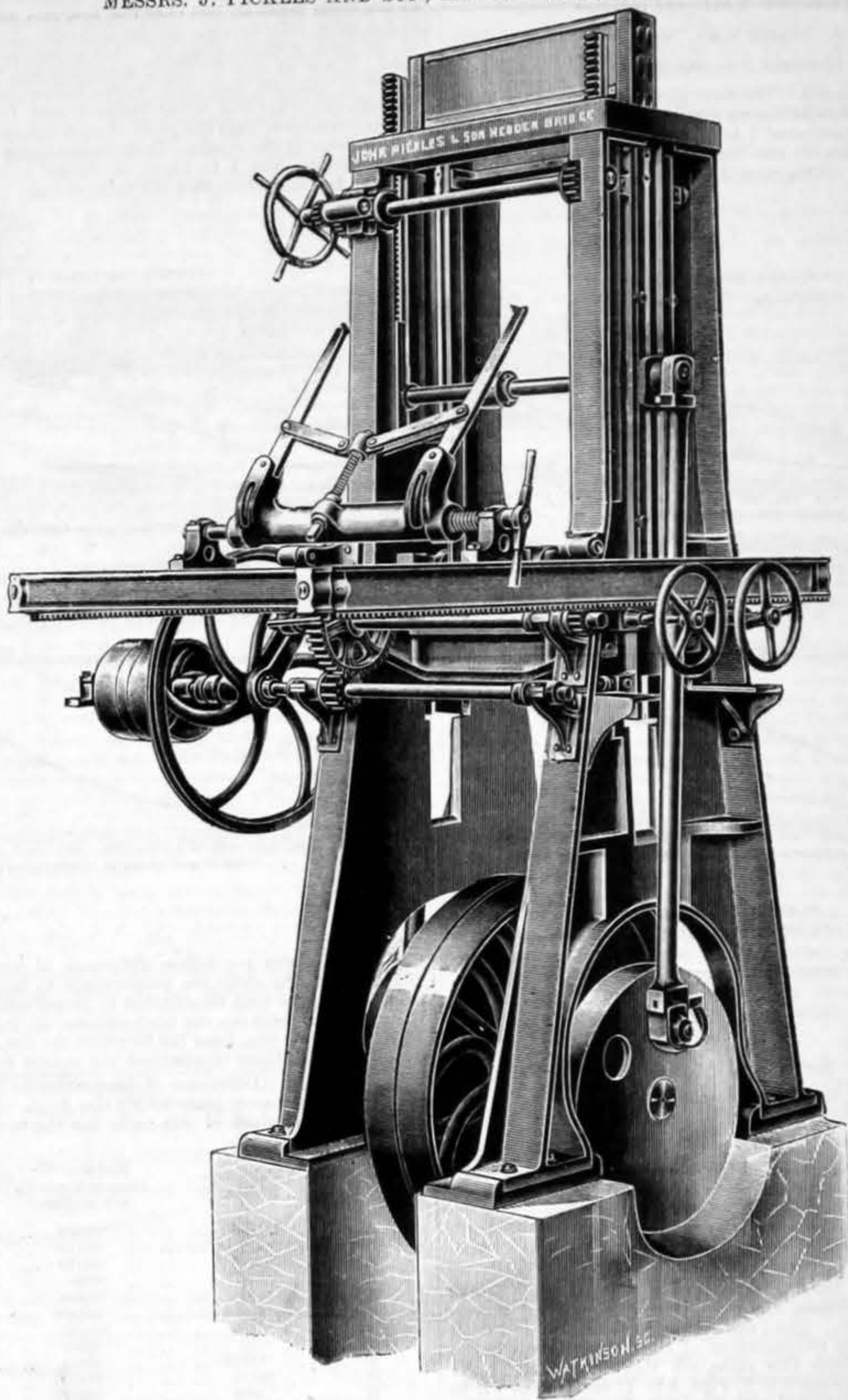
1 324	534	648	1,091	2,005	322	436	.01430	.01938	.1875
2 0	771	989	3,276	6,010	559	777	.01382	.01920	"
2 0	955	1242	5,641	10,360	743	1030	.01354	.01880	"
1 45	1340	1625	13,550	24,880	1128	1413	.01559	.01955	"
Mean							.01431	.01923	

Boiler surrounded top and sides by air jacket, which was well covered with asbestos. No allowance has been made for loss by radiation. This plate was machined on both sides.

PREPARATIONS, by Admiralty order, are at once to be made at Sheerness Dockyard for the construction of the new sloop-of-war Torch, designed by Mr. W. H. White, Director of Naval Construction. This vessel is to be 180ft. long, 32ft. 6in. beam, and 960 tons displacement, at which her draught will be 11ft. 6in. Being specially designed for service on foreign stations where few facilities exist for docking men-of-war, she will be sheathed and coppered. The Torch will be fitted with engines capable of developing 1400 indicated horse-power under forced draught, giving her a speed of 13½ knots, and 1050-horse power under natural draught, with a speed of 12½ knots. Her armament will consist of six 25-pounder and four 3-pounder quick-firing guns. All the latest improvements in steering gear, electric lighting, &c., will be adopted in her outfit. A similar vessel to the Torch, to be named the Alert, is to be laid down in the same dockyard during the present financial year.

LOG FRAME WITH TRAVELLING RACK

MESSRS. J. PICKLES AND SON, HEBDEN BRIDGE, ENGINEERS

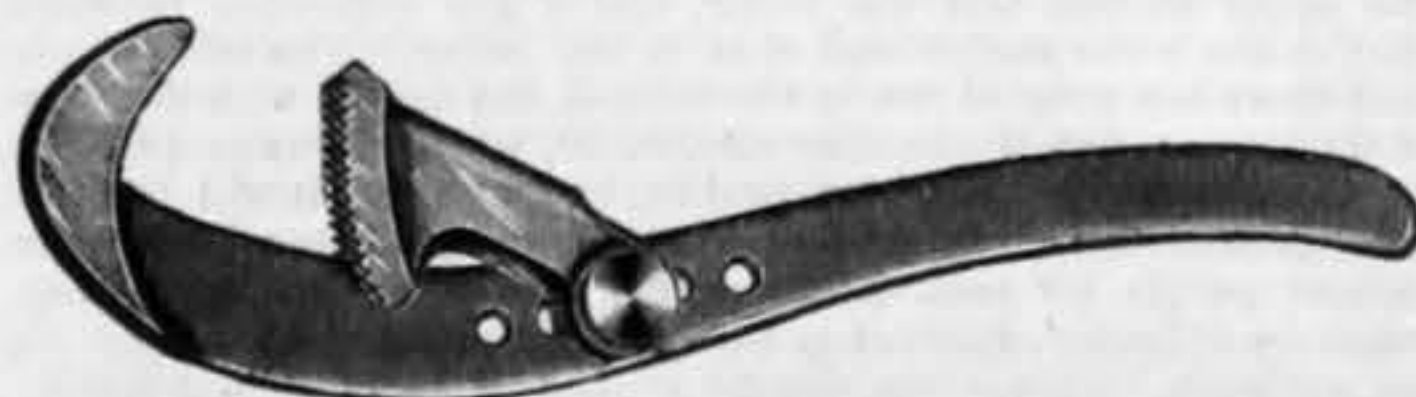


LOG FRAME WITH TRAVELLING RACK.

The illustration below represents a log or timber frame with travelling rack, in which attention has been paid to the severe strains experienced by such machines, and to setting all the hand motions within easy reach of the operator. The main frame is fixed upon sole plates, and connected by suitable cross rails and tablet at the top, room being secured for facilitating the saws being put in or out. In place of the ordinary crank working in the centre of the frame, the main shaft is of straight steel, and on each end is a disc with a crank pin. These discs are of large diameter, and cored out to counterbalance the weight of the working frame, &c. The driving pulleys are placed in the centre of frame, and are of a large diameter. The connecting rods being on the outside of the main frame, enables them to be of great length. The driving shaft runs in two long phosphor-bronze bearings, the pedestals for which are fixed to the sole plates. The working frame which carries the saws is made entirely of steel, and works in long continuous adjustable bearings, which are readily accessible for oiling or adjusting. The machine is provided with silent variable feed and quick return motion for working the travelling rack which works between rollers running in stands fixed to the saw mill floor. Screw clips, as shown, are provided for holding the timber to be sawn; there is also provision made for giving lateral movement to the end of the log by screw motion. The bearing rollers are capable of being adjusted to suit the irregular nature of the timber. The down-pressure apparatus consists of two strong steel racks, with cross shaft and roller, which slide up and down in suitable ways formed in the main standard, and worked by pinions fixed upon the shaft across the top of the frame, and connected with a lever and weight outside the frame. The arrangement for the back of the frame is a swing spur, fitted with adjustable screw, and easily turned up out of the way. The machines are of different sizes, that of 42in. width being intended to take in and work sixty saws. The machine is made by Messrs. John Pickles and Son, Hebden Bridge.

"TIGER" PIPE WRENCH.

The accompanying engraving illustrates a new form of wrench. Its means of gripping will be seen from the



engraving. It has a very large capacity, and can be used as a spanner; it is made of wrought steel and tempered. It is a strong tool, and can be used with great quickness. It is made

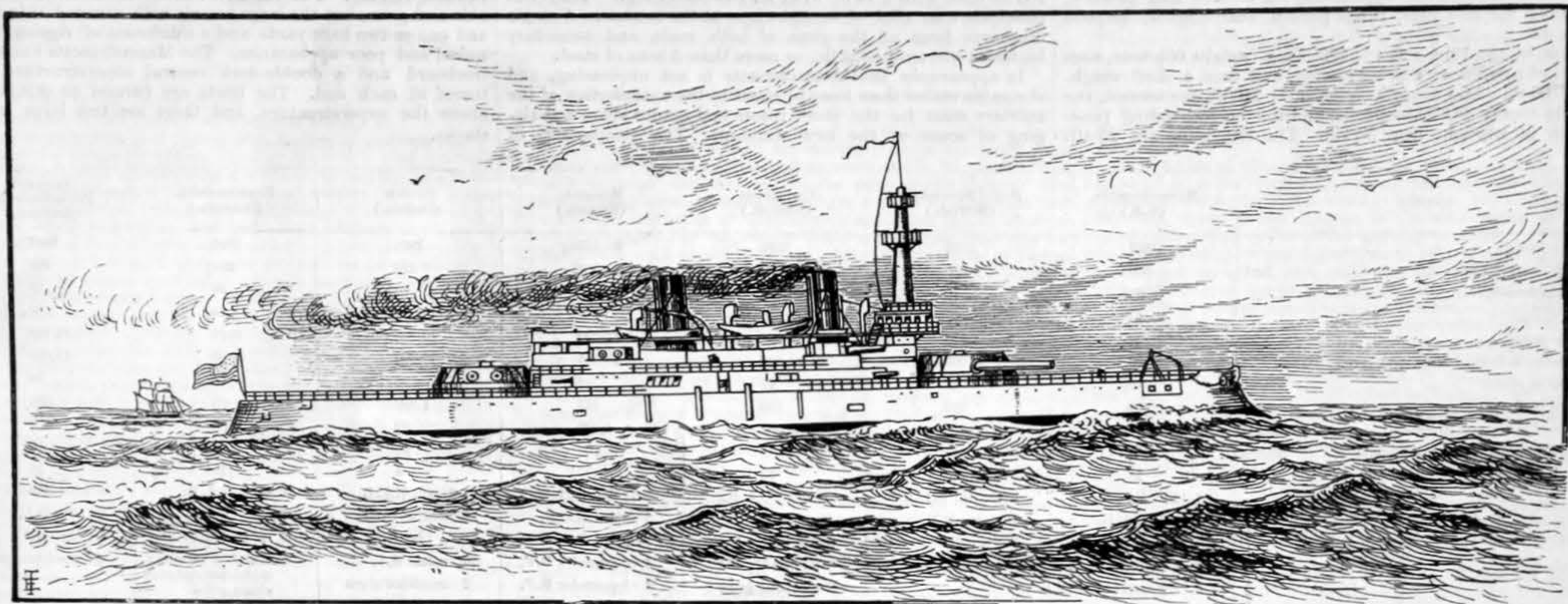
by special machinery, and is produced and sold at a small cost by the inventor, Mr. T. R. Paxton, Burton, Westmoreland.

S.S. LUCANIA.

THE Lucania, the second of the two new Cunard vessels built by the Fairfield Company, was taken from the wet basin alongside Fairfield Shipyard in the afternoon of the 29th ult., and berthed at the North Quay of the Queen's Dock. The transference of the huge vessel to her new position in the crowded harbour of Glasgow was safely effected, four of the Clyde Shipping Company's powerful tugs being in attendance, two forward and two aft. The vessel also used her own propellers at intervals, and during her progress up the harbour she was watched by thousands of spectators who lined the banks of the river. On the afternoon of Monday the 31st the second and more arduous step of taking the huge vessel down the river to the Tail-of-the-Bank was accomplished. She left her berth about half-past one o'clock, with the assistance of four of the Clyde Shipping Company's most powerful tugs. She was drawing close on 26ft. of water aft, and while the tide was only fairly good she appeared to encounter no difficulty in proceeding, especially in the middle of the channel, and when the boundaries of the harbour proper had been passed. The several sharp bends in the course of the river were negotiated with apparent ease, and her passage down the comparatively narrow navigable channel did not present the inconveniences to smaller craft that were anticipated. River steamers and boats of various sizes came and went as if the passage of the greatest of modern transatlantic greyhounds was an everyday occurrence. The anchoring of the vessel opposite Greenock was safely accomplished. On the upper and promenade decks of the Lucania, as she proceeded down the river, it was seen that a very large number of workmen were employed. This would seem to point to the conclusion that a good deal still remains to be done before the completion of the vessel. It is intended that she will start to-day—Friday, 4th August—or to-morrow on a preliminary cruise round Ireland, with the view of fulfilling the contract conditions with regard to long distance steaming, as in the case of her sister ship Campania, finishing up at Liverpool, where she is to be docked and painted. Early next week it is intended the vessel will return to the Clyde and be subject to her official trials for speed, and she will in all likelihood be formally handed over to the Cunard Company about three weeks hence.

THE Ealing Local Board have just accepted tenders for the provision and laying of mains and the erection of buildings for electric lighting, and agreements have also been signed by the Chiswick Local Board in the same direction. At Richmond considerable progress has now been made with the laying of mains in the borough, and the new municipal buildings are already furnished with the electric light.

UNITED STATES BATTLESHIP MASSACHUSETTS



THE BATTLESHIP MASSACHUSETTS, UNITED STATES NAVY.

ONE of the heaviest and most powerful of the vessels for the new navy of the United States is the battleship Massachusetts, which was launched at Philadelphia on June 10th, and of which an American correspondent sends the following description. She is one of three sea-going coast defence battleships authorised by Congress in June, 1890, up to which time the new ships authorised had been mostly different classes of the cruiser type. The contracts for two of these, the Massachusetts and Indiana, were let to Cramp and Sons, of Philadelphia, and that for the third, the Oregon, to the Union Ironworks, of San Francisco. The contract prices for hulls and machinery—exclusive of armament, which is provided by the Government—were 3,020,000 dols. for each of the first two, and 3,180,000 dols. for the third. The leading particulars of the Massachusetts are as follows:—

Length on load water-line	360ft.
Beam, extreme	69ft. 3in.
Draught, mean (same fore and aft)	24ft.
Draught, with bunkers full	26ft. 9in.
Freeboard, forward	12ft.
Displacement, at normal draught	10,200 tons.
Weight to increase draught 1in.	42 tons.
Coal capacity at normal draught	400 tons.
Coal capacity of bunkers	1800 tons.
Horse-power	9000 I.H.P.
Speed, maximum	16½ knots.
Speed, sustained sea speed	15 knots.
Complement of officers and men	460.

The hull is of steel throughout, with heavy steel castings, for the stern, sternpost, propeller braces or struts, and the rudder frame. The transverse frames, or ribs, are placed 4ft. apart along the double bottom, and 3ft. 6in. at the ends of the ship, the double bottom not being continuous. The vessel has a flat keel-plate, ¾in. thick, and the side plating is 7/8in. to 1in. thick. The interior is divided into watertight compartments by longitudinal and transverse bulkheads, and a centre-line bulkhead, extending from the keel to the protective deck, separates the engine and boiler rooms.

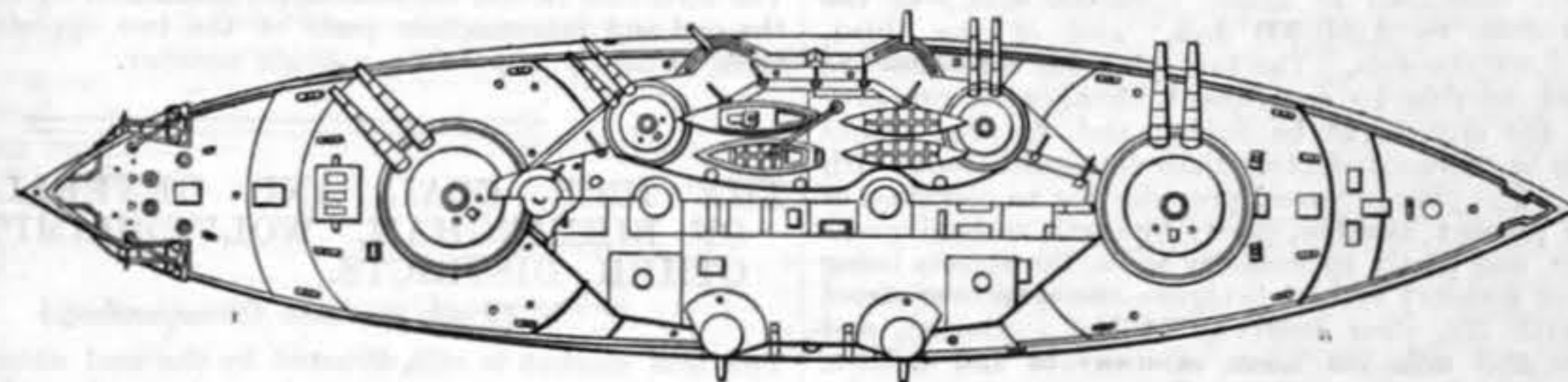
The hull is protected by belts of heavy armour 7½ft. wide, turned in forward and aft to sweep around the bases of the armoured redoubts at the bases of the gun turrets. Forward and aft of this belt are heavy, underwater protective decks sloping down to 4½ft. below the water-line at the sides. Another armoured deck extends across the ship above the belt. Above the belt, too, the sides are protected by 5in. vertical steel armour. Coal bunkers are built over the belt deck, and cellulose will be placed on the slopes of the protective decks forward and aft. In addition, there is heavy armour protecting the guns. The water-line belt will be of Harveyised nickel steel 18in. thick, the redoubts rising at each end of it being 17in. thick. These redoubts protect the bases of the turrets, the revolving gear, the loading apparatus, and other vital machinery, besides preventing a raking fire from forward and aft. The 18in. belt is backed by six inches of wood, two ¾in. steel plates and a 10ft. belt of coal in the bunkers referred to above. The protective decks forward and aft of the water-line belt are 2¾in. thick, while that over the belt is 3in. thick. These decks are formed of two layers of ¾in. steel plates, the remaining thickness being made up of one plate of solid steel. There is a 10in. armoured conning tower forward, with a 7in. tube for conducting the speaking tubes, electric wires and steering connections below.

The Massachusetts has twin screws, driven by a pair of direct-acting, inverted-cylinder, triple-expansion engines. The diameter of the high-pressure cylinders is 34½in.; of the intermediate, 48in.; and of the low-pressure, 75in.; the common stroke of all being 42in. The engines are to develop 9000 indicated horse-power, and a maximum speed of 16½ knots, with a sustained sea speed of 15 knots. The supply of coal at the normal draught will be 400 tons, but there is bunker capacity for 1800 tons, which would increase her draught by about 33in. As coal was consumed, however, she would gradually return to her normal draught, and could thus accomplish a long voyage without re-coaling, arriving at the scene of action with a large supply of coal and at fighting draught. The radius of action of 1800 tons supply, at the ordinary cruising speed of 10 knots, is estimated at 16,000 nautical miles. There are four double-ended boilers, each 18ft. long and 15ft. in diameter, and two single-ended donkey boilers, each 8½ft. long and 10ft. in diameter. All the boilers are of steel and of the horizontal return-fire tubular type. Each boiler has eight furnaces, and the total heating surface of the main boilers is 17,460 square feet, with a total grate surface of 552 square feet. Each boiler and engine is placed in a separate watertight compartment, in order to localise injury to any one of them.

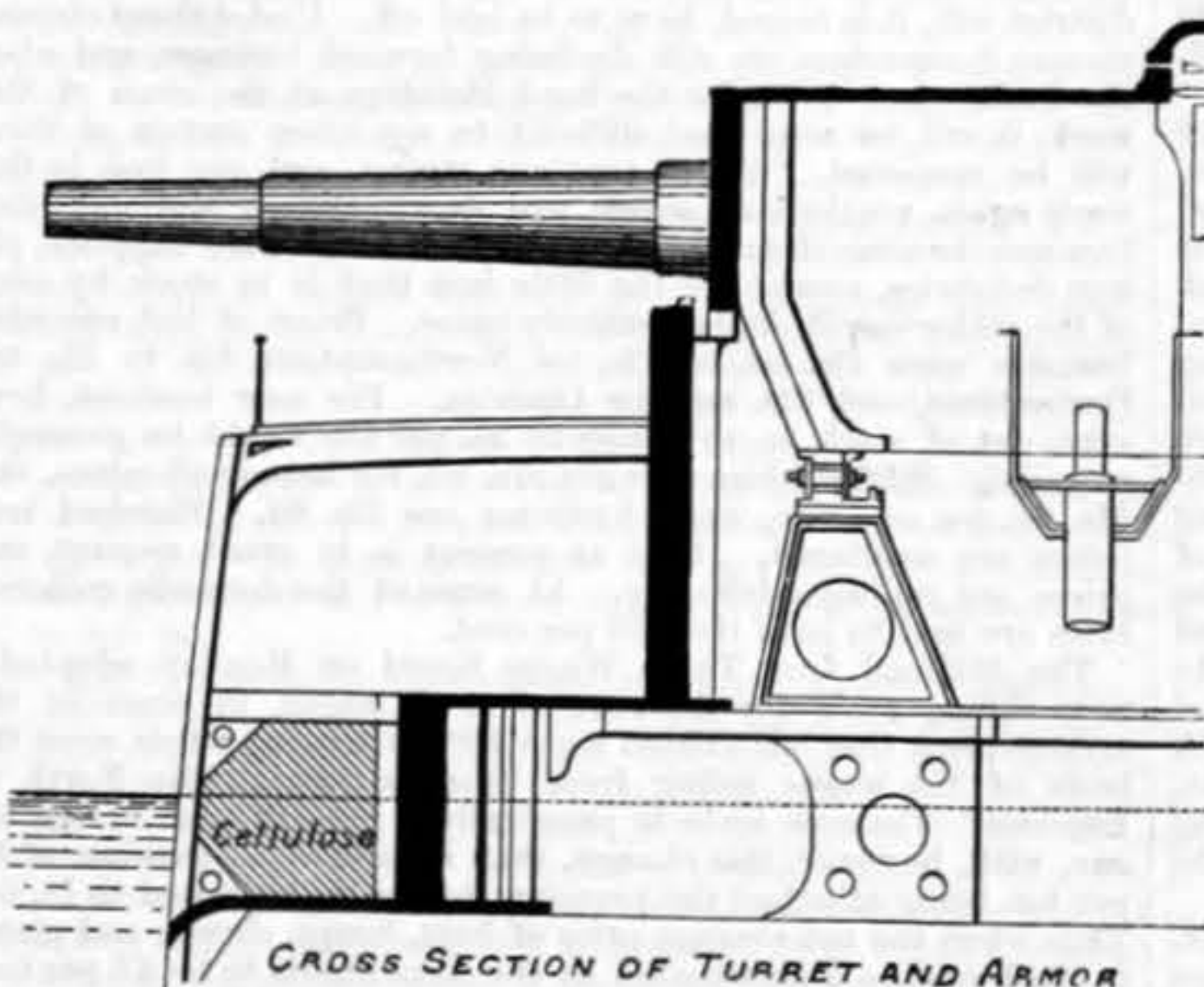
It has been objected that the vessel will be deficient in

speed and coal capacity; but this is not well founded, as she is intended for coast-line service, and not for service in distant parts of the world. For this reason, and as it would be practically impossible to make her suitable for every class of service, it was wisely determined to emphasise the essentially important features of armament and protection. To do so it was necessary to sacrifice speed and coal endurance, but this was not done to an unreasonable extent. For the ordinary purposes of coast service the sustained sea speed of 15 knots is ample, especially in view of the fact that, being near home stations and docks nearly all the time, the bottom of the Massachusetts would be kept in much better condition than those of hostile battleships acting far from their base, and she would thus, in practice, be apt at all

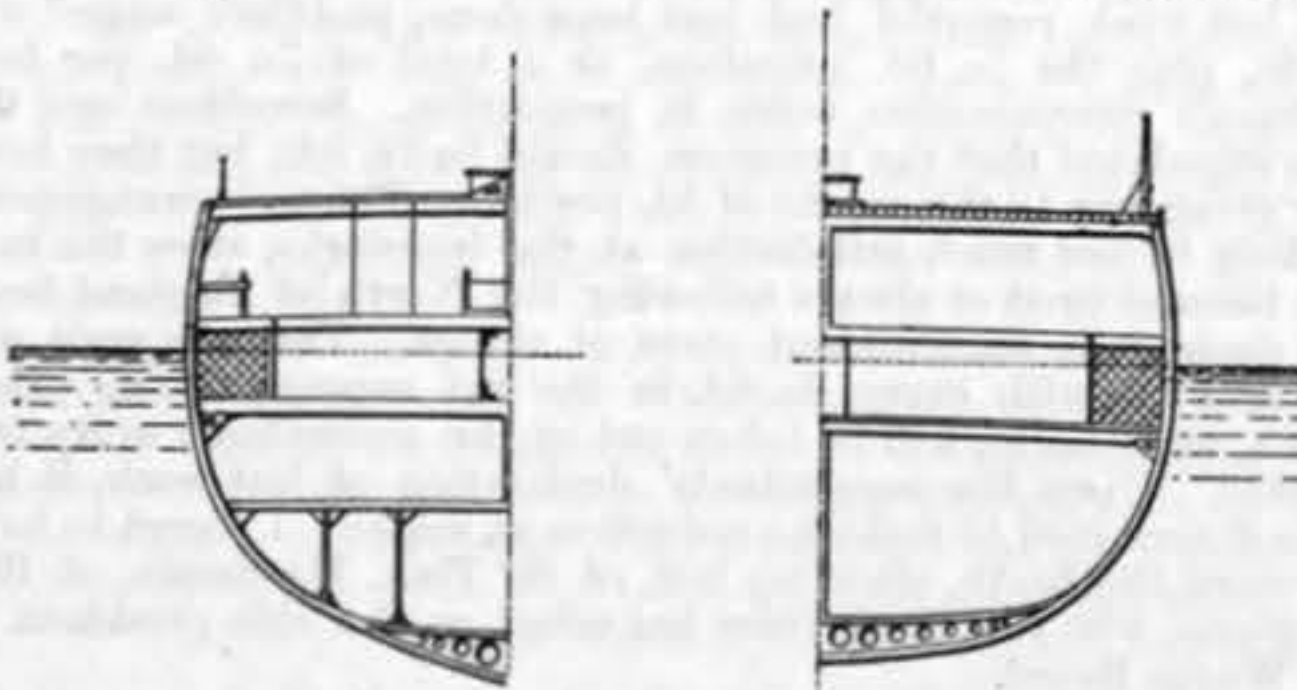
over which they fire. They are thus sufficiently high up to give them an excellent platform from which they may be fought effectively in any sea. They are also sufficiently elevated to minimise injury to the deck from their "blast" when fired over it. One of the best and most distinctive features of the manner in which they are mounted, however, is the fact that they may be loaded in any position of horizontal train. This is a distinct advantage, insuring unusual rapidity of firing, and possessed by few if any foreign battleships, the largest guns of which can generally only be loaded in one position, to which they must be returned, at great loss of time, after every shot. The 8in. guns are likewise mounted in pairs in armoured turrets, 8½in. thick, one of which is located at each corner of the superstructure. They



MAIN-DECK PLAN

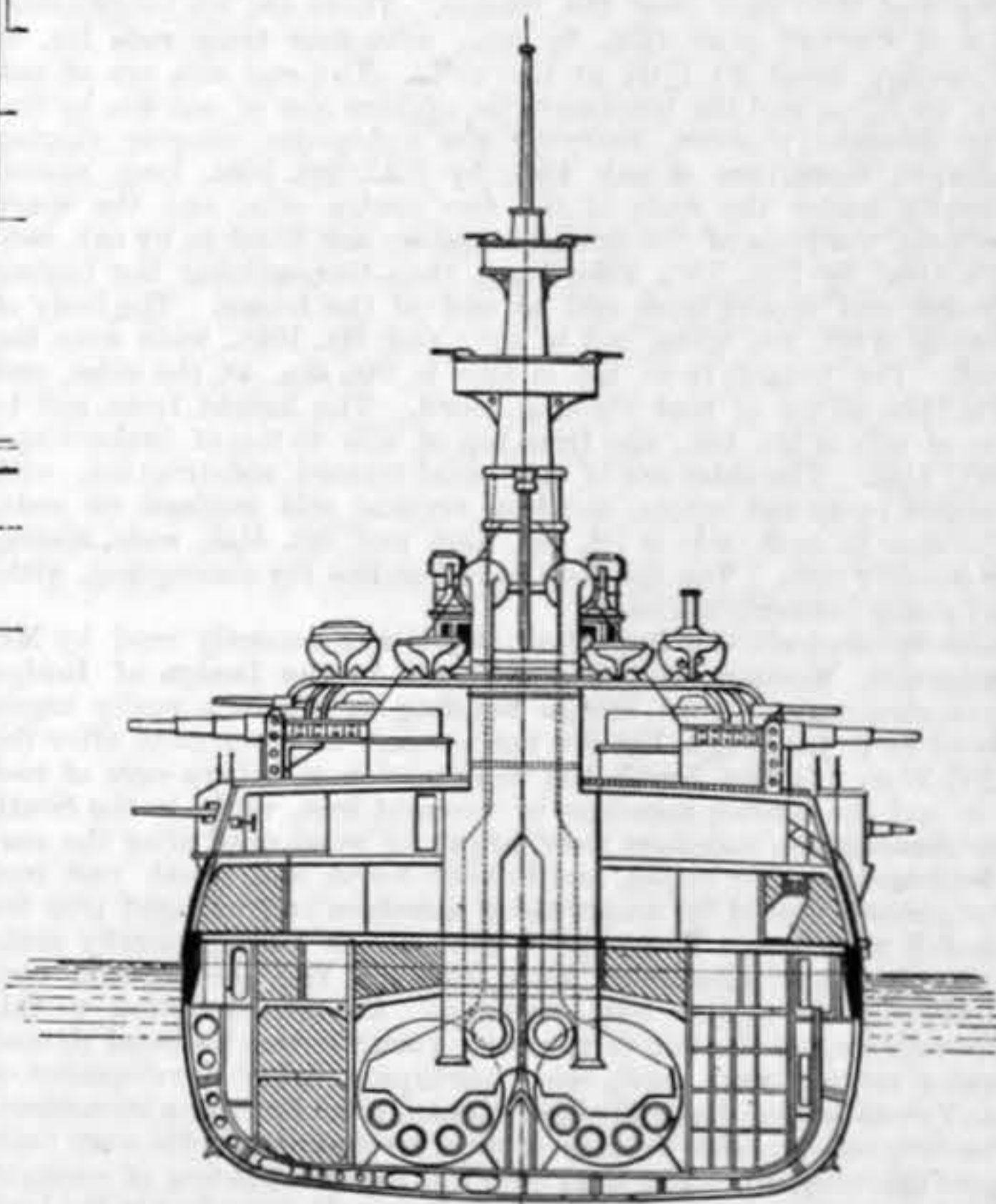


CROSS SECTION OF TURRET AND ARMOR



HALF SECTION AFT.
Showing Cellulose Belt

SECTION FORWARD
Showing Cellulose Belt
and Floor Plates



MIDSHIP SECTION
Armor Belt in Black

PLAN AND SECTIONS OF THE U.S. BATTLESHIP MASSACHUSETTS

times to develop her record speed, while her antagonists would, in all likelihood, fall off considerably from theirs. At any rate, very few foreign battleships exceed in service the speed designed for the Massachusetts. As for the coal endurance, the same fact of being near home ports would enable her to replenish her bunkers with great frequency, and, in case of necessity, as already stated, she has space on board for stowing nearly five times her normal supply.

The armament is very powerful in itself and as compared with that of foreign battleships, as shown by the accompanying table. It consists of four 13in., eight 8in., and four 6in. breech-loading rifles; twenty 6-pounder, and four 1-pounder rapid fire guns; four Gatling guns, and six torpedo tubes. The 13in. guns are mounted in pairs in two turrets, one forward and one aft, the bases of each being protected by the armoured redoubts. The walls of these turrets are 17in. thick, and they are at such a height that the guns are 17ft. 8in. above the load water-line, and 6ft. above the deck

are 24ft. 9in. above the water, and can fire over the turrets on the deck below containing the 13in. guns. The 8in. gun can pierce or shatter, at a distance of two miles, the armour of most of the modern foreign armoured cruisers. They can open fire early in an engagement, on account of their great height above the water, and can be used with destructive effect upon the more lightly armoured portions of heavy hostile battleships. The 6in. guns are mounted 14ft. 10in. above the water on the main deck, within the superstructure. They are protected by 5in. of armour, and have 2in. steel splinter bulkheads worked around them, inside of which the ammunition is passed up.

Special attention has been devoted to the means of supplying ammunition to the battery when in action, with a view of securing rapidity, certainty and thorough protection of the service to the guns. The smaller guns of the secondary battery are mounted in effective positions about the decks and in the fighting tops of the big military mast. Of the six

torpedo tubes, two are fixed in the bow and stern respectively, while the others are training tubes, placed two on each broadside.

The Massachusetts will also be provided with all the modern miscellaneous appliances for offence and defence, including torpedo nets, range-finders, searchlights, torpedo boats, &c.

Each of the 13in. rifles is 40ft. long, weighs 60½ tons, uses 550lb. of powder, as a firing charge, and fires a shell weighing 1100lb. The muzzle velocity is 2100ft. per second, the muzzle energy 33,627 foot-tons, and the corresponding penetration in wrought iron 30·1in. The 8in. guns are 25·4ft.

long, weigh 13·1 tons, and fire a 250 lb. shell with a charge of 105lb. to 115lb. of powder. The muzzle energy of the 8in. rifle is 7498 foot-tons, and the penetration in wrought iron 18·1in. The 6in. guns are 18·8ft. long, weigh 5·2 tons, fire a 100lb. shell with a 44 lb. to 47 lb. powder charge. They will penetrate over 13in. of wrought iron at the muzzle. A single discharge from all the guns of both main and secondary batteries will emit 6924 lb., or more than 3 tons of steel.

In appearance the Massachusetts is not unpleasing, and she gains rather than loses in effect by the substitution of the military mast for the short masts and scanty spars and rigging of some of the new warships. The comparison of

appearance of modern warships was very effective at the recent great naval review at New York. The most beautiful ships were the full-rigged Russian and French cruisers, with their lofty masts, long yards, and intricacy of standing and running rigging. The vessels without masts looked serviceable and grim, but the large vessels with stunted thin masts and one or two bare yards and a minimum of rigging had a naked and poor appearance. The Massachusetts has a high freeboard and a double-deck central superstructure, with turret at each end. The boats are carried on skid beams above the superstructure, and there are two large smoke-stacks.

Details.	Massachusetts. (U.S.)	Royal Sovereign. (British.)	Centurion. (British.)	Messena. (French.)	Sicilia. (Italian.)	Brandenburg. (German.)	Georgi Pobedonosets. (Russian.)
	1893	1891	1891	Building	1891	1891	1891
Date of launch	1893	1891	1891	Building	1891	1891	1891
Length on load line feet	360	350	360	363½	420	354½	320
Extreme breadth "	69½	75	70	65½	76½	64	69
Mean draught "	24	27½	25½	26½	28½	24½	26½
Displacement tons	10,200	14,150	10,500	11,700	13,208	9842	10,280
Maximum indicated horse-power	9,000	13,000	13,000	11,000	19,500	9500	15,000
Maximum speed knots	16½	17	18	18	18	16	16
Normal coal capacity tons	400	900	750	585	1,200	(?)	700
Radius of action at 10 knots sea miles	3,550	5,000	5,000 (?)	4,000	(?)	(?)	(?)
Maximum thickness of Turrets inches	17	17	9	(?)	18	11½	12
armour { Belt "	18	18	12	17½	4	15½	16
Armament	4 13in. B.L.R. 8 8in. B.L.R. 4 6in. B.L.R. 20 6-pounder R.F. 4 1-pounder R.F. 4 Gatlings	4 13½in. B.L.R. 10 6in. R.F. 25 small R.F. 8 machine guns	4 10in. B.L.R. 10 4·7in. R.F. 8 6-pounder R.F. 9 3-pounder R.F. 7 machine guns	2 11·5in. B.L.R. 2 10½in. B.L.R. 8 5½in. R.F. 4 20-pounder R.F. 4 9-pounder R.F. 12 3-pounder R.F. 10 machine guns	4 13½in. B.L.R. 8 6in. B.L.R. 16 4·7in. R.F. 27 small R.F. 2 machine guns	6 11in. B.L.R. 6 4in. R.F. 8 3·4in. R.F. A number of small rapid-fire and machine guns	6 12in. B.L.R. 7 6in. B.L.R. 8 4in. R.F. 6 machine guns
Torpedo tubes	6	7	7	4	5	7	7

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Elimination of grade crossings.—The city of Newton, Mass., has recently been considering methods for eliminating the grade or level crossings of its streets by railway tracks, and the matter has been the subject of an engineer's report. The railway has four tracks. The three methods considered were:—(1) The changing of the route of the railway and reconstruction without grade crossings; (2) the elevation of the railway and depression of streets; and (3) the depression of the railway and elevation of streets. The cost of the first, allowing for acquisition of the land now occupied, was estimated at about 1,366,000 dols.; of the second, 2,000,000 dols. to 2,250,000 dols.; and of the third, 2,000,000 dols. to 2,300,000 dols. The first plan was considered to be likely to cause trouble by consequent changes in property values, for which the city might be liable; and elevated tracks were considered to be more satisfactory than depressed tracks with low-level stations. The plan proposed provides for an elevation of the tracks on the present location, partly by earth embankments with sodded slopes, and partly by masonry walls, the streets being spanned by steel or masonry arched bridges—one span over street and sidewalks—with 7ft. clear headway at the abutment, and having water-tight and noiseless floors of concrete and ballast. Certain changes would be required in the arrangement of the freight yards. The report recommends the construction of station platforms level with the car platforms for the suburban traffic, but this would be impracticable with the ordinary cars having side steps. Special cars without steps, like those of the elevated railways, would be required.

A 30-ton freight car.—The standard box cars of 60,000 lb. capacity of the Chicago, Milwaukee, and St. Paul Railway, are 33ft. 6in. long and 9ft. wide over the frames. There are six longitudinal sills of Norway pine 4½in. by 8in., with four truss rods 1in. in diameter, upset to 1½in. at the ends. The end sills are of oak 5in. by 7½in., and the transverse tie timbers also of oak 4in. by 8in. The draught timbers, carrying the automatic coupler rigging between them, are of oak 4½in. by 7in., 9ft. 10in. long, placed directly under the ends of the two centre sills, and the space between the ends of the draught timbers are filled in by oak sub-sills 4½in. by 7in., 15ft. 10in. long, thus transmitting the buffing strains and shocks from end to end of the frame. The body of the car is 9ft. 2in. wide, out to out; and 9ft. 10in. wide over the roof. The height from top of sills is 8ft. 3in. at the sides, and 9ft. 1½in. to top of roof running-board. The height from rail to top of sills is 3ft. 4in., and from top of sills to top of brake-wheel 10ft. 4½in. The sides are of the usual trussed construction, with wooden posts and braces, and iron vertical and inclined tie rods. The door in each side is 7ft. 6in. high and 5ft. 4½in. wide, sliding on outside rails. The couplers have handles for uncoupling, without going between the cars.

Bridge design.—An important paper was recently read by Mr. George S. Morison on "The Advance in the Design of Bridge Superstructure." Iron bridge building in America really began about forty years ago, but did not amount to much until after the Civil War. In the North the compression members were of cast iron and the tension members of wrought iron, while in the South the compression members were largely of wood until after the war, when development began, and in both North and South cast iron was generally used for compression members and wrought iron for tension members. The tension connections were generally made with pins, but sometimes with screws. The compression connections were square butt bearings. As one exception to this general rule, on the line of the New York Central Railroad riveted lattice bridges were used, being perhaps a higher development of the Towne lattice, but more likely copied from European structures. The first considerable number of field riveted structures were built upon this railroad. The next step was the substitution of wrought iron for cast iron in compression members. It came first in the long web members, and followed in the shorter members of the chords, but cast iron details continued to be used at the joints. With the substitution of wrought iron for cast iron in compression members, it became evident that cast iron was out of place even in the details of the connections, and that the bugbear of field riveting was imaginary. The cast iron joint box therefore gradually disappeared, and the advantages of riveted floor connections were recognised. Until about 1873 wooden stringers were generally used on iron bridges. With riveted connections iron stringers came into use and panel lengths increased. About fifteen years ago, what is now the general American practice was practically established. Cast iron had disappeared from all truss members, and riveted connections in top chords and floor systems were generally preferred. The Pratt truss or the iron bridge with vertical posts was commonly used, and the importance of stiff connections and rigidity as compared with theoretical lines of strain and flexibility was recognised. Since that time the changes have been rather in the direction of improvements of details, in increased loads provided for, in better material and workmanship and in reduction of strains, than in radical changes of structure. The bridge of to-day is simply the development of the bridge of 1878. The approved practice of 1893 makes bridge superstructures entirely of wrought iron or steel, and they are generally rigid structures with little vibration either in the whole structure or the details.

The noisy rattle which was very common some twenty years ago is seldom heard now. For short spans plate girders are generally used, and the length of this class of structure, which was formerly limited to about 40ft., has gradually increased to 100ft., and will probably go higher as soon as the rolling mills can furnish web plates for longer structures. A few longer spans have already been built and shipped in single lengths from the shops. In many places skeleton riveted structures are preferred for bridges of from 50ft. to 150ft. spans. They are commonly called lattice bridges, but the name is not strictly correct. For long spans, pin-connected trusses, very different in all other details from the pin-connected bridges of twenty years ago, are the general American practice. The structure should be thoroughly connected by bracing, so that the end and intermediate posts of the two opposite trusses shall form, as nearly as possible, a single member.

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

(From our own Correspondent.)

THE iron market is still directed by the coal situation. For the present ironmasters are able to keep the works going, but as the number of colliers out in Staffordshire increases, and supplies of fuel become scarcer, mills and forges in various parts of the district will, it is feared, have to be laid off. Under these circumstances ironmasters are still declining forward business, and when the works shut down for the Bank Holidays at the close of this week, it will be somewhat difficult to say when certain of them will be reopened. Prices continue strong, and pig iron is this week again particularly scarce and dear. When Midland blast furnaces become stopped for want of coal and coke supplies, pig iron deliveries, except for the little iron that is in stock by some of the makers, will almost entirely cease. Prices of last recorded business were 41s. 6d. to 42s. for Northampton, 42s. to 42s. 6d. Derbyshires, and 44s. net for Lincolns. For new business, however, out of stock, more money by 2s. per ton would be generally required. Staffordshire pigs are 57s. 6d. for hot-air all-mines, and 37s. 6d. for common, while hydrates are 52s. 6d. Finished iron prices are unaltered. Coal at present is in great request, and prices are rapidly advancing. At some of the domestic collieries rates are said to have risen 50 per cent.

The Midland Iron Trade Wages Board on Monday adopted a new sliding scale for the regulation of wages, in place of the arrangement that has existed since 1889 of settling wages upon the basis of the wages ruling from time to time in the North of England. The new scale is practically a reinstitution of the old one, with, however, this change, that instead of a premium of 1s. per ton being attached the premium is now to be raised to 1s. 6d. Thus when the net average price of bars, hoops, sheets, and plates in Staffordshire is certificated by the accountants to be £6 per ton, as I last week reported had just been done, puddlers' wages will be 6s. plus the 1s. 6d. premium, or a total of 7s. 6d. per ton, millmen's remuneration being in proportion. Sometime ago the men stipulated that the premium should be 1s. 9d., but they have now given way to the extent of 3d. per ton. The new arrangement is likely to find much satisfaction at the ironworks, since the men had become tired of always following the North of England lead, and desired an independent state of things. The new scale will rise and fall with every 2s. 6d. in the net average selling price, which, as hitherto, will be taken out by the accountants every two months. Upon the accountants' declaration of last week, it has been determined to make no reduction of wages. I regret to have to record the death, since my last, of Sir Thos. Martineau, of Birmingham, who for many years has acted as the able president of the Wages Board.

The purchase by Messrs. Bayliss, Jones, and Bayliss, engineers and ironfounders, of the Monmoor Ironworks, Wolverhampton, late the property of Messrs. E. T. Wright and Sons, is confirmed, and it is the intention of the firm to use them for the manufacture of puddled bars. The works have a valuable and extensive fixed plant, including four powerful engines and driving machinery, forges, plate, sheet, and merchant-mills, shears, cranes, three powerful steam hammers, eight upright and two horizontal boilers, roll-turning and screw-cutting lathes, drilling and planing machine, with independent vertical engine, powerful lever testing machine, punching and shearing machine, electric lighting plant, blowing engine, and refinery. The works also contain several hundred tons of iron floor-plates, tram rails, and a large quantity of spare rolls.

Messrs. W. and J. Player, of Lionel-street, Birmingham, who have had a long experience as makers of power hammers, for planishing, forging, &c., and as manufacturers of machine tools, are just putting upon the market a new pneumatic power hammer, the patent of Mr. S. W. Amphlett, their manager. The hammer, which I have inspected at work this week, is made with either single or double frames of similar type to the steam hammer, and to run at any desired speed from 150 to 500 blows per minute. The plant consists in the provision of a valve with a helical slot in a circular valve chest on the back of the cylinder proper. Holes are bored at different heights through the valve chest into the

cylinder, any one of which by means of the slot can be opened to the outside air, while the other holes remain shut. The valve is adjustable by either treadle or hand gear while the hammer is running, and this can be done instantly from the lightest to the heaviest blow, or any intermediate force being delivered. The cushion of air beneath the piston in the main cylinder is varied according to the operation of the valve. When the hammer is working the tools or pallets do not come into collision, but keep the maximum distance apart until the tup is brought down. In this way a blow or any number of blows can be given, and the hammer immediately taken off the work without shifting the belt. The work can also be moved to any part of the bottom tool, or can be changed from one die to another. It is important that the speed of the hammer does not change with the number of blows delivered, a provision which very materially increases the amount of work that can be turned out compared with working under steam or power hammers. The new tool is made in sizes of from ½ cwt. up to 20 cwt., and the foot gear is only employed on the smaller sizes. The firm calculate that the power required to drive is about one-twentieth of that required in a steam power of equal size, and all shock to the working parts is avoided, as the piston is always suspended on the top air and bottom air cushion, and these cushions are varied according to the blow to be delivered. The hammer is already erected at certain Birmingham edge-tool and cycle manufacturing works, and is well spoken of. In addition it is deemed specially suitable for tube-drawing and tapering, scythe skelping, tilting steel, and general drawing down and smithy work; and it should prove much superior to the old type of forge hammers with rocking shaft. These last are inapplicable to edge-tool works on account of the blow not being quick enough for plating purposes, but the pneumatic hammer will do any work of a small steam hammer, and it has the additional advantage of running off a belt or shafting.

The Council of the National Amalgamation of Chainmakers' Associations has just been considering in East Worcestershire the recent statement in Parliament that worn-out chains, which were cast aside by the Government dockyards, were being readily bought by makers and merchants in this country, and after re-blackening shipped to other markets as new material. The secretary read a letter in answer to one which he had sent to the Admiralty, which stated that further inquiries were to be instituted. The Council allege that more than 500 tons of this chain arrive in this district yearly, and that as soon as it arrives it is "snapped up" and re-shipped. The Council state their intention to furnish the Admiralty with proof of their allegations.

Further indication is forthcoming of the success of the local railway wagon building and rolling stock hiring concerns. The Birmingham Railway Carriage and Wagon Company have declared an interim dividend of 7½ per cent. per annum on their ordinary capital, and 6 per cent. on the preference capital. Brown, Marshalls and Co., whose dividend I announced last week, made a profit for the year of £16,572, from which £6765 has to be deducted for general expenses, but there is also an available balance of £4230 brought forward from last year. At the meeting of the Union Rolling Stock Company, on Tuesday, an interim dividend at the rate of 6 per cent. on the preference shares, and 10 per cent. on the ordinary capital, with a bonus of 2 per cent., was declared, and the chairman reported that the operations of the company during the last half-year had been £35,000 larger than in the six months ending 1892. At the close of another six months he had no doubt that a further increase in business would be registered. The rents due on rolling stock were £4000 more than at the close of December. It might have been expected that a company like theirs, which was financing railway companies in want of additional capital, would have severely felt the crisis in America. He was happy to announce, however, that so far the directors did not see any likelihood of lessening from that cause, and already the worst seemed to be over.

Much interest has been excited in the Birmingham district by the question put to the Secretary of War in the House of Commons on Tuesday by Mr. Lough, whether he was aware that 16 per cent. of the members of the Amalgamated Society of Engineers in Birmingham and the surrounding districts were now out of work. Mr. Lough asked that, under these circumstances, the Secretary for War would reconsider his decision with regard to the Government Arms Factory at Sparkbrook, and in case of a falling off in work, put the whole of the men on short time rather than dismiss any portion of them. Mr. Woodall's reply was, that in the event of a further decline in orders—a contingency which, however, he did not think probable—the short-time system will be adopted.

There is some important electrical construction work to be given out shortly in connection with Stafford. At a meeting of the Stafford Town Council this week the Electric Lighting Committee recommended that the scheme proposed by Mr. Bell, gas engineer, and endorsed by Dr. J. Hopkinson, be carried out, and that application be made to the Local Government Board for authority to borrow £20,000 for the erection of buildings and an electrical installation, £12,000 of which was to be spent at once. Dr. Hopkinson thought they could supply the electric light at a small profit with 15,000 to 20,000 lamps at a charge of 7d. per unit. The system recommended was the continuous current, low tension. The scheme was adopted.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—The now almost absolute certainty of a prolonged stoppage of the pits, which is not generally regarded as likely to be less than about two months, is necessarily tending to seriously disorganise the engineering and iron trades of this district. The less than a week's absolute cessation of the output of coal has, of course, not yet caused any real scarcity of fuel, but in view of a protracted stoppage of the pits, colliery owners are not at all anxious to part with their stocks, and since the men came out there has been a very considerable upward movement in prices, the advance having to a large extent been put on with a view of checking the filling up of coal on the pit banks. Already there is a very general talk of the stoppage of ironworks, and one of the largest firms in Lancashire have intimated by circular that as they will be unable to keep their rolling mills going, deliveries on contracts are for the time being suspended, and quotations withdrawn, any small quantity of finished iron they may be in a position to supply from the one or two mills they may be able to keep running being subject to special quotations, which, I hear, are about 5s. per ton above recent current rates. One or two Lancashire forges have, however, secured supplies of fuel to carry them over a month or so, but others are badly situated. The local pig iron furnaces have a considerable stock of fuel in hand, which will keep them going for some time, but the Lincolnshire and Derbyshire furnaces, which largely supply this market, are in many cases being damped down, and there is consequently a prospect that district brands of pig iron will very soon be scarce, and users will have to replace these with outside brands from the North of England and Scotland, where the miners are working, and which are still readily obtainable at very little over late rates.

The Manchester iron market on Tuesday brought together about an average attendance, but business all through was reported as slow. Users of pig iron, owing to the uncertainty as to how they may be placed with regard to fuel supplies, are holding back from buying, whilst makers from the same cause are very cautious about selling. Local makers were asking an advance of 2s. per ton on recent rates, forge qualities being now quoted at 42s., and foundry at 43s., less 2s., on trucks, and these prices were being got on moderate sales. With regard to district brands, very few of the makers were quoting at all; where prices for Lincolnshire could be got they were very firm at 40s. for forge to 41s. 6d. for foundry as the minimum, whilst for Derbyshire foundry, makers who had anything to sell were asking 47s. 6d., net cash, delivered Manchester. Outside brands were generally without any really quotable change, but firm at about 44s. 4d., net cash, for good foundry Middlesbrough, delivered equal to Manchester. 44s. 6d. for Eglinton, and 46s. for Glengarnock, net, prompt cash, delivered at the Lancashire ports.

In the finished iron trade most of the makers are just now pressed with specifications on account of contracts, but they do not report any large weight of actually new business coming forward. As regards prices there is no actual advance, but local makers are firm at about 15s. 10s. as the minimum for bars, whilst Staffordshire makers are not quoting under 15s. 12s. 6d.; Lancashire sheets average 17s. 5s., and Staffordshire, 17s. 10s.; but hoops remain at 15s. 17s. 6d. for random, and 16s. 2s. 6d. for special cut lengths, delivered in the Manchester district.

In the steel trade business generally continues only quiet, with good foundry hematites not averaging more than 53s. to 54s., less 2s., delivered Manchester. Local makers of steel billets are, however, pretty full of orders for their limited production, and have not been quoting under 44s. 5s. net, delivered Manchester, whilst further orders are now only being taken subject to special quotations. For steel boiler plates the orders giving out continue only moderate, and good qualities can still be bought at 46s. 5s. to 46s. 7s. 6d. per ton, delivered in the Manchester district.

In the metal market a fair amount of business is reported, with list rates for manufactured goods generally unchanged, except perhaps a rather easier tone in brass wire.

The condition of the engineering trades remains without any material change, the position of works generally being still unsatisfactory, and new work coming forward only very indifferently.

I was shown the other day a design in furnace bars specially adaptable for heavy firing. It is, of course, well known that the ordinary straight bars under heavy firing are not only very soon burnt down, but they are liable to warp, and a good deal of fuel is in consequence wasted. The design which was shown me has been introduced by Messrs. Lever, Holland, and Co., of Manchester, who have given a corrugated form to their fire bars which insures greater strength, whilst with this particular form there is a zig-zag air space between the two bars which, in addition, are perforated on the broad surface between the corrugations. About $\frac{1}{4}$ in. space is allowed between the two bars, which, in addition to their special form, are further stiffened by means of a fin underneath the bar. Messrs. Lever, Holland, claim that with this form of bar there is no possibility of warping, whilst as to their duration, it is stated that one of the first sets of bars made on this design was placed in a furnace, where under very heavy firing the ordinary straight bars were burnt down in five or six weeks, but these new corrugated bars have now been in the furnace eighteen months without being replaced. The firm have also introduced an improvement in driving belts, which are a combination of solid woven hair or cotton belting covered with Helvetia leather, thus securing great tensile strength and flexibility, whilst the leather covering is an effective protection to the belt against the edges being worn down by friction through the action of guide forks and cross-driving, and also against surface wear on the pulleys. A special joint is also made for this belt, which gives it a perfectly easy running surface, and, if required, it can be made endless. These belts are specially adaptable for heavy drives and quick speeds, and it is claimed that they will not stretch as much as leather, and having a perfectly even surface, they are adaptable for running on both sides at the same time. In the large widths of belting for heavy driving, the under surface of the belt only is completely covered with leather, which is taken over on the edges, allowing the upper surface free, but the smaller belts are completely enveloped in the Helvetia leather. These belts have already been supplied, with very satisfactory results, for brickmaking machinery, and for dynamo driving.

The actual stoppage of the pits has been followed by rather lessened pressure of demand for all classes of fuel, consumers and merchants having to a very large extent bought in extra supplies, to carry them over some time, before the cessation of work at the collieries, but the demand for all descriptions of fuel for iron-making, steam and general manufacturing purposes, is still considerably more than colliery proprietors are able to cope with, and they are endeavouring to limit the draw upon their stocks as much as possible. Since the stoppage of the pits there has been a considerable further advance in prices, the leading colliery firms in the Manchester district having made a second advance of 1s. 8d. per ton upon their pit, wharf, and delivered rates, whilst the station, or railway prices for delivery to outside districts have been put up another 2s. per ton, making an advance of 3s. 4d. on pit, wharf, and delivered prices, and 3s. 4d. to 4s. per ton on railway prices. In the West Lancashire districts—except in very exceptional cases, where colliery proprietors have not put up their prices more than about 2s. 6d. per ton—there has been practically a general advance of 5s. per ton upon all descriptions of fuel, and in some cases what are really fancy prices are being quoted for supplies taken out of stock. So far as anything like definite quotations can be given, the best qualities of round coal may be said to average about 14s. to 15s., second qualities 12s. 6d. to 13s., and common 11s. to 11s. 6d., whilst for engine fuel 10s. to 11s. at the pit mouth are about the average figures. So far colliery proprietors have had no difficulty in obtaining the requisite labour for filling up the coal out of the stocks they hold, but these to a large extent now consist almost entirely of the better qualities

of round coal, engine fuel being extremely scarce, and one large colliery concern, which hold a heavy stock of this description of fuel, has intimated that they will not entertain any further orders for the next fortnight, as they are determined to see how matters are likely to turn before letting go any more of their stock. Owing to the scarcity of the lower qualities of fuel, users for iron making, manufacturing, and other purposes, are having to fall back upon the better qualities of round coal to keep them going, and for these they are of course having to pay the full market price.

With regard to the shipping trade, as I intimated last week, local colliery proprietors were not disposed to offer much coal at the ports on the Mersey, as they had more than sufficient inland demand; the result is that extraordinary prices are being asked for supplies, and I have heard of as much as 17s. 6d. per ton being paid for steam coal delivered at the ports on the Mersey. Coal from other districts where the miners are still working has, however, been obtainable at considerably under this figure; Staffordshire at about 14s. 6d., North Wales coal at 15s. 6d., and best Monmouth coals at about 17s. 6d., delivered in trucks at Birkenhead, or 1s. 6d. extra put alongside vessels in the Mersey, but there has since been an advance of about 1s. per ton.

Barrow.—The hematite pig iron trade of this district has during the past week shown a rather better front, and prices have gone up. There is, however, no new life to note in the demand for the inquiry, for iron continues to be as quiet as possible; but the difficulty in the coal trade has been the means of the stronger tone, and that only. Makers are asking 46s. per ton net f.o.b. for mixed numbers of Bessemer iron, and are firm at that quotation, and at the same time are doing next to nothing in the direction of new business. The tendency at present is to hold on. The effect of a complete stoppage of the furnaces, as was the case when the Durham strike was on, would be most harmful to the trade of the North-West Coast, for it would drive away buyers to other parts. In the warrant market sellers are asking 45s. 3d. per ton, net cash for their holdings. The stores of warrants have been decreased this week to the extent of 110 tons, leaving the total held at 65,201 tons, or an increase on the year of 22,348 tons. There are still thirty-seven furnaces blowing. The steel trade shows no new feature. The demand for steel rails is about the same, not being by any means brisk, and heavy sections are the only class engaging the attention of buyers, and the quotation is 15s. 15s. per ton. Light sections are at 15s. 10s., and colliery rails at 16s. per ton. Tin-plate bars are quoted still at 14s. per ton, but there is little offering in the way of new business. The orders held in this department are fair, and a pretty good tonnage is being shipped from Barrow. Hoops are quiet at 16s. 15s. The demand for steel shipbuilding material is not sufficient to justify makers in re-starting the plate-mills, and hence nothing is doing in that direction.

The shipbuilding and engineering trades are quietly employed, and new orders are scarce. The contracts in hand are almost finished, and new ones are badly wanted all round.

The iron ore trade is quiet. At the pits there is a great want of activity. Average sorts are quoted at 8s. 6d. to 9s. per ton net at mines. The demand all round is quiet, and is lessened considerably by the importations of foreign ores that are constantly being made into the district.

East Coast finds a good market, and 17s. is the value per ton delivered to West Coast smelters.

The shipments for the past week from West Coast ports of iron and steel represent 16,457 tons, as compared with 11,589 tons in the same week of last year, an increase of 4868 tons. The exports to date stand at 441,217 tons, as compared with 414,008 tons in the same period of last year, an increase on the present year of 37,200 tons.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE miners' strike is now an accomplished fact. Work has been stopped in every direction, and the country is clear of smoke, while the collier can be seen in the Sheffield streets enjoying the holiday his leaders have prescribed for him. Several of our largest establishments have arranged to keep going for a month, and at one or two the principals state their ability to keep the leading departments in operation for six weeks; but no amount of preparation can provide supplies all round. The result is that not a few of our manufacturers have been obliged to close several branches, and two or three have stopped work altogether. Yorkshire is beginning to receive supplies of household coal from Durham, and the stocks which the coalowners and the coal merchants have in hand find ready purchasers at large advances. Three companies have made a further advance of half-a-crown a ton this week. The Midland Railway Company are stated to have purchased the stock, amounting to 10,000 tons, of the Denaby Main Colliery Company. Two small collieries are still working in South Yorkshire. In these cases the men are not in the Union, and having received no notice to leave or to have wages reduced, go on as before.

The men employed in the railway material department have a little more to do, owing to orders which have come into the town for axles, tires, springs, buffers, and similar goods. These lines are from the home railway companies, but they are quite inadequate to keep the plant fully engaged. When railway material was so brisk a few years ago, the productive capacity of the works was greatly increased, and it was said at the time that unless foreign trade was fully maintained there could not possibly be work for all the mills. That statement has turned out true. There is very little doing with foreign markets, and not much prospect of anything for a considerable period. The anticipations entertained regarding the revival in Mexico, as well as the Argentine Republic and other South American markets, are as yet far from realisation. Very little railway material is being sent into Argentina, which four or five years ago was a most lucrative market.

The rolling mills, tilts, and forges are severely affected by the stoppage of coal supplies. The proprietors have been unable to obtain a quantity sufficient to keep the works in operation beyond seven days, although one or two state that they can go on for a fortnight or three weeks. The managers of one large concern have been laying in stocks ever since the agitation commenced. They were thus able to make provision at low rates and in full weights, and will thus keep on working for six weeks. Generally, rolling managers will be shut up to one course. They will do what work is sent in so long as they have fuel for it, or can procure supplies elsewhere at reasonable prices. When their stocks are exhausted, and there is no hope of replenishing them, they will simply close their mills and wait for the termination of the strike. This action, of course, will have the effect of adding immensely to the number of unemployed.

Several of our companies engaged in the heavy trades, particularly those touching Bessemer steel and iron, are looking forward to a very dull autumn trade, and as the first half of the year has been disappointing, the tendency is to suspend the payment of interim dividends. Of course, this is merely a matter of precaution, and at the close of the twelve months' working these concerns may be able to pay a fair dividend, but in no case is it anticipated that the return to the shareholders will be equal to what it was during the previous year. In the dividends already announced a fall of one-fourth has been declared by companies which are ranked amongst our most stable concerns.

Messrs. Moorwood, Sons, and Company, ironfounders, Harleston Ironworks, Sheffield, have just completed a cooking apparatus of unusual dimensions for one of the largest Atlantic-going steamers. The apparatus is of wrought iron, and the flues are self-contained in the range, which will cook dinners for between 600 and 700 persons at one time. The firm state that they have in hand a number of important orders for this class of work. They are

also busy upon their patent Canopy Dog Grates, which have taken a firm hold on the market. The best class of stove grates, which have always been a feature of the old Sheffield trades, are still freely ordered, but the cheaper grade of goods, the parts of which can be reproduced in large quantities by machinery, are not manufactured in this town to any great extent. The cooking ranges for the ill-fated Victoria were made by this firm. Messrs. Steel and Garland, of the Wharfedale Stove Grate Works, whose exhibits for the Chicago World's Fair was a noteworthy example of what can be done in combining utility with beauty, have not yet heard the result of the awards given by the jurors. Visitors to the Exhibition tell me, however, that there is nothing in the Show at all to be compared with Messrs. Steel and Garland's productions.

A good idea of the conditions of the cutlery trade can always be obtained from the ivory, stag, buffalo, and horn merchants. These traders give a deplorable account of business, but I find on inquiry that one cause of the languor is the substitution of xylonite, metal, and other material for hafting purposes. Some of our manufacturers are importing artificial handles, supplied by French and German manufacturers, which are wonderfully cheap, remarkably artistic, and elegantly finished. The use of these materials in handling the steel is all in favour of cheaper production, which is the one essential thing to retain foreign trade now-a-days. Some of our local manufacturers, doing an American business, anticipate a "boom" with that market in the event of a reduction of the tariff. Stocks have been worked down to the bone, and no goods are being ordered while tariff reform is pending. At some of our local establishments provision is being made to meet this demand the moment it occurs.

Some very good orders have recently been received from the West Indies, Canada, and the Cape, as well as from Australia. The latter feature is exceptionally welcome, as the Australian market has been practically a blank since the banking collapse, and in local circles these new orders are regarded as evidence that the crisis has been turned, and that the Australian business will soon right itself again.

The new Master Cutler will be Mr. George Howson, of the firm of Messrs. Harrison Brothers and Howson, cutlery manufacturers and silversmiths, Norfolk-street, Sheffield. He will be elected on August 8th, and installed on September 7th. The Cutler's Feast is usually held on the evening of that date, but I understand Mr. Howson intends to give it either at the end of October or beginning of November.

THE NORTH OF ENGLAND.

(From our own Correspondent.)

BUSINESS has been somewhat slack this week in this district, and the difficulty with the miners has not so far brought the accession of orders or the increase in price that was expected. Indeed, the value of iron, instead of rising, has barely been maintained. Traders seem to think it best to wait, and speculators are holding off. It appears certain that the strike, if prolonged, however much it may improve the trade in Cleveland iron, will detrimentally affect the hematite pig iron trade, which hitherto has been comparatively flourishing. But the strike, by causing a dearth of fuel, must lead to the stoppage of a good many of the steel works in the Sheffield and Rotherham district, and they will cease to need supplies of hematite iron. When it is considered that the makers in this district send 10,000 tons weekly of that description of pig iron to the neighbourhood of Sheffield, or one-third of all the iron made other than Cleveland brands, it is apparent that the matter is a momentous one, as it will be almost impossible to find other markets for so large a proportion of the output. Thus it will be necessary to put the surplus iron into stock, or damp down the furnaces. Some producers might elect to put their furnaces on Cleveland iron, but that would hardly be satisfactory, seeing that there is already as much Cleveland pig produced as a market can be found for. About 43s. 6d. per ton f.o.b. is the price for mixed numbers of hematite, and it is not very strong at that.

The value of No. 3 Cleveland G.M.B. pig iron this week has been maintained at 35s. 3d. per ton for prompt f.o.b. delivery, but several of the leading brands cannot be had under 35s. 6d. Generally makers are well supplied with orders for this month's delivery, and they are not anxious sellers. Cleveland warrants have seldom been steadier than they have been this week, the price keeping about 35s. 7d. cash, and on Wednesday the close was at 35s. 9d. Connal's stock of Cleveland warrants on Wednesday night was 77,950 tons. The increase during July was 7543 tons, of which the greater part was accumulated during the last week. In future Messrs. Connal and Co. will, at the end of each month, make known the amount of hematite iron they have in stock, and it would be well if the Ironmasters' Association followed their example, for then the state of the market could be more accurately gauged. They do publish the record of the make and shipments, and it would render the information more complete if they published the stocks of hematite also. Connal's stock of hematite at July 31st was 24,446 tons. Grey forge pigs do not improve in the least, and can be had at 32s. 6d. readily.

The pig iron exports from Middlesbrough during July were less than in May and June; they recorded 175,140 tons against 81,346 tons in June, and about 99,000 tons in May. Of manufactured iron and steel, the quantity was less satisfactory in the aggregate. The following is a summary of the record:—

	Pig iron.	Manu- factured iron.	Steel.	Total
	Tons.	Tons.	Tons.	Tons.
July, 1893..	75,140	10,500	12,848	98,578
June, 1893..	81,346	28,067	11,613	121,026
July, 1892..	88,608	18,847	9,536	62,041

The average pig iron exports, 54,957 tons, were almost the largest on record, but there was a large falling-off to Scotland. Large quantities of hematite were sent to Russia and Italy. The steel was chiefly sent to India, Russia, and Spain, and the manufactured iron to India and the Argentine Republic.

The iron ore trade is steady, but a stoppage of certain of the Cleveland mines is seriously threatened; indeed at the North Skelton, Skelton, and Longacres mines, the men have resolved to give in their notices, because they cannot agree with the employers as to the payment for working the ratchet drill, which has recently been introduced into these mines. The miners do not object to the use of such drills, and are not intending to strike against the employment of machinery, as has been represented in some quarters, because for years drilling by machinery has been extensively carried on at several of the mines, there being the pneumatic drill, the hydraulic drill, the petroleum drill, and the electric drill in operation, but what they do object to is the price that the employers propose to pay. That there will be considerable economy in the use of the ratchet drill is not to be denied, as it will enable three men to get as much stone as four have been able to get under the old system. The ratchet occupies a position midway between the machine drills above mentioned and the old hand "jumper," and because it will displace so much hand labour, the men do not look favourably upon it. They say also that it will reduce their earnings. The local mining engineers speak very highly of the tool, and if a wage, not too high, were arranged for working it, the apparatus would be adopted at more of the mines. The demand for Spanish ore is well maintained, and the price of average Rubio is not below 12s. 9d. per ton delivered on the Tees, which is 1s. above the lowest figure that has ruled this year, and that means 2s. advance in the cost of production. Makers of hematite iron have also to pay 9d. per ton more for their coke, so that their win will now cost them nearly 3s. per ton more than it did a short time ago, whereas their selling prices have only risen 1s., and thus they are 2s. worse off than they were in the early spring. The Consett Spanish Ore Company will pay a dividend of 4s. 6d. per share, which is at the rate of

22½ per cent. per annum. Messrs. J. Wild and Co., Middlesbrough, have contracted to take the whole of the iron ore raised in the island of Elba during the three years commencing January 1st next. It is expected that a million tons will be produced during this period, and the contract price is said to be 11s. per ton f.o.b.

The steel railmakers are fully employed, and orders already booked will keep them so for a considerable period, so that the sellers adhere to £3 17s. 6d. net as their price for heavy rails. This week a most significant shipment of rails has been made from the Tees, 1000 tons having been dispatched to an entirely new market and by an entirely new route, viz., to Siberia, the rails being conveyed round the North Cape, and through the Sea of Kara to the river Yenisei, where they will be transhipped to Russian river steamers, and carried to their destination—the Trans-Siberian Railway. Hitherto all goods have had to be carried across the Urals at very great cost. The s.s. Orestes, which conveys the rails, is commanded by Captain Wiggins, a Sunderland man, and the discoverer in 1874 of the ocean route to Siberia, it being before that believed that the Sea of Kara was unnavigable, being frost-bound throughout the year. But it was found that vessels could get through in the summer and autumn, and a route has been established which will enable goods to be conveyed at a cost which is not prohibitive, and is much below that incurred when sending goods overland. The Orestes, besides carrying rails, is also taking out gold-crushing machinery for the use of miners in Eastern Siberia, as well as steam launches and other boats to work on Siberian rivers. Three light-draught river steamers are now being built on the Clyde for Siberia. The Russian Government are apparently determined now to develop commercially their Siberian provinces. They have given permission for foreign vessels to navigate inland waters hitherto exclusively reserved by law for the Czar's subjects, and they have conceded important privileges in the way of freedom from Customs' duties.

The demand for steel plates and angles is fairly well maintained, and the price of the former has been advanced to £5 5s., less 2½ per cent. at works, while the latter are at £4 15s., less 2½ per cent. The Consett Iron Company, who are the largest producers of steel plates and angles in the district, making weekly 2500 tons of steel plates and 1100 tons of steel angles, besides 400 tons of iron plates, report that their profit for the last financial year was £110,971, or £61,350 tons less than in the previous year, the directors stating that despite the economies they have made in the cost of production, the profits on their coal, coke, pig iron, manufactured iron, and steel, have all fallen off. The output of the new angle mill is being steadily increased. The Darlington Steel and Iron Co. have introduced a new sleeper press at their works which is giving very good results. It is the invention of their manager, Mr. Bowen, and the chairman of the company is of opinion that there is no plant in the kingdom which can manufacture sleepers more economically or better than they can with this press.

The coal trade is very active, partly owing to the difficulties in the Midland trade, and owners have taken the opportunity to advance their prices considerably. There is great improvement also in the export demand, and one day last week no less than 29,936 tons of coal were despatched from Tyne Dock alone. Steam coal has been put up to 10s. 6d. per ton, and even 11s. f.o.b., whereas a short time ago sellers were glad enough to get 8s. 6d. Gas coals are also selling more freely. The Middlesbrough Corporation have given out orders for 35,000 tons of gas coal, at prices varying from 8s. to 9s., the general figure being about 8s. 3d. delivered. Messrs. Bolckow, Vaughan, and Co. have acquired the lease of the Chilton, or Dean's Bridge Colliery, formerly carried on by the South Durham Coal Company, but which has not been working for twelve years, and has long been dismantled. The output used to be about 300 tons per day. Coke has gone up considerably in price, where it is required for delivery in districts affected directly by the miners' strike, and a very heavy demand has sprung up from consumers in South Yorkshire, who are paying 12s. 6d. per ton at the ovens, and in some cases even 14s. at the ovens is quoted; indeed very few have any to sell, their regular contracts taking up nearly the whole of their output. Local consumers have been paying 12s. 6d. delivered at their furnaces.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market has been firm, owing to the coal crisis. The demand for Scotch warrants has, however, been only moderate, and the price has been fairly steady at about 42s. 2d. cash. Cleveland iron has been in better demand in our market at 35s. 6d. to 35s. 7d. cash. There has likewise been a firmer feeling in hematite, of which it is feared there may be some scarcity, owing to the mining trouble in Cumberland. Several hematite furnaces are reported to be out from a want of coke. The price of Cumberland warrants is 45s. 3d., and Middlesbrough warrants 43s. 3d. cash.

The shipments of pig iron from Scottish ports in the past week were 6116 tons, compared with 9806 in the corresponding week of last year.

The prices of makers' iron are a shade higher, as follows:—G.M.B., f.o.b. at Glasgow, No. 1, 43s.; No. 3, 42s.; Carnbroe, No. 1, 43s. 6d.; No. 3, 42s. 6d.; Clyde No. 1, 47s.; No. 3, 44s.; Gartsherrie and Summerlee, Nos. 1, 43s.; Nos. 3, 45s.; Calder, No. 1, 48s.; No. 3, 45s. 6d.; Coltness, No. 1, 53s. 6d.; No. 3, 47s. 6d.; Langloan, No. 1, 54s.; No. 3, 45s.; Glegarnock, at Ardrossan, No. 1, 48s. 6d.; No. 3, 45s.; Dalmellington, No. 1, 46s.; No. 3, 44s.; Eglinton, No. 1, 44s. 6d.; No. 3, 43s. 6d.; Shotts at Leith, No. 1, 51s.; No. 3, 48s.; Carron at Grangemouth, No. 1, 52s. 6d.; No. 3, 46s. 6d.

There are 62 furnaces in blast, compared with 67 last week, and 75 in the corresponding week of last year. The makers appear to be steadily adhering to their policy of feeding the market, but refraining from accumulating stocks. A small quantity of iron continues to be withdrawn weekly from the stock in Connal and Co.'s Glasgow stores, which now amounts in the aggregate to about 335,000 tons.

The steel works in the West of Scotland are now in general operation after the holidays. Some of them did nothing all last week, while others were fully occupied. The prospect is, if anything, a little better. The orders in hand and in sight for ship-building steel are fully greater than at this time last year, and there is also more doing in bridgework. The Dalzell Steel Works, Motherwell, are very busy, their turn-out of material being reported just now to be the largest since the beginning of the year. Good contracts are in course of execution for railway bridges in the same district. The prices of steel are steady, being quoted on the basis of £5 5s. to £5 7s. 6d. for ship plates, less 5 per cent. for delivery in Glasgow district.

There is a decidedly better feeling in the malleable iron trade, and work is more general than for a long time. Whether this state of matters is likely to be of any permanence it is not easy to discover, because the work is for the most part for delivery over short periods, and consists of moderate lots. This kind of business, however, is frequently more profitable than are heavier and more extended contracts. Makers quote the lowest grade of common bars £5; second grade, £5 5s.; highest grade, £5 7s. 6d.; best bars ranging up to £5 17s. 6d.; less the usual 5 per cent. discount.

More activity is reported in sheets and tubes, and prices are tending firmer. Sheets are quoted on the basis of £7 5s. for iron singles, less 5 per cent. The principal demand in the case of tubes is for the larger sorts, but more inquiry is now springing up for marine tubes.

The iron and steel manufactures shipped from Glasgow in the past week embraced locomotives worth £2500, machinery about £36,000, steel goods £9000, and general iron goods £36,000.

The foundry trade has been quiet, but a number of contracts

are dropping in. Messrs. David King and Sons, Keppoch Iron-works, Glasgow, have obtained a contract for a large quantity of iron railing for Torquay. Macfarlane, Straing, and Co. have secured a contract for 36in. cast iron pipes for Glasgow Corporation, and another for pipes from 6in. to 12in. diameter for Dundee Waterworks. Messrs. Dixon and Corbett, and R. S. Newall and Co., have completed a new haulage rope for the Cowairs incline of the North British Railway, which is five inches in circumference and 4500 yards in length.

The coal trade is in a somewhat irregular position. The Scotch miners have held a series of meetings, at which they have considered their interest in the movement of the English colliers. They have expressed their sympathy with their English brethren; but they have been in most districts unable to adopt any definite resolution for decided action, owing to a want of organisation and funds. The leaders of the men hold different opinions as to what course they should pursue, some exhorting them to strike and others to continue working short time, in the expectation of receiving higher pay should there be a scarcity of coals. In the meantime the coalmasters are indifferent. The men have made demands for advances of wages; but the employers have not even met this week to consider these, although the men expected that they would meet on Wednesday. The fact is, that by their policy of restriction—which they have observed now for about two months—the Scotch miners have made it impossible for shippers to enter into forward contracts. For this reason the coalmasters are not obtaining higher rates for any considerable portion of their output. On the other hand, they have large contracts running to supply the iron and steel works, entered into early in the season at low prices. They cannot thus afford to pay high wages, and should the men strike the masters will be protected by the strike clause in their contracts. This explains the indifference with which the employers look upon the present crisis. It would serve no good purpose to quote coal prices this week, as they are very irregular.

In the course of July 18 vessels of 37,560 tons were launched from the Clyde shipyards, compared with 23 vessels and 29,414 tons in July, 1892. The output is larger than in any corresponding month for at least fourteen years. During the seven months 150 vessels have been put into the water aggregating 159,260 tons, compared with 187 vessels and 215,219 tons in the corresponding period of last year. The new orders placed during the month are estimated about 23,000 tons, and the work on hand is about 20,000 tons greater than at this time last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

As might be expected, there is a remarkable degree of vitality in the coal trade. Up to a late period steam coal was improving gradually, but now the movement has extended to house coal, and in every valley there is a good deal of briskness. This has been the case especially this week, with Bank Holiday in front, as under any circumstances, pressure or not, the collier will have his holiday. The week's totals from Cardiff alone are certain to exceed 300,000 tons. Last week they totalled 281,476 tons, and Newport, Swansea, and Llanelly all share in the activity. Newport, with the Powell Duffryn shipments, will certainly show increased totals. As regards prices, these are going up steadily. There has been no upward bound in steam as yet, but I have heard of 1s. 1d. to 1s. 6d. in steam, and even 2s. advance per ton in house. The mid-week quotation on 'Change at Cardiff will fairly mark the state of things.

Best steam, 11s. 9d. to 12s. 3d.; seconds, 11s. to 11s. 6d. Monmouthshire coals, 10s. 9d. to 11s. 3d.; inferior coal, from 9s.; small, 5s. to 5s. 9d. House coal, best, 11s. to 11s. 6d.; No. 3 Rhondda, 10s. 9d. to 11s.; brush, 8s. 9d. to 9s.; small, 6s. 9d. to 7s.

Coke and patent fuel prices are retained, all with upward tendency. Swansea prices patent fuel, 9s. to 10s. Iron ore, 11s. 6d. to 11s. 7½d. Bituminous coals, 10s. 9d. to 11s. 3d.; anthracite, from 8s. 9d. to 13s., according to quality. Pitwood slightly lower, but this is only regarded as temporary.

Reviewing the condition of the coal market, it is evident that higher prices must prevail. The caution exercised in booking is marked; and it is "quite on the cards," seeing that the leading coalowners are well sold for shipment foreign, to the coal stations, and steamers, that new customers coming in will have to pay in excess of quoted prices. As regards the railways, Taff, Rhymney, and Barry prospects are exceedingly good, and stock is advancing.

I regret that the improvement in trade does not extend to iron and steel. In fact, an advance on coal to manufacturers who are supplied with coal from other quarters means rather a reverse of good, especially when the movement in price affects wages. The outlook at present is far from good. In steel rails there is very little doing, some small consignments for the Great Western and local railways, and light for local collieries, being the closing business. Stocking of pig continues heavily at Cyfarthfa, and consignments of steel bars have been very heavy. The Midland, Great Western, and Rhymney lines have constantly exhibited large collections at sidings of late. In the matter of crop ends and special sizes, Cyfarthfa also has been sending off large quantities.

Some surprise has been manifested that present low prices do not tempt to more business. These are now as low as can possibly be quoted, and judging from the arrangement of the ironworkers' sliding scale, which has just declared no change in wages, the minimum and maximum having been settled after a great deal of discussion, no rail business in Wales can be anticipated at lower figures than last quotations. These are as follows:—Cardiff Exchange: Steel rails, heavy, £3 15s.; light, £4 15s.; tin-plate bar, £4 7s. 6d.; steel sheets, singles, £7 to £8; sheet iron, £6 19s. to £7 10s. It will be seen that Swansea Exchange quotations are slightly better than these. Steel rails, heavy section, £3 17s. 6d. to £4; light, £4 10s. to £4 12s. 6d.; Bessemer steel bars, £4 7s. 6d. to £4 10s.; Siemens, £4 10s. to £4 17s. 6d.

Other quotations are:—Glasgow pig, 42s. 1½d.; Middlesbrough, 35s. 6d.; hematite, 45s. 3d.; Welsh bars, £4 15s. to £4 17s. 6d.; sheet iron, £6 10s. to £7 10s.; tin plates, Bessemer steel coals, 11s. 6d. to 11s. 9d.; Siemens, 12s. to 12s. 3d.; ternes, per double box 28 by 20, at 21s., 22s., 23s. Best charcoal, 12s. 9d. to 14s. 6d.; wasters, 6d. to 1s. per box less. Block tin, £82 2s. 6d. to £82 7s. 6d. Copper, Chili bars, £41 13s. 9d. to £41 18s. 9d. Lead, English, £10 6s. 3d.; Spanish, £10 3s. 9d.

Ferndale—D. Davies and Son—has again come out well with a declaration of a 10 per cent. dividend.

The Taff Vale dividend is 3½ per cent., equal to 8½ per cent. upon old ordinary stock. The result of the issue of the report has been a favourable one, showing as it does in the face of a falling revenue—now again looking up—that extreme care has been practised, and the keenest economy shown in lopping off all that could be regarded as not absolutely necessary. Two items may be specially noted, overtime and expenditure for coal.

There is a steady average make going on in tin-plate, but there is nothing of special note to chronicle, only an absence of vitality in the American trade.

Latest advices from coke oven centres show that an advance is likely. It is difficult to get quotations, and especially for forward trade.

There is a good deal of discussion going on at Cardiff on the matter of the rumoured Taff Vale and Rhymney Railway arrangement, but I shall give no credence to any "amalgamation" until distinctly and officially announced. The "rumours" previously circulated in the local press have done a great deal of mischief, benefiting a few but injuring a large number. Thousands of pounds, I am informed, have changed hands of late.

The deep sinking at Gilfach Colliery—Mr. Christmas Evans—is progressing well, and is now into the solid.

The Aberdare-Merthyr Collieries have been restarted on the Hirwann side of the taking, and a good output is assured.

On Monday it was calculated that 10,000 colliers in North Wales were idle, and it was stated that notices from other collieries were about to be handed in. It is not, however, expected that the stand in North Wales will be a severe one. In the Forest of Dean there is little change in the situation. Probably, both there and in North Wales, the improvement in the South Wales coalfield will have a favourable effect in bringing about a compromise.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE outlook in the engineering and iron trades in this country presents no really new feature. Traders look in vain for any sign of improvement, and the depression promises to be further prolonged. The condition under which business is at present alone possible could scarcely be more unsatisfactory, anything like remunerative prices being in most cases quite out of the question.

In Silesia the business in pig iron continues languid. In the malleable iron branch there is some movement to be noted in bars and plates, foreign inquiry being rather more active this week. The employment at the machine and wagon factories is very irregular and unsatisfactory. There are some orders for locomotives holding out, one for nineteen locomotives for the Berlin Railway Administration, but unfortunately competition for any work that is to be got is so keen that in many cases it is not a question of profit, but as to what the actual loss will be on the orders booked. The German arms factory Mauser-Loewe has secured a contract for 154,000 rifles, 7-65 mm. calibre, for the Turkish Government.

On the Austro-Hungarian iron market pig iron remains rather quiet, while for finished iron the demand has further improved, which is due in a great measure to the favourable harvest accounts that are coming in from most districts. Prices have not changed.

In the French iron trade a slightly decreasing tendency is to be noticed. Dealers show a strong inclination to clear their stocks, and are selling bars at 152-58f., girders at 162-50f. p.t. Iron girders are in very slow demand, those in steel being generally preferred. The steel works are, as a rule, well off just at present, having secured a fair amount of new orders, especially rails. Statistics recently published show shipments on the canals to have increased about 800,000 t., or 3 p.c. against last year, which is chiefly due to an improvement in the general coal trade.

The Belgian iron business remains, unfortunately, very depressed, and there is not the slightest symptom of an improvement perceptible. Nominally, prices have not altered since former weeks, being for bars 105f. p.t. for export; plates, 125f. p.t.; and steel girders, 110f. p.t. For orders of some weight the usual concessions are granted. At a late tendering for railway carriages there were sixteen competitors, all offering at very low prices. Wagons, for instance, which cost 1600f. in March of present year, were being offered at 1313f. to 1329f. now.

The Society of Belgian Engineers intends paying a visit to the Rhenish-Westphalian mining districts towards the end of present month.

There is still very little doing in the iron and steel trade of Rheinland-Westphalia. With the exception of those more favoured articles that are being regularly inquired for, prices continue to show a decreasing tendency. Iron ore is depressed generally. For spathose iron ore M. 7-10 to 7-80 p.t. is given; roasted do., M. 10-50 to M. 10-80 p.t., net at mines. Nassau red iron ore, 50 p.c. contents, fetches M. 9-10 p.t. Minette of Luxemburg and Lorraine is being quoted M. 2-40 to 2-60 and 3-20 p.t., according to quality. The pig iron business is dull, next to no demand coming forward. Stocks are, however, but slowly increasing, the weekly output having been reduced to the minimum. Makers of pig iron never had a worse time; manufacturers and dealers are simply buying from hand to mouth, and are not likely to do any other for months to come. Regarding the different sorts of pig iron, nothing new can be reported since last week. Prices are the same as previously reported, being for spiegeleisen 10 to 12 p.c. grade, M. 51 p.t.; forge, No. 1, M. 43 to 44 p.t.; No. 3, M. 40 to 41 p.t.; Siegerland good forge quality stands at M. 41 to 42 p.t.; hematite, M. 62 to 63 p.t. Foundry pig, No. 1, costs N. 62; No. 3, M. 53 p.t.; basic is, comparatively speaking, rather well inquired for at M. 42 to 43 p.t. German Bessemer costs M. 48 p.t.; Luxemburg forge pig, M. 40 to 41 p.t. at works. In the malleable iron trade the mills are reported to be but irregularly occupied, and the general returns are to the effect that the manufactured iron business has never been in a more unsatisfactory condition. There is next to no demand coming in for bars; in girders, too, very little has been doing upon the week, and the prices fetched are, in most instances, below basis quotation. Some fair orders for hoops have been secured just lately, but to get these a further reduction in price had to be agreed to. The business that has been doing in plates may be termed a fairly good one, so far as demand is concerned, but prices, however low, cannot be maintained, makers willingly accepting the famine prices offered them to secure employment. Sheets are in somewhat better request now; in Rheinland the demand for that article has been quite satisfactory, and activity at the works is well maintained. Prices, though still unremunerative, show a firm and even rising inclination. In wire rods, drawn wire, and wire nails there are only occasional small orders going out, and for these there is a good deal of competition at low figures. At the foundries and machine shops little work has been doing; the wagon factories, too, are reported to be but partially employed during the last week. The steel works have been fortunate in securing a Government order for 5500t. rails; they expected to get the whole lot, but, to their great dismay, an order for 1500t. has been given to a Belgian firm.

The following are the present list quotations per ton at works:—Good merchant bars, M. 110 to 115; angles, M. 120 to 122-50; girders, M. 87-50 to 95; hoops, M. 125 to 132-50; billets in basic and Bessemer, M. 85; heavy plates for boiler-making purposes, M. 150; tank ditto, M. 140; steel plates, M. 140; tank ditto, M. 130; Siegen thin sheets, M. 120 to 130; common sheets, M. 135 to 140; iron wire rods, M. 120; drawn wire in iron or steel, M. 100 to 125; wire nails, M. 127; rivets, M. 145; steel rails, M. 112 to 115; fish-plates, M. 87 to 110; steel sleepers, M. 106; complete sets of wheels and axles, M. 270 to 280; axles, M. 220; steel tires, M. 215 to 230; light section rails, M. 95. Statistical figures show German import and export to have been, during the first two quarters of the present year, as under:—

	Import.		Value of import.
	100 kilos.		M.
1893	133,673,800		2,042,669,000
1892	137,024,192		2,115,575,000
1893	-3,350,392		-72,906,000
	Export.		Value of export.
	100 kilos.		M.
1893	99,832,051		1,671,659,000
1892	91,178,390		1,479,289,000
1893	+8,658,661		+192,370,000

Thus, import during the first two quarters of the present year shows a decrease of 2-5 per cent., while value of import decreased 3-6 per cent., compared to the same period the year before. Export rose 8-8 per cent.; value of export increased 12-9 per cent., against 1892. Among the goods which show a decided decrease in import are:—Corn, decrease in import 9,381,197—100 kilos.—wood, cattle. Goods showing an increase in import are:—Coal, increase 5,951,510—100 kilos.—artificial coal and ore, raw material required for textile fabrics, petroleum, pig iron. A decided increase in export show coal and coke, the former, 2,838,308—100 kilos.—the latter, 1,251,670—100 kilos.—briquettes, ore, iron and iron manufactured goods, zinc, earthenware, paper and pasteboard, spices and general grocery wares, sweetmeats and pastry, drugs, colours and dyeing materials, and oils.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, July 26th, 1893.

TO-DAY'S telegraphic reports from interior points indicate a healthy industrial and commercial condition, despite the lagging demand. Stocks of cereals are unusually heavy, and prices phenomenally low. Iron and steel are dragging at the lowest figures ever known. Crude iron output is declining, and furnace owners are unwilling to run beyond the completion of contracts in hand. Merchant iron mills are all idle. Sheet mills resumed full time this week. Plate and structural iron mills will resume gradually, as orders are booked. Steel rail mills are turning out but few standard sections, but are fairly busy on light rails. Railroad traffic is at a low ebb at present, but an improvement is expected before September 1st. The army of unemployed is increasing, and is now larger than at any time since the panic of 1873. Manufacturers are everywhere restricting output to immediate demands. Wages reductions are being made here and there, without strikes resulting. Capital is disinclined to embark in uncertain enterprises. A groundwork of confidence is necessary for a revival of activity.

LAUNCHES AND TRIAL TRIPS.

A new Cardiff steamer was successfully launched at the shipbuilding yard of Messrs. Palmer, Jarrow, on Saturday. The Anthony Radcliffe, built for E. Thomas Radcliffe and Co., of Cardiff, has a carrying capacity of 4100 tons on a draught of 19ft. 6in., and has all the best and latest appliances. Her engines will be triple-expansion, she will be fitted with steam gearing, have five hatchways, and a powerful steam winch at each.

On Tuesday, the 1st inst., Earle's Shipbuilding and Engineering Company, Hull, launched for the Boston Deep-sea Fishing and Ice Company the fine iron screw trawler Sutterton, 100ft. long, 20ft. 6in. beam, and 11ft. depth to top of floors. She is built to Lloyd's highest class, with short raised quarter-deck and forecastle, and has all the most recent improvements for steam fishing; including patent trawl ports, dandy scores, and steam winch, of Messrs. Earle's special design. Her engines are of the triple-compound type, with cylinders 11in., 17in., and 30in. diameter by 21in. stroke, and she has a large steel boiler to work at a pressure of 150lb. per square inch.

On Monday afternoon Messrs. Sir Raylton Dixon and Co., Middlesbrough, launched a steel screw steamer of the raised quarter deck type, which has been built to the order of Messrs. J. and E. Kish, Sunderland. The principal dimensions of the vessel are:—Length, 292ft. 6in.; beam, 40ft. 6in. by 22ft. depth moulded; with a large deadweight carrying capacity. Engines will be fitted by the North-Eastern Marine Engineering Company, of Wallsend-on-Tyne, the cylinders being 22in., 36in., and 58in. by 39in., with two large boilers working at 160 lb. pressure. The construction of the vessel has been under the superintendence of Mr. Thomas Metcalf, of Sunderland, and as she was leaving the ways she was named the Coquet by Miss Annie Kish, sister of the owners.

Following the launch on the 15th ult. of the largest oil vessel yet built, and the largest vessel built by Messrs. Craig, Taylor, and Co., in their establishment at Thornaby—viz., the s.s. Tees, which was of the following dimensions:—355ft. by 45ft. by 30ft., and which vessel will carry over 5000 tons of oil, in addition to 700 tons of bunkers—this firm launched last Friday, the 25th ult., one of the smallest vessels they have yet built for the oil trade, her dimensions being 185ft. by 31ft. by 15ft. 10in. This vessel has been built to the order of Messrs. L. Mercader and Uda de Londaiz, of San Sebastian, for their oil trade between American ports and San Sebastian, Spain, and will carry over 900 tons of oil in bulk. She is fitted with all the latest improvements, including pumping and electric light installations, rigged as a barquentine, and is built of steel to the highest class in Lloyd's. As she left the ways she was named the San Ignacio de Loyola by Senora Gamecho, wife of the captain who takes command of the vessel.

Messrs. W. Doxford and Sons, Sunderland, launched on Saturday afternoon the second specimen of the "turret deck" type of cargo steamer which that firm has patented. The vessel is for the same owners as the first steamer, Messrs. Petersen, Tate and Co., Newcastle. Her dimensions are:—Length, 311ft.; breadth, 8ft. 2in.; depth, 24ft. 1in.; with a load draught of 19ft., and a carrying capacity of 3650 tons, with a gross register of about 2200 tons, and a net register of about 1380 tons. She has been constructed of Siemens-Martin steel with the usual parts of iron. Among the improvements introduced in this vessel as compared with the first is a new arrangement of construction of sheer strake and stringers, producing a large increase in the strength of the vessel with the same amount of material. The hatches are exceptionally large and arranged to facilitate the shipping of large pieces of machinery, &c.; the holds also are well clear of obstructions. She is fitted with four horizontal steam winches which are driven by an extra large horizontal multitubular donkey boiler, and the exhaust steam from all deck machinery is returned by piping to the receiving tank in the boiler-room. These winches are arranged so that two work the main hold and one works each of the other holds, and the cargo is manipulated by the usual derrick arrangements. The machinery is fitted aft, as in the s.s. Turret, leaving the whole of the holds amidships clear for cargo. The after end of the vessel is arranged so as to have a clear deck. The vessel is to be fitted with powerful triple-expansion engines, having cylinders 23in., 37in., and 60in., by 42in. stroke, working with a steam pressure of 160 lb., and have many recent improvements, including an ash ejector which is operated from the stoke-hole, dispensing entirely with the necessity of hoisting ash on deck and discharging it overboard.

THE CORINTH CANAL.—The opening of the Corinth Canal has been definitely fixed for Sunday next. Nine British warships have just arrived,

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.

19th July, 1893.

- 14,007. MARKING and NUMBERING SHEEP, R. Bouquet, London.
- 14,008. TURNING MACHINES, C. E. Hedriod-Bachni, London.
- 14,009. TIN OPENER, W. Heald and J. F. Heald, London.
- 14,010. FOLDING TABLE for PICNIC BASKETS, E. Drew, London.
- 14,011. TIRES, T. Beevers and H. B. Sheridan, London.
- 14,012. ELECTRIC BATTERIES, H. Bonner, London.
- 14,013. AUTOMATICALLY DELIVERING LIQUIDS, H. P. Turner, London.
- 14,014. NEW BASIC COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
- 14,015. FIELD COOKING APPARATUS, A. A. Edwards, London.
- 14,016. DINNER and BREAKFAST PLATES, A. W. Edwards, London.
- 14,017. MOUSTACHE PROTECTOR, S. Glaisel, London.
- 14,018. IMPROVED WATCH and JEWEL CASE, F. Ulrich, London.
- 14,019. CASES for SPOONS, FORKS, &c., F. Ulrich, London.

20th July, 1893.

- 14,020. CLOSING WATER-TIGHT COMPARTMENTS, L. Radmore, Cardiff.
- 14,021. TUBULAR FIRE BARS for FURNACES, H. Foster, Newcastle-upon-Tyne.
- 14,022. ADJUSTABLE WRENCHES, &c., J. Harrison, Stamford.
- 14,023. CYCLE FRAMES, J. S. D. Shanks and R. R. Best, Belfast.
- 14,024. COLOURS for PHOTOGRAPHS, F. C. D. Beacham, Bristol.
- 14,025. WINDOW SASH LIFTER, J. A. Towle and W. G. Stones, Manchester.
- 14,026. INJECTORS, T. W. Morrow, Newcastle-on-Tyne.
- 14,027. IMPROVED POLICE LANTERNS, S. B. Edmonds, Birmingham.
- 14,028. PNEUMATIC TIRES for CYCLES, F. Smith, Manchester.
- 14,029. APPLIANCE for BILLARD TABLES, R. Rear, Manchester.
- 14,030. SUSPENSION of ELECTRIC LIGHT FITTINGS, B. Thomas, Cheshire.
- 14,031. FIXING SEAT-BACKS to VEHICLES, J. H. Sutcliffe, Yorkshire.
- 14,032. SCARF PIN, W. Lawrence and H. Wood, Birmingham.
- 14,033. FOOT REST for CYCLES, J. and J. Hadley, and J. C. Meredith, Birmingham.
- 14,034. METAL-MELTING FURNACES, T. Robinson, Liverpool.
- 14,035. SADDLES for CYCLES, J. B. Brooks, Birmingham.
- 14,036. DETECTIVE HAND CAMERAS, A. J. Buncher, Birmingham.
- 14,037. CIGAR CASES, &c., J. Rose and E. Brough, Birmingham.
- 14,038. COLLAPSIBLE GUARD for CYCLES, A. O'Brien, Leicester.
- 14,039. MAPS and MAP-PRINTING, &c., J. F. Williams, Liverpool.
- 14,040. UNIQUE SPRINKLER for LIQUIDS, &c., S. Hill, London.
- 14,041. MUSICAL BOXES, H. Nehmer, London.
- 14,042. TOBACCO POUCH and PIPE CLEANER, E. Erlanger, London.
- 14,043. CHIMNEY COWLS, E. Smith, Birmingham.
- 14,044. CAKE MACHINES, P. D. Harton, London.
- 14,045. HAND CAMERAS, W. P. Thompson.—(*A. Delug, Germany.*)
- 14,046. REVERSING GEAR for ENGINE VALVES, H. Read, London.
- 14,047. BEDSTEAD, J. W., J. C. H., and W. Davison, London.
- 14,048. DEVICE for LIGHTING PIPES, &c., L. F. Godard, London.
- 14,049. BUCKLES, J. Ramsay, London.
- 14,050. ALE MIXING ROUSER, D. C. M. Fitzmaurice, Ramsgate.
- 14,051. FIRE-ESCAPE LOWERING APPARATUS, J. Moran, London.
- 14,052. PIPE WRENCHES, E. E. Doddrell.—(*G. Doddrell, Portugal.*)
- 14,053. CYCLE BRAKES, W. J. Armitage and A. J. Eli, London.
- 14,054. THERMOSTATIC STEAM TRAPS, E. E. Gold, London.
- 14,055. TOY HORSES, &c., F. H. Aytes and H. Pitts, London.
- 14,056. ELECTROLYTES for BATTERIES, W. H. Longsdorf, London.
- 14,057. RAILWAY CHAIRS, G. Brockelbank, London.
- 14,058. STEERING of CYCLES, W. Crowther, Dewsbury.
- 14,059. VALVE GEAR, A. Collman, London.
- 14,060. TREATMENT of CARDED BANDS, E. Gessler, London.
- 14,061. AIR-WARMING STOVES, Blackman Ventilating Company.—(*J. D. Smead, United States.*)
- 14,062. TRANSPORTING BODIES, C. D. Abel.—(*M. Zahn, Germany.*)
- 14,063. VELOCIPEDS, J. G. Stidder, London.
- 14,064. CLOTHES HOLDERS, E. Richter and R. Singer, London.
- 14,065. BATHS, C. Watkins and C. J. Knowles, London.
- 14,066. FLANGED TUBE MANUFACTURE, J. E. Howard, London.
- 14,067. BEAM SCALES, W. C. Farmer and H. Ellick, London.
- 14,068. CENTRAL DRAUGHT LAMPS, H. H. Lake.—(*E. Miller and Co., United States.*)
- 14,069. CYCLES and like VEHICLES, A. Newbould, London.
- 14,070. STEERING CYCLES, R. Eastham and G. Haworth, London.
- 14,071. CENTRAL DRAUGHT LAMPS, H. H. Lake.—(*E. Miller and Co., United States.*)
- 14,072. LAMP-WICK RAISERS, H. H. Lake.—(*E. Miller and Co., United States.*)
- 14,073. KNIFE CLEANING MACHINES, J. G. P. Haller, London.
- 14,074. PHOTOGRAPHIC APPARATUS, B. J. Edwards, London.
- 14,075. HALOGEN ISODITHIOSALICYLIC ACID, H. Baum, London.
- 14,076. ELECTRIC MEASURING INSTRUMENTS, H. H. Lake.—(*A. H. Armes, United States.*)
- 14,077. DOOR LATCH or FASTENER, E. Sprenger, London.
- 14,078. DEALING with NOXIOUS LIQUID, M. Schwab, London.
- 14,079. BOTTLING AERATED LIQUIDS, A. H. Cannon, London.
- 14,080. INFECTING the SURFACE of ROADS, R. W. Western, London.
- 14,081. FOOT PAVING, E. Bannister, London.
- 14,082. IMPROVED TIRES for CYCLES, &c., J. B. Torres, London.
- 14,083. "AT HOME" MEMORANDUM TABLET, G. Bairnsfather and A. Althaus, London.
- 14,084. PRODUCING LEAF-METAL PATTERNS on WOVEN FABRICS, F. Lehmann, London.
- 14,085. RAILWAY BRAKES, J. Lipkowski, London.
- 14,086. SUGAR, J. Y. Johnson.—(*J. E. Pellegrini, Spain.*)
- 14,087. INCANDESCENT LAMPS, H. H. Lake.—(*The General Electric Company, United States.*)

- 14,088. CENTRE-PIN HOOK, W. Hodge and J. Pearson, London.
- 14,089. MAKING PARIS BLUE by ELECTROLYSIS, H. Goebel, London.
- 14,090. FOLDING FRAME for HAMMOCKS, A. Karnbach, London.

21st July, 1893.

- 14,091. IMPROVED ELECTRIC FUSES, F. W. T. Brain, London.
- 14,092. DRESS GUARDS for LADIES' CYCLES, J. B. Brooks, Birmingham.
- 14,093. MAKING CUP, &c., RACKS, J. Barnes, Birmingham.
- 14,094. PNEUMATIC TIRES for CYCLES, A. S. Cartwright, Birmingham.
- 14,095. CYCLE CLIPS, T. Middlemore and W. A. De Lattre, Birmingham.
- 14,096. CASH REGISTERING TILL, T. Shepherd and J. B. Cumming, London.
- 14,097. FORCING WATER into BOILERS, J. Hall, Manchester.
- 14,098. FASTENING TIRES for CYCLES, E. H. Seddon, Manchester.
- 14,099. FIELD CULTIVATOR, J. H. Topham.—(*M. Macleod, United States.*)
- 14,100. WATER GAUGE for BOILERS, J. Newton, Staffordshire.
- 14,101. SHOES, J. Dennis, Manchester.
- 14,102. NIGHT LIGHT, C. Smith and W. T. Smith, Birmingham.
- 14,103. CLIPS for VELOCIPED SADDLES, F. R. Baker, Staffordshire.
- 14,104. TRIMMINGS for DRESSES, E. A. Cocke, Bognor.
- 14,105. ELECTRIC GAS LIGHTERS, A. Eckstein and H. J. Coates, Manchester.
- 14,106. IMPROVED SCARF FRAME or HOLDER, H. Scott, Liverpool.
- 14,107. SQUARE FIRE-LIGHTERS, J. M. Wardale, Edinburgh.
- 14,108. ROPE LETTERING, T. E. Vickers, Birmingham.
- 14,109. STEERER for DIRIGIBLE BALLOONS, S. Kelliher, Ireland.
- 14,110. PUMPING ENGINES, W. P. Theermann, Manchester.
- 14,111. FEEDING TROUGHs for CATTLE, E. Morgan, Birmingham.
- 14,112. OPTICAL LANTERNS, S. J. Levi and A. J. Jones, London.
- 14,113. SPOOLS for SEWING COTTON, H. E. Wollmer, Manchester.
- 14,114. WATER-HEATING APPARATUS, J. Rowley, Manchester.
- 14,115. MANUFACTURE of WIRE CARDS, W. S. Guild, Manchester.
- 14,116. MECHANISM for PROPELLING CYCLES, G. Vernon, Manchester.
- 14,117. MATCH-BOX and CIGAR-CUTTER, F. F. Stokoe, Liverpool.
- 14,118. CHILDREN'S CONVERTIBLE CARRIAGES, J. Taylor, London.
- 14,119. PASTE for POLISHING METALS, M. A. Hyman, London.
- 14,120. PRODUCTION of BEVERAGES, J. E. Johnson-Johnson, Stratford.
- 14,121. VESSELS for CARRYING GRAIN, G. J. Hay, London.
- 14,122. BRACELETS, B. E. Archer, London.
- 14,123. TOY, J. B. Botting, London.
- 14,124. RUNNING GEAR, A. J. Boulton.—(*H. A. and D. Bonnar, Canada.*)
- 14,125. APPARATUS for HOLDING REINS, D. H. Stubbs, Liverpool.
- 14,126. BRICK MANUFACTURE, J. Davies, Liverpool.
- 14,127. BOILER TUBE CLEANING APPARATUS, J. Hayes, London.
- 14,128. COCOA DRYING APPARATUS, A. A. Van Delden, London.
- 14,129. FISHING TACKLE, A. W. Betham and A. A. Andrew, London.
- 14,130. NITRATES, &c., J. Hargreaves and T. Bird, London.
- 14,131. NITRATES, &c., J. Hargreaves and T. Bird, London.
- 14,132. FILTERS, A. da Silva Prado and B. Medina-Santurio, London.
- 14,133. PIG-RING, L. W. Cutter, King's Lynn.
- 14,134. FRAME for PURSES and BAGS, J. Moche, London.
- 14,135. CONVERTIBLE WALKING-STICK, J. A. Norton, London.
- 14,136. CLASP for CORSETS, H. H. Lake.—(*R. Hinrichsen, Germany.*)
- 14,137. PENS, A. Smith, London.
- 14,138. LUBRICATING STEAM CYLINDERS, H. G. Hausmann, London.
- 14,139. CRICKET STUMPS, H. B. Lister and J. I. Buckton, London.
- 14,140. APPLIANCE for HOLDING PASTILLES, P. Fouquier, London.
- 14,141. TOY, L. B. Lilley, London.
- 14,142. CHILDREN'S TOYS, W. C. Latham, London.
- 14,143. WRITING DESKS, W. Renwick, London.
- 14,144. REGISTERING the SPEED of VESSELS, E. Raverot and P. Belly, London.
- 14,145. LIQUID WARMING APPARATUS, R. C. Baker, London.
- 14,146. BOOT TREES, W. J. Yapp, London.
- 14,147. WALKING STICKS and UMBRELLAS, H. Park, London.
- 14,148. SCREW HAMMERS, J. T. Norris, London.
- 14,149. FIRE-ESCAPE, T. L. Morgan, London.
- 14,150. GAME, W. E. Plowden, London.
- 14,151. MAKING INFUSIONS, A. Farinetti and A. Parietti, London.
- 14,152. MAKING INFUSIONS, A. Farinetti and A. Parietti, London.
- 14,153. MUZZLES, A. J. Boulton.—(*C. Cavinac, France.*)
- 14,154. IMPROVED DYEING APPARATUS, J. O. Obermaier, London.
- 14,155. BREAK-FEED APPLIANCES for ELECTRIC ARC LAMPS, F. J. Beaumont, London.
- 14,156. MACHINERY for RECEIVING COINS, E. Moriarty, London.
- 14,157. ELECTRICITY METERS, H. W. C. Cox, London.
- 14,158. LIFEBOAT TENDER, A. Browne.—(*J. A. Cox and A. W. Read, India.*)
- 14,159. RUG STRAPS, W. Wills, London.
- 14,160. STARTING TRAMCARS, J. Willoughby, London.

22nd July, 1893.

- 14,161. LUBRICATION of SPINDLES, S. Straker, London.
- 14,162. GEARING for VELOCIPEDS, W. F. Taylor, Croydon.
- 14,163. CHANGING BOX for PHOTOGRAPHIC FILMS, W. R. Baker, Surrey.
- 14,164. CONSTRUCTION of CYCLE WHEELS, J. Wilkinson, Birmingham.
- 14,165. BOLTING, &c., SPRING LOCK, C. P. Smith, Manchester.
- 14,166. MAKING HATCHET HEADS, &c., E. Wright, London.
- 14,167. LABEL HOLDERS for RAILWAY TRUCKS, H. Williams, Glasgow.
- 14,168. STANDS for GLOBES, G. Bacon and T. Best, London.
- 14,169. CARVING FORK GUARDS, W. Hampshire, Sheffield.
- 14,170. BRAKE, F. V. Russell, London.
- 14,171. HANDLE for WATER BUCKETS, J. Pethick, Plymouth.
- 14,172. CONNECTING CURTAIN RODS, W. Wright, Plymouth.
- 14,173. DRIVING MECHANISM, A. B. Barker, Keighley.
- 14,174. MOTIVE-POWER ENGINES, J. Macdonald, Glasgow.
- 14,175. GAS and other ENGINES, D. Clerk and F. W. Lancaster, Birmingham.
- 14,176. TIRES, G. Clark, W. O'Hare, and P. Leonard, Glasgow.
- 14,177. WATER GUTTERS or SPOUTS, W. Longmore, Birmingham.

- 14,178. CREPON WAFFLE, A. Dux, Manchester.
- 14,179. QUILTS, W. O'Hanlon, and T. and W. Holt, Manchester.
- 14,180. BACK FORK ENDS for CYCLES, H. Chamberlain and W. Colligan, Coventry.
- 14,181. CONDENSERS, T. K. Barclay, Glasgow.
- 14,182. FEEDING FUEL in DUST or LIQUID FORM, A. Riedinger, Manchester.
- 14,183. TIRES, G. Macaulay-Cruikshank.—(*J. Köt, Germany.*)
- 14,184. STEAM VALVES for PUMPS, W. P. Theermann, Manchester.
- 14,185. WINDOW SASHES, J. Williamson, Glasgow.
- 14,186. SAWS, H. H. S. Gledhill, Huddersfield.
- 14,187. SHUTTLE GUARD for LOOMS, J. Lund, Halifax.
- 14,188. GREASE, D. D. Brown, Glasgow.
- 14,189. CHLORINATING ANTHRACENE, R. G. Bennett, London.
- 14,190. PADLOCKS, J. Frakes, Birmingham.
- 14,191. PULP for PAPER-MAKING, J. P. Cornett, Newcastle-on-Tyne.
- 14,192. VENTILATORS, W. Cooper, London.
- 14,193. WINDOW SASHES, R. W. Barker.—(*Sharp and S. L. Ralph, United States.*)
- 14,194. HORSESHOE, G. Burgstaller, London.
- 14,195. SOFTENING WATER, A. Smith, London.
- 14,196. HATS, P. P. Aries, London.
- 14,197. LACE TRIMMINGS, W. Gane, London.
- 14,198. TOYS or PUZZLES, M. M. Wilson, Liverpool.
- 14,199. CHAMPAGNE TAPS, J. Farrar, London.
- 14,200. FIRE-BARS, C. Möhring, London.
- 14,201. FRAMING for VELOCIPEDS, G. W. Tarver, London.
- 14,202. DYNAMO-ELECTRIC GENERATORS, L. Pyke and E. S. Hartis, London.
- 14,203. OVENS or FURNACES, E. Stauber, London.
- 14,204. WATER-CLOSETS, J. Jones and S. H. Rowley, London.
- 14,205. STAPLE DRIVERS, J. H. Eberhardt.—(*C. L. Lach and Co., Saxony.*)
- 14,206. BUOYANT FABRICS, J. G. Heinze, London.
- 14,207. COLOURING MATTERS, O. Imray.—(*The Farbwerke vormals Meister, Lucius and Brüning, Germany.*)
- 14,208. COLOURING MATTERS, O. Imray.—(*The Farbwerke vormals Meister, Lucius and Brüning, Germany.*)
- 14,209. TOY TARGETS, E. G. Templeton, London.
- 14,210. TUBULAR POSTS, Siemens Brothers and Co. and C. E. J. May, London.
- 14,211. PREVENTING INCORUSTATION in STEAM BOILERS, V. Gane, London.
- 14,212. APPLICATION of AIR and GAS to DRIVING ENGINES, W. Smethurst, W. E. Vickers, and G. R. Rogers, London.
- 14,213. CYCLING SUIT, F. E. Young, London.
- 14,214. SEATS, T. Ely and J. Mallett, London.
- 14,215. PROPELLING WATER, M. E. D'Engelbronner, London.
- 14,216. KNITTING MACHINES, C. H. Aldridge, London.
- 14,217. GLASS, F. B. McCrea, London.
- 14,218. TRIMMING the WICKS of LAMPS, W. Thomson, London.
- 14,219. OILS, S. A. Johnson, London.
- 14,220. TRANSPORT, H. Mühlberg, Berlin.
- 14,221. SIFTING and SORTING APPARATUS, C. H. A. Stütz, London.
- 14,222. HAND BAGS, H. H. Lake.—(*E. P. Hinkel, Germany.*)
- 14,223. BREACH MECHANISM of GUNS, H. H. Lake.—(*Die Firma Fried. Krupp, Germany.*)
- 14,224. INDIA-RUBBER, E. Arboucau née Fourquet, London.
- 14,225. DRIVING CHAINS for BICYCLES, W. Wippermann, jun., Germany.

24th July, 1893.

- 14,226. MATCHLESS SELF-LIGHTING CIGARETTE, A. M. Edwards, Bristol.
- 14,227. TAPS, H. Kent, Englefield Green.
- 14,228. "PERFECTION" CYCLE SEAT, F. H. Jones, Stoke-upon-Trent.
- 14,229. USE of METALS, E. J. Ball and H. C. Jenkins, London.
- 14,230. SPINNING MULES, J. Hodgson and F. Dowling, Halifax.
- 14,231. BRAKE for CYCLES, A. S. J., and J. A. Duthie, Aberdeen.
- 14,232. GAS ENGINES, F. W. Crossley and H. W. Bradley, Manchester.
- 14,233. TRANSMITTING ELECTRIC CALLS, T. J. Gough, Manchester.
- 14,234. SWIMMING BELT, W. Orrell, W. Holt, and H. H. Royle, Manchester.
- 14,235. RIMS of CYCLE WHEELS, H. Fenney, Birmingham.
- 14,236. FASTENING PNEUMATIC TIRES, J. M. and W. Starley, and T. Groves, Birmingham.
- 14,237. IMPROVED DRAWING TABLES, &c., R. Diggle, Accrington.
- 14,238. BATHS, &c., H. A. Satchell, London.
- 14,239. DRIVING GEAR for CYCLES, R. J. Carson, Belfast.
- 14,240. PROPELLER for VESSELS, G. Durland and R. T. P. Davenport, Plymouth.
- 14,241. APPLIANCES for MAKING BUTTER, F. T. Bond, London.
- 14,242. TRUNKS, J. and W. Gittings, and J. Chilton, Wolverhampton.
- 14,243. IMPROVED GOLF CLUBS, J. W. Hartley, Kilmarnock.
- 14,244. RINGS for SPINNING FRAMES, J. H. Buckley, Bolton.
- 14,245. FURNACES for the DESTRUCTION of TOWN REFUSE, W. Horsfall, Bradford.
- 14,246. BOTTOMS of FIREGRATES, J. T. Johnson, Manchester.
- 14,247. FASTENERS for GLOVES, &c., C. A. Pfennig, Manchester.
- 14,248. MUD GUARD for CYCLES, &c., L. A. Hurst, Leeds.
- 14,249. RAILWAY SIGNAL SLOTS, J. Walker, Wigan.
- 14,250. WATCH PROTECTOR, L. J. N. Gorton, Wolverhampton.
- 14,251. PROPELLER for STEAMBOATS, W. P. Roberts, Yorkshire.
- 14,252. STERILISING MILK, &c., F. A. Kleemann, Glasgow.
- 14,253. DIRECTION TAGS or LABELS, A. J. Johnson, Birmingham.
- 14,254. PICTURE FRAMES, A. Anholt.—(*M. Hartmann, Holland.*)
- 14,255. LOCKING GEAR for LIFTS, M. T. Medway, London.
- 14,256. DRYING APPLIANCE for BRICKMAKERS, M. Gentry, Essex.
- 14,257. IMPROVED BRUSH for HORSES, S. Giesecke, London.
- 14,258. ELECTRICITY METER, F. J. Beaumont and F. Hallows, London.
- 14,259. DYNAMO-ELECTRIC MACHINES, W. Lowrie, London.
- 14,260. CYCLE BRAKES, W. Pomfret, London.
- 14,261. SIGNAL POSTS, O. Ledz.—(*E. de la Sauce and H. Kloss, Germany.*)
- 14,262. SELF-ACTING VIOLIN MUTE, G. Skinner, London.
- 14,263. DEEP-WATER DIVING APPARATUS, J. H. Robinson, London.
- 14,264. TICKET PRINTING MACHINES, P. Hooker, London.
- 14,265. TAPS or COCKS, T. H. Jones and T. V. de Loo, London.
- 14,266. SPRAY DIFFUSER, T. H. Jones, London.
- 14,267. TEAT MOULDS, T. H. Jones and A. H. V. Schildknecht, London.
- 14,268. VESSEL for the INFUSION of TEA, G. F. Griffin, London.
- 14,269. CAR REPLACER, E. T. Hughes.—(*H. Saunders, United States.*)
- 14,270. DISH WASHING MACHINES, E. T. Hughes.—(*O. O. Hodgson, United States.*)
- 14,271. DISTRIBUTING ELECTRICITY through SUBSTATIONS, C. Bertram and W. J. Hope-Johnstone, London.

14,272. PEGS for TENTS and like PURPOSES, C. H. Groom, London.
14,273. COVERS of NEWSPAPERS, &c., R. J. Crowley, Queenstown.
14,274. FILMS, F. Crane and J. B. B. Wellington, London.
14,275. FISH BAIT, J. V. Husberg, London.
14,276. SOLES and HEELS for BOOTS, &c., R. Foster London.
14,277. FOUNTAIN PENS, J. Janka, London.
14,278. BUTTON-HOLE SCISSORS, E. Edwards.—(B. Trenkler, Germany.)
14,279. VELOCIPEDES, E. T. Pike, London.
14,280. TREATMENT of HOPS, W. Watson, London.
14,281. APPLIANCE for HOLDING ASPARAGUS, L. Schuhmann, London.
14,282. EXTENSIBLE and CONTRACTILE RINGS, A. Ratz, London.
14,283. SPRING-FITTING FINGER RINGS, A. Daub, London.
14,284. ARMS for CHAIRS, G. H. Rubery, jun., and J. Bell, London.
14,285. PURIFYING AIR, G. J. Epstein, London.
14,286. TREATMENT of WOUNDS, O. Imray.—(W. Schultz, Germany.)
14,287. APPARATUS for CALENDERING FABRICS, E. Clavier, London.
14,288. STOPPERS for BOILER TUBES, J. P. Halket, London.
14,289. WATCHES, A. Douard, sen., London.
14,290. TILLS, F. E. L. Frucht, London.
14,291. HOLDER for CIGARETTE PAPERS, F. M. B. Bertram, London.
14,292. MANUFACTURE of BLOCK ICE, H. V. Weyde, London.
14,293. SADDLES and HARNESS for HORSES, S. Jacobs, London.
14,294. BOILERS, L. P. Perkins, London.
14,295. MACHINES for MAKING CHAIRS, J. L. Dexter, London.
14,296. WATER-CLOSET FLUSHING APPARATUS, P. Donaldson, London.
14,297. MAKING ROLLED METAL ARTICLES, H. H. Lake.—(G. F. Simonds, United States.)

25th July, 1893.

14,298. FILAMENTS for ELECTRIC LAMPS, H. K. Tompkins, Surrey.
14,299. ATTACHING BUTTONS, A. G. Brookes.—(H. H. Cummings, United States.)
14,300. SKIRT FASTENER and BELT, F. H. Wollaston, Southsea.
14,301. FOLDING SHAFT, C. Campbell, Manchester.
14,302. MOTOR for ACTUATING ORGAN BELLOWS, F. A. Slater, London.
14,303. ATTACHING OUTER CASE of a PNEUMATIC TIRE to RIM of WHEEL, J. T. B. King, Manchester.
14,304. SMOKELESS, &c., FURNACE, L. Weigert-Sterne, Bournemouth.
14,305. PNEUMATIC CUSHION for HEAD-RESTS, T. H. Wem, Birmingham.
14,306. OIL-CAN, J. Duncan, Glasgow.
14,307. PUZZLE, A. Stewart, Glasgow.
14,308. ATTACHING PNEUMATIC TIRES to RIMS, W. T. White, Newcastle-on-Tyne.
14,309. METALLIC EYES for HANDLES, J. W. Hunt, Wolverhampton.
14,310. ANCHORS, H. Hutchinson, Newcastle-on-Tyne.
14,311. OPENING of ENVELOPES, F. Algar, Exeter.
14,312. GRAPPLE FORK, J. R. Robinson, Stockton-on-Tees.
14,313. STEAM PUMPS, W. H. Duncan, Shropshire.
14,314. DECORATING SURFACES, R. N. Havers, G. W. Harwin, and L. R. Havers, Bradford.
14,315. GALVANIC ELEMENTS, C. W. A. Hertel, Manchester.
14,316. COMPRESSING DISTENDED EARS, A. Thamm, Manchester.
14,317. OPENERS and SCUTCHERS, H. Brüggemann, Manchester.
14,318. SELF-WINDING, &c., CLOCKS, A. G. Wiseman, London.
14,319. SEWING MACHINES, A. Anderson.—(The Singer Manufacturing Company, United States.)
14,320. MUSICAL RATTLES, J. T. Walker and A. C. Crow, Sheffield.
14,321. PREVENTING EXPLOSION of BOILERS, J. Foord, London.
14,322. FOLDING TABLES, N. Schumacher, London.
14,323. SCREW-PROPELLERS, J. Yates, London.
14,324. STEAM ENGINES, A. H. Tyler and J. S. E. de Vesian, London.
14,325. APPARATUS for ROLLING METAL BARS, J. W. Milner, London.
14,326. TOE-CLIPS for VELOCIPEDE PEDALS, J. J. H. Sturtevant, London.
14,327. HAIR-BRUSHING MACHINE, D. Beaton and D. Macdonald, Essex.
14,328. YARN HOLDERS, G. W. Holzborn, London.
14,329. SAFETY LOCK for CYCLES, &c., G. M. Dudley, London.
14,330. WEAVING WIRE BANDS and NETTING, J. A. Tatro, London.
14,331. VENTILATING APPARATUS, F. C. Chadborn, London.
14,332. WOVEN FABRICS for ELASTIC TIRES, J. Lyall, London.
14,333. WHEELS and TIRES for VELOCIPEDES, H. Price, London.
14,334. METALLIC RAILWAY TIES, J. P. Lancaster and S. Prosky, London.
14,335. FROST NAIL KEYS, A. J. Boulton.—(F. Richard-Legros, Belgium.)
14,336. BRAKE for TRAMCARS, J. Till and W. Ronson, Liverpool.
14,337. MIDDINGS PURIFIERS, W. P. Thompson.—(W. D. Gray, United States.)
14,338. PREPARING COAL for TRANSPORTATION, W. C. Andrews, London.
14,339. COCKS or TAPS, W. R. Davies and F. Crook, Liverpool.
14,340. HOLDER for LUNAR CAUSTIC, W. P. Thompson.—(P. Henger, Germany.)
14,341. RECEIVING WATER-BORNE COAL, W. C. Andrews, London.
14,342. CHANGE MAKER, C. L. Travis, London.
14,343. HOLDER for STAIR-RODS, D. Poupard, London.
14,344. FURNACES, D. Keger, London.
14,345. COLOURING MATTERS, H. E. Newton.—(The Farbenfabriken vormals Friedrich Bayer and Co., Germany.)
14,346. MUSTARD-POT, M. Reiche, London.
14,347. GUN MOUNTS, W. H. Driggs, London.
14,348. JUNCTION BOXES, E. J. McEvoy, London.
14,349. CLEANING SEEDS, C. Graham and V. Galochkin, London.
14,350. WRENCH, C. H. Bernheim and B. Shemwell, London.
14,351. PENCIL SHARPENERS, P. McMenamin, London.
14,352. MAKING TUBES, J. Wüstenhöfer and W. Surmann, Germany.
14,353. ORNAMENTAL FLOWER-STANDS, K. Hirshager, London.
14,354. INSTRUMENT for ASCERTAINING ANGLES, W. G. Angell, London.
14,355. DEVICES for TEACHING CHILDREN, J. Gallegos, London.
14,356. EDUCATIONAL DEVICES, J. Gallegos, London.
14,357. BRAKE, D. P. Martin, E. Hervais, and F. Loppé, London.
14,358. DIES, L. Doig.—(The Russell and Ervin Manufacturing Company, United States.)
14,359. CURTAIN FIXTURES, H. H. Lake.—(A. W. Herr and L. M. Long, United States.)
14,360. CORD for TRIMMINGS, H. F. and L. Moreau, London.
14,361. TOOLS for CUTTING SCREW THREADS, C. A. Higbee, London.
14,362. BOLTS, C. A. Higbee, London.
14,363. FILES, T. Waring, London.
14,364. CALCULATING PHOTOGRAPHIC EXPOSURES, A. Watkins, London.
14,365. LADDERS, H. L. Hawes, London.

14,366. PROTECTORS for BOOTS and SHOES, W. G. Peck, London.
14,367. SELF-ACTING BRAKES for LIFTS, G. W. Ludovici, London.
14,368. RIDING HABITS and SKIRTS, C. E. Bradley, London.
14,369. FASTENING BOOTS and SHOES, J. B. E. Field, London.

26th July, 1893.

14,370. CYCLE, W. Scorer, South Shields.
14,371. SLIP HOOK with LOCK ATTACHMENT, J. Newbould, Rotherham.
14,372. BOOT STRETCHERS, C. C. Rothwell, Stratford-on-Avon.
14,373. SYRUPS, EXTRACTS, &c., R. E. Evans, Stratford-on-Avon.
14,374. BOTTLING MACHINES, T. Parker and S. Snape, Bolton.
14,375. CORN LIFTER, P. Stonehouse, Leicester.
14,376. FIRE-GRATES and MECHANICAL STOKERS, W. E. Kochs, Cardiff.
14,377. DRAWING FIBROUS MATERIAL, W. Wadsworth, Bradford.
14,378. COMPRESSED FUEL, G. V. Priestley, Leeds.
14,379. APPLIANCE for MEASURING CLOTH, W. H. Moorhouse, Halifax.
14,380. STEERING APPARATUS for SHIPS, M. Mullineux, Manchester.
14,381. ROLLER BEARINGS for JOURNALS, H. Austin, Leeds.
14,382. POTATO DIGGER, W. Wilson, Manchester.
14,383. PREVENTING the RISK of FIRE, W. Wilson, Manchester.
14,384. AUTOMATIC WATER-CLOSETS, G. H. Smith and B. Cooper, Rhodes, near Manchester.
14,385. ADJUSTMENT for VELOCIPEDES, S. Muir, Birmingham.
14,386. STANDS for WET SPINNING FRAMES, W. Scott and J. Mackie, Belfast.
14,387. TENNIS RACQUET PRESS, E. Rooke, Hertfordshire.
14,388. CONSTRUCTION of THRESHING MACHINES, J. Thomas, Manchester.
14,389. TREADING MOTION of LOOMS, W. A. Rothwell, Manchester.
14,390. BORING MACHINES, A. H. Morier and J. M. Collins, Glasgow.
14,391. SHEAF-BINDING REAPING MACHINES, J. and R. Wallace, Glasgow.
14,392. CALKS for HORSESHOES, E. de Pass.—(G. de R. de Sales, France.)
14,393. TUBULAR STEAM BOILERS, G. and J. Weir, Glasgow.
14,394. PURIFYING SACCHARINE LIQUIDS, J. N. S. Williams, Glasgow.
14,395. AUTOMATIC TRACHEOTOMY TUBE, R. C. Thompson, Doncaster.
14,396. WINDOW SASHES, H. Woodruff, Sheffield.
14,397. KETTLES, H. Woodruff, Sheffield.
14,398. TEA-POTS, F. I. Gibbs and W. Wright, Birmingham.
14,399. PNEUMATIC TIRES, W. S. Mappin, London.
14,400. BETTER GUIDANCE of SHIPS, G. H. Blenkinsop, Swansea.
14,401. MANUFACTURE of WIRE NETTING, J. J. D. Paul, London.
14,402. STOVE GRATES, T. P. Moorwood and S. Jessop, Sheffield.
14,403. MOTORS, E. Hérisse, London.
14,404. METALLIC POSTS, S. W. Carlton, London.
14,405. FILLING BOTTLES, G. F. Redfern.—(J. J. Chavasse, G. Bengough, and A. J. Phillips, Canada.)
14,406. TOURING LEGGINGS, J. B. Smith, Birmingham.
14,407. COMPOUNDS of IRON with FATTY ACIDS, A. K. Huntington, London.
14,408. TUBULOUS BOILERS, J. P. Halket, London.
14,409. BOOT STUD, G. Mahaffy, London.
14,410. ADVERTISING, G. E. Miall, London.
14,411. FUMIGANTS, I. S. and J. T. McDougall, London.
14,412. INSECTICIDES, I. S. and J. T. McDougall, London.
14,413. CIGARETTE CASES, E. G. Brewer.—(A. H. G. Pigg, South Africa.)
14,414. INDICATING DEVICE for VALVES, J. Bergstein, London.
14,415. BELT GRIP, A. Tomlins and W. V. Williams, London.
14,416. BLAST PIPES for LOCOMOTIVE ENGINES, M. Atcock, London.
14,417. PNEUMATIC TIRE, G. L. Trott.—(M. Foy, New South Wales.)
14,418. CONSTRUCTING ROAD SURFACES, G. Bird, London.
14,419. SECURING TIRES to WHEEL RIMS, P. Davies, London.
14,420. CARTRIDGES, H. M. Chapman, London.
14,421. CONDENSERS, F. O. H. Haeder, London.
14,422. COVERING ELECTRIC CABLES, J. B. Atherton, Liverpool.
14,423. DRIVING, &c., TACKS, H. and T. Claughton, London.
14,424. WINDOW BLINDS, J. W. Cronkshaw and R. Rusden, Manchester.
14,425. AIR CUSHIONS, H. C. Sheldon.—(G. Schüfer, Germany.)
14,426. WATER-WASTE PREVENTERS, J. Jones, F. T. Farrer, and W. W. Brown, London.
14,427. SCUTCHING FLAX, F. Pears and the Fibre Machinery Company, Ltd., London.
14,428. BRAKE APPARATUS, H. H. Lake.—(O. Chiozza, Italy.)
14,429. REPAIR of ASPHALT PAVEMENTS, A. H. Perkins, London.
14,430. FURNACES, W. Hawdon and R. Howson, London.
14,431. TIRES for VELOCIPEDES, &c., H. Thompson, London.
14,432. CAMERA FOCUSING APPLIANCE, F. T. Y. Niblett, London.
14,433. SEWING STRAW PLAIT, &c., G. Humphrey, London.
14,434. PROMOTING COMBUSTION in FURNACES, C. A. Couch, London.

27th July, 1893.

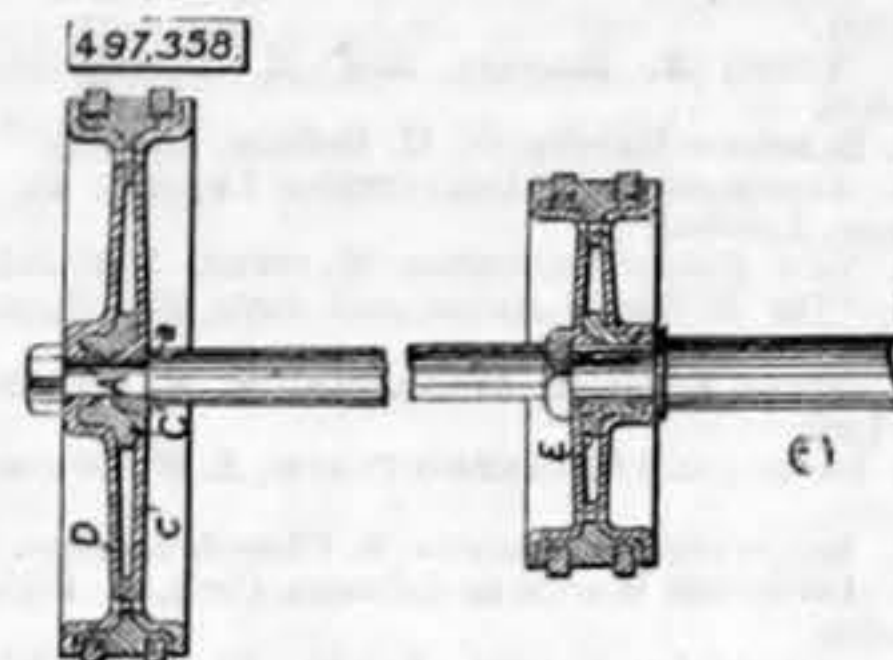
14,435. IMPROVED PNEUMATIC TIRES, A. P. Jordan, London.
14,436. FOG SIGNALLING on RAILWAYS, W. S. Holloway, London.
14,437. MANUFACTURE of BRICKS and TILES, J. Nash, Salford.
14,438. CYCLE GEARING, P. Weston, Birkenhead.
14,439. LEVER BOXES for RAILWAY POINTS, J. W. White, Lancashire.
14,440. BUCKET-PUMPING ENGINES, S. Walker, Manchester.
14,441. MOTIVE-POWER ENGINES, J. Sime.—(E. S. Matthews, Japan.)
14,442. SURGICAL INSTRUMENT, R. Brown, Newcastle-on-Tyne.
14,443. MULTIPLE CLIP, W. L. Dennis, Birmingham.
14,444. MAKING CARDBOARD BOXES, J. M. Baines, Bradford.
14,445. LOOM HEALD-OPERATING MECHANISM, S. Hey, Yorkshire.
14,446. FIRE-BARS in FURNACES, J. Abbott, Bristol.
14,447. SUNKEN SHIP RAISER, E. J. R. Baldwin, London.
14,448. NEEDLE for PASSING SURGICAL SUTURES, A. Clark and S. J. Pegg, Leicester.
14,449. ANTI-CONCUSSION CARRIAGE, H. W. D. Dunlop, Dublin.
14,450. CASEMENT CLOSING MECHANISM, J. Lilly, Birmingham.
14,451. DABING BRUSHES of COMBING MACHINES, H. Denison, E. Bray, and G. Dixon, Leeds.
14,452. POLISHING, &c., BRUSHES, J. M. Plunkett, Dublin.
14,453. TIRE of VELOCIPEDES, J. M. Plunkett, Dublin.
14,454. STARTING GAS ENGINES, H. N. Bleckerton, Manchester.

SELECTED AMERICAN PATENTS.

From the United States Patent Office Official Gazette.

497,358. PISTON, G. S. Strong, New York, N.Y.—Filed September 19th, 1892.

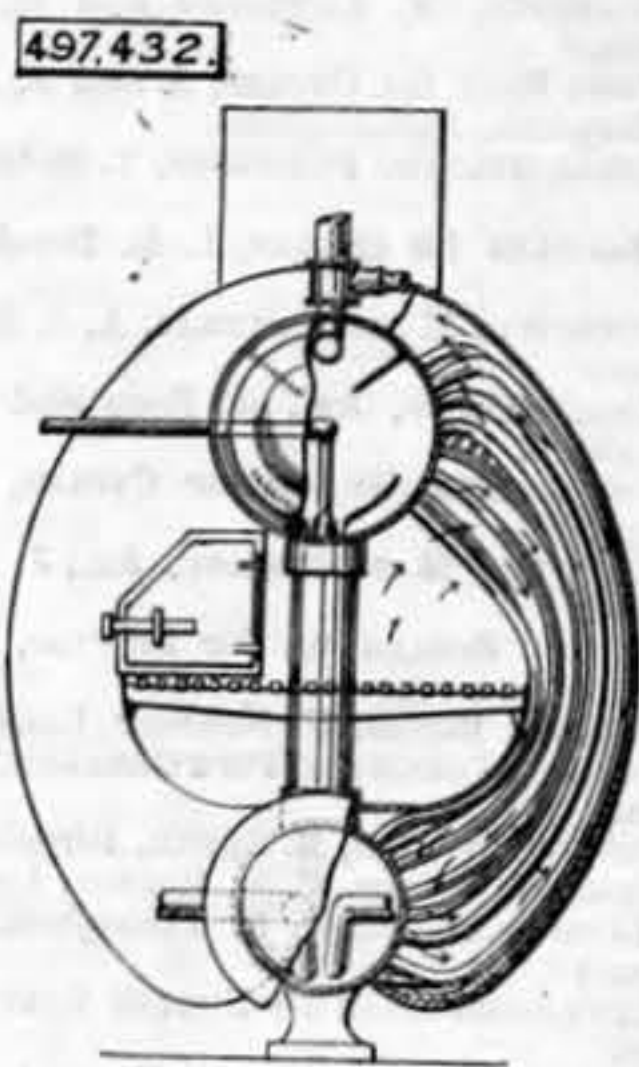
Claim.—(1) A piston consisting of dished wrought iron metal plates C and D having flanges at their centres in combination with a bearing ring F situated between the rims of said plates, a hub E situated between said plates at their centre and adapted to be held by the flanges thereof, and means for drawing the plates together so as to tightly grip the ring F and hub E. (2) A piston-rod A having a shoulder a and extension A' of smaller diameter in combination with dished plates C D having flanges as C' D' at their centres, a bearing ring F situated between the rims of



said plates, a hub E situated between said plates at their centre and adapted to be held by the flanges thereof, and a nut B screwing on the end of the extension A' so as to clamp the piston between it and the shoulder a. (3) A piston consisting of dished wrought metal plates C and D in combination with a bearing ring F situated between the rims of said plates, a hub E situated between said plates at their centre and means intermediate the centre and the rim for holding the plates together so as to tightly grip the ring F and hub E.

497,432. STEAM BOILER, C. L. Seabury, Nyack, N.Y.—Filed June 8th, 1892.

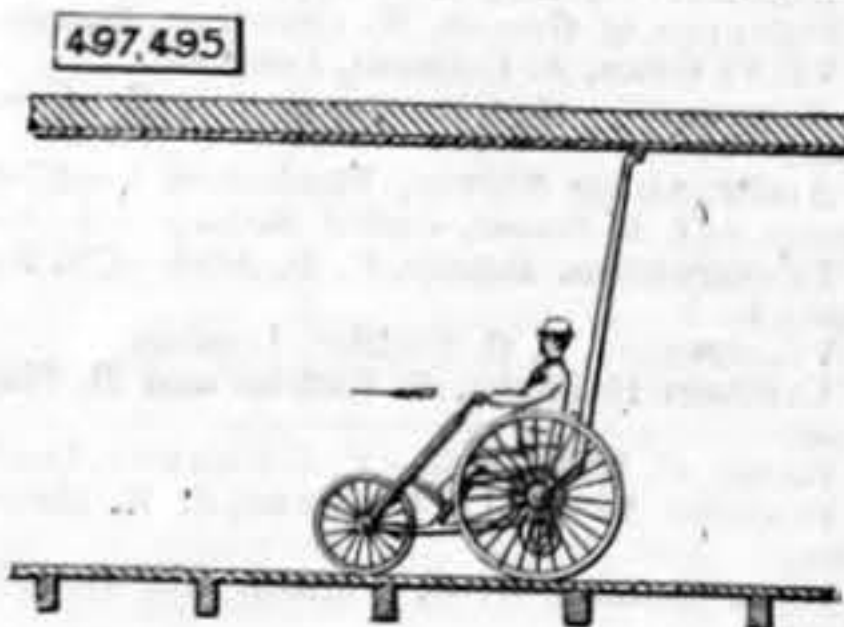
Claim.—(1) In a steam boiler, the combination with an inclosing shell, of two drums longitudinally disposed in the space inclosed by said shell and one above the other, water tubes connected to said drums on both sides, the combustion chamber being wholly inclosed between said drums and said tubes, a water leg connecting said drums, a transverse head at the rear end of said combustion chamber and connected to the upper drum, a second transverse head at the forward end of said chamber and connected to said water leg, and a series of tubes connecting said transverse heads and constituting a grate in said chamber,



substantially as shown and described. (2) In a steam boiler, the combination with an inclosing shell, of two drums disposed one above the other, a series of tubes connected to said drums in staggered or zig-zag lines and bent to stand laterally in contact for a portion of their length, the spaces between the upper portions of said tubes being left open, a second series of tubes outside of the first, similarly connected to said drums and similarly bent to stand laterally in contact for a portion of their length, the spaces between their upper portions being closed by a baffle plate while the spaces between their lower portions are left open, substantially as shown and described.

497,495. ELECTRIC RINK, M. W. Hassan, Rochester, N.Y.—Filed May 28th, 1891.

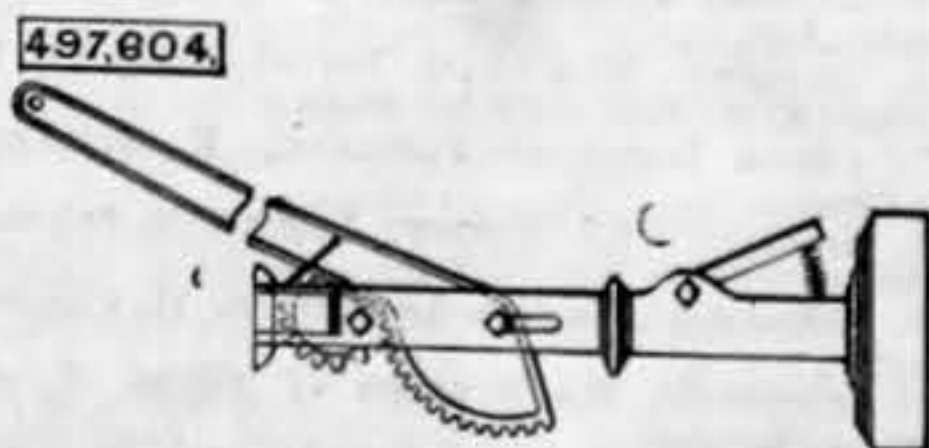
Claim.—The combination, in a rink or hall, of a ceiling provided with electrically charged strips arranged in pairs and forming a track, a non-con-



ducting floor provided with guide lines coincident with the strips, a vehicle provided with a motor, a trolley provided with double bearings connected with the strips of each pair forming the track, and electrical conductors connecting the trolley bearings with the motor, as and for the purpose specified.

497,604. LIFTING JACK, H. Reichwein, New York, N.Y.—Filed February 23rd, 1893.

Claim.—In a lifting jack, the combination, with a lower lifting section bifurcated at its upper end, and an upper lifting section having sliding movement upon the bifurcated portion of the lower section, of a lift lever comprising a handle and a segmental toothed

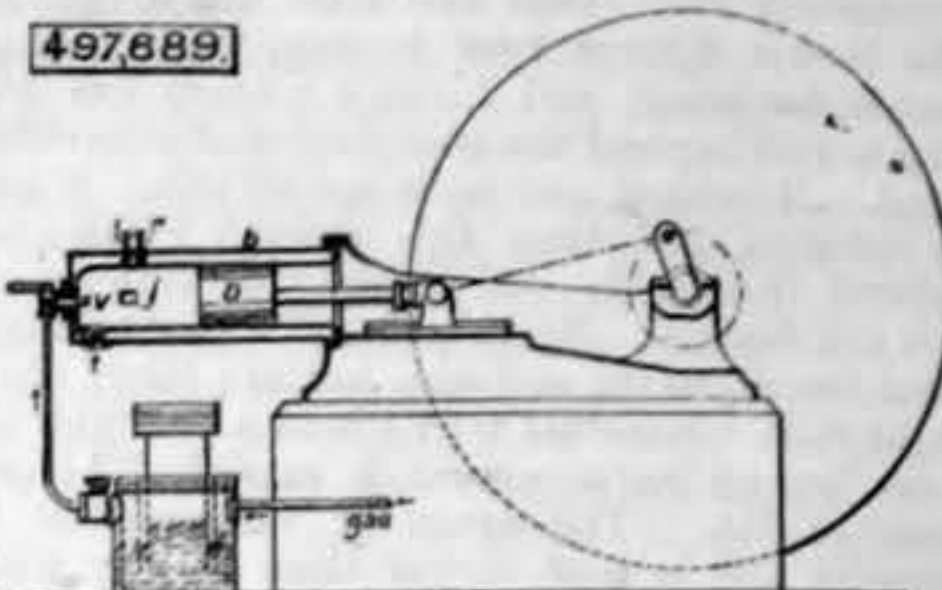


head, the segmental toothed head of the lever being fulcrumed between the upper members of the lower section, and a segmental gear eccentrically pivoted in the lifting section and meshing with the teeth of the head of the lift lever, as and for the purpose set forth.

497,689. GAS OR OIL MOTOR ENGINE, H. Schumm, Cologne-Deutz, Germany.—Filed June 12th, 1891.

Claim.—In a four-stroke cycle gas or petroleum motor engine, the combination of a piston a, a cylinder b provided with a self-acting air inlet valve c, a

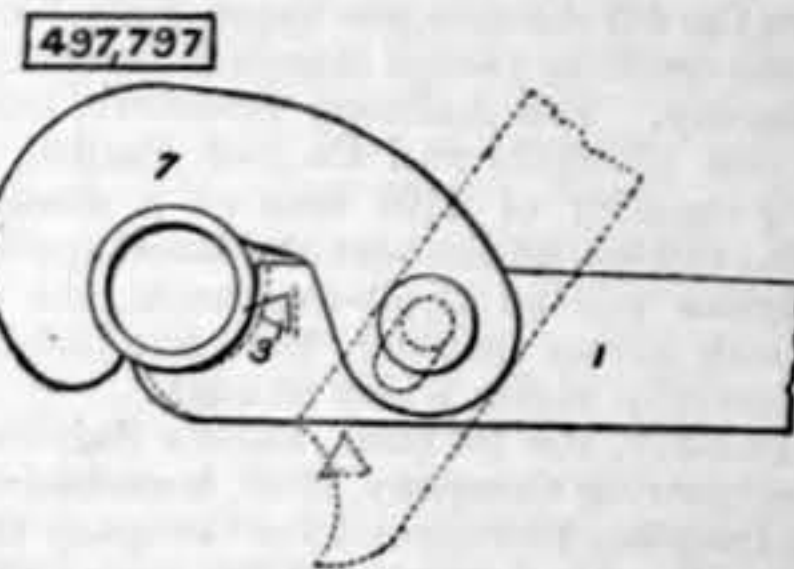
discharge valve i and an inlet opening r for combustible gas or explosive mixture, a slide d which controls said inlet opening, a counter shaft x extending substantially parallel with the axis of the cylinder, revolving at half the speed of the crank shaft and carrying the cams l a o, the cam o serving to open the discharge valve during a part of the compression stroke of the piston, the cam a serving to open the



discharge valve during the expelling stroke of the piston, and the cam l serving to operate the slide which controls the inlet, and means for supplying combustible gas or gaseous mixture or petroleum vapour under pressure through the said slide to the cylinder during the compression stroke of the piston, substantially as described.

497,797. PIPE TONGS, R. C. Jones, Mars, Pa.—Filed March 24th, 1893.

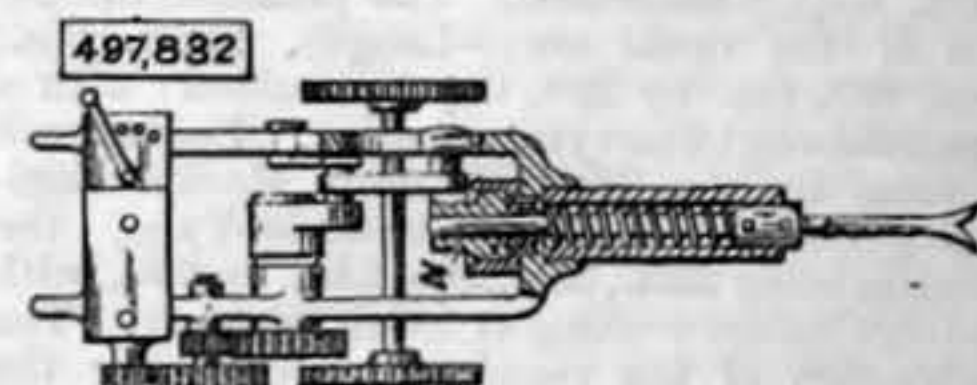
Claim.—The herein-described pipe wrench, consisting of the bar 1 having the sharpened edge 4 and



curved portion to fit neatly about the pipe, the removable triangular piece 3, the slot 2 formed in the said bar 1, the clamping jaw 7, and the pivot 6, all arranged and combined for service, substantially as and for the purpose described.

497,832. ELECTRIC MINING MACHINE, E. A. Sperry, Chicago, Ill.—Filed October 8th, 1888.

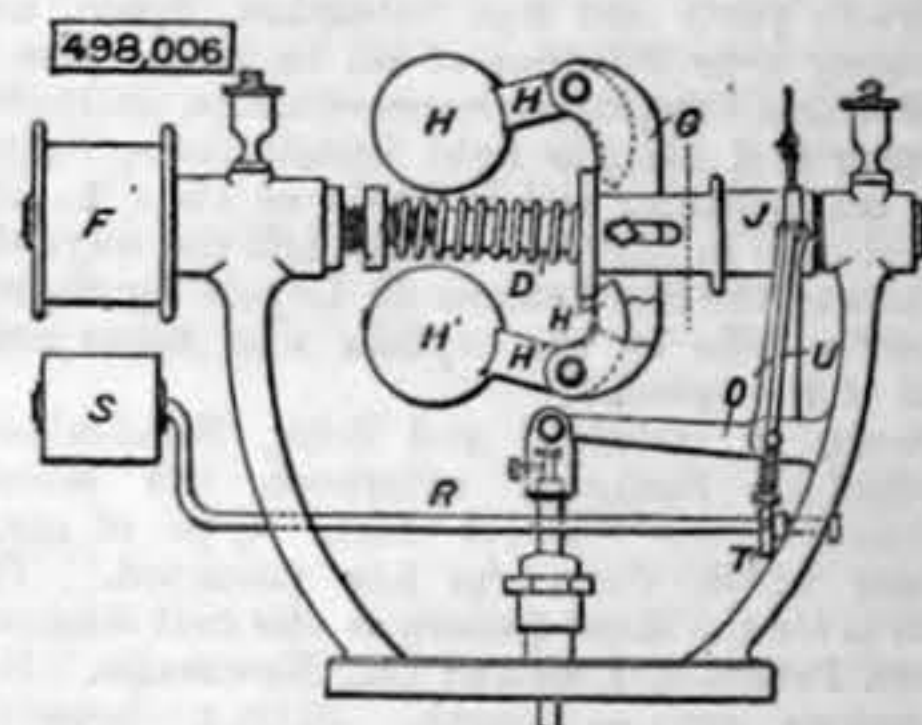
Claim.—(1) In an excavating machine, the combination of a movable supporting frame with a continuously-acting electric motor mounted thereon, a cutter holder or bar reciprocating longitudinally in a line passing practically through the centre of inertia of the machine, a power storing and delivering spring, operating the cutter bar, a speed reducing gear or gears between the motor and the spring, a catch to



intermittently connect and release the motor and the spring and a cushion device as N O to relieve the machine from the shock of the drill bar when the same is not encountering resistance, substantially as and for the purpose shown and described. (2) A moving manually directible bi-wheeled excavating machine, consisting in part of a power motor having the axis of the shaft of the motor parallel with the axis of its supporting wheels, combined with a flexible connection to the source of power supply.

498,006. STEAM ENGINE GOVERNOR, G. H. Egan, St. John, Canada.—Filed February 16th, 1893.

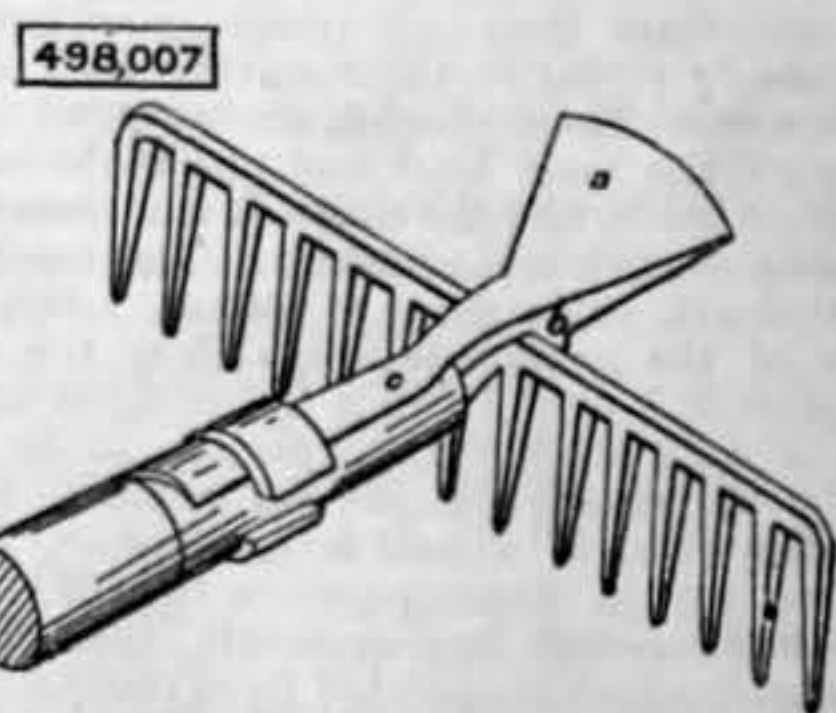
Claim.—The combination with the horizontal shaft D, carrying a driving belt pulley F, a yoke G, sleeved on said shaft and rotating therewith, governor balls H H, having arms H¹, hinged to said yoke and moving with said shaft, a sleeve J, sliding on said shaft and operated in one direction by the ball arms and in the



opposite direction by a spiral spring K, surrounding said shaft, a saddle N, straddling said sleeve, an elbow lever O, connecting said saddle to a valve stem B, and a shaft R, journaled parallel to shaft D, and having at one end a crank carrying an idler pulley S, and the other end provided with a cam T, to engage and lift a yoke U, pendent from said saddle when the idler pulley gravitates, to operate the lever O, and shut off steam, as set forth.

498,007. RAKE, W. T. Gallt, Port Byron, N.Y.—Filed July 19th, 1892.

Claim.—(1) The combination, with a metallic rake head, of a spud consisting of a cutter, an open socket which fits the rake head, and a shank which fits the end of the handle, and suitable means for securing the spud in place, as specified. (2) The combination, with a metallic rake head, of a spud having a cutter, an open socket which fits the rake head, and a shank



which fits the end of the handle, and a sliding collar which secures the shank to the handle, as herein shown and described. (3) The attachment herein-described, consisting of the thin shank c adapted to fit the handle of the rake, the open socket b adapted to fit the rake head and embrace the under side thereof, and the blade a standing at an obtuse angle to the shank, as and for the purpose specified.