GLASGOW SUBWAY AND CABLE TRACTION.

(*Continued from page* 40.)

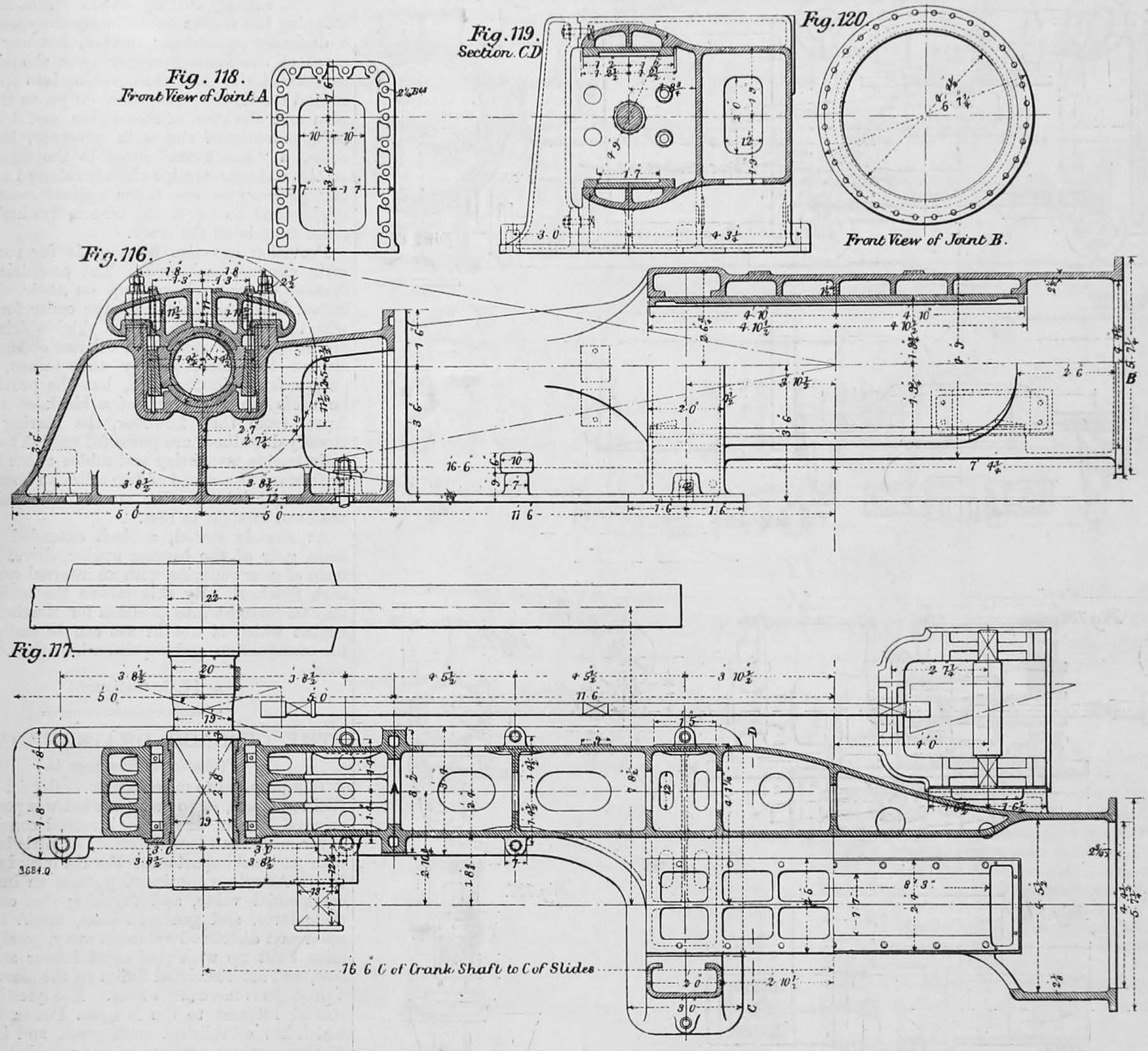
WE commence the publication this week of the details of the cable machinery by reproducing on the two-page plate, the elevation and plan of one of the main engines, with details of the cylinders and valves, while on this and the following pages the engine framing is shown, and on page 96 the valves and valve gear are illustrated. The cylinders of the main engines are 42 in. in diameter by 6 ft. stroke, the bodies being cast with a special mixture, twice melted, and containing equal parts of picked scrap, No. 3 Scotch pig, and cold-blast iron (Blaenavon), producing a strong and very close-grained cylinder metal. The completed cylinders were subjected to a hydraulic pressure of 200 lb. to the square inch. The valve chambers, it will be seen, were cast with the cylinder bodies, and the steam jackets are formed by separate liners (Fig. 108). The front and back covers are also jacketed, and every provision is made for complete and automatic drainage of the several sections. The outer surfaces of the jackets and covers are thickly coated with non-conducting composition, over which is fitted timber lagging, an air space being left between the lagging and the composition. The covering is finished all over with blue planished steel, and the corners with polished steel angles. Steam for the jackets is taken from the mains on the boiler side of the stop valves, which are fitted with pilot valves to facilitate opening and closing, and with hand gear and wheel, brought down to a convenient level. Over the stop-valves are butterfly throttle valves, which are set full open, and only come into use in connection with an automatic knock-out gear, which will be referred to later.

The pistons, which are shown on Figs. 108 and 112, are 12 in. deep, of special iron like the cylinders, box section, well ribbed, but light, with liberal solid rubbing surface and Buckley's packing rings of recent design. The stuffing-boxes have "elastic" metallic packing. The glands and neck bushes are lined with phosphor-bronze, and oil glands are fitted in front of the main glands. The piston-rods are of Siemens-Martin steel, having, like all other shafts, pins, and forgings, a rather larger percentage of carbon than usual, in order to secure good hard working surfaces. The dimensions and mode of attachment to the piston and crosshead are shown in Fig. 108. The rods are extended through the back cylinder covers, close to which are fitted strong brackets, with phosphor-bronze half-bushes 21 in. long, to assist in bearing the weight of the piston and rod (Figs. 104 and 105). The tail-rod provides a means of compounding the engines, but in the meantime, for cable driving, the advantages of the engines in their present form are many: they are simple and durable, give good results through a wide range of loading, while the mechanical efficiency, owing to the long stroke and small number of moving parts, is higher than for any other type of engine.

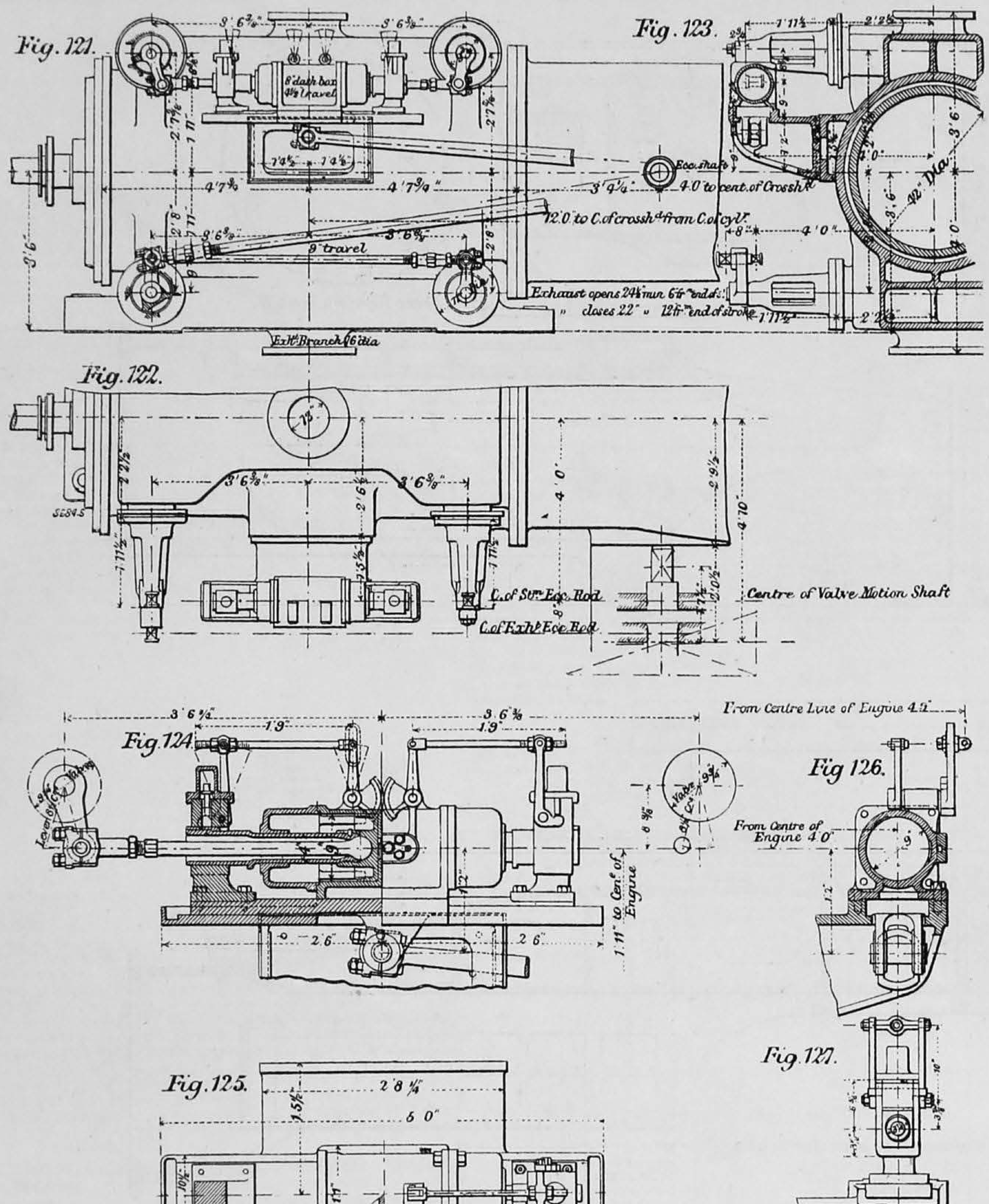
The crossheads are of Whitworth fluid-compressed steel of the type now usually employed on high-class marine engines, with double gudgeons forged in one with the boss; the piston-rod end passes through and is secured by a nut. The piston-rod is tapered down from $7\frac{1}{2}$ in., at the rate of 1 in 12, and the screw is $6\frac{1}{2}$ in. over the threads. The guide slipper surface is 36 in. by 19 in., with four flat oil-grooves. The connecting-rod is 16 ft. 6 in. in length, two and three-quarter times the length of stroke; the diameter at the crosshead end is 8 in., at the crank end $8\frac{1}{2}$ in., and in the middle 10 in., the body being turned to a parabolic curve. The crankpin bearing is 13 in. by 13 in., the crosshead bearings (two) are 8 in. by 8 in. each; the bolts at the crosshead end of mild Siemens steel are $3\frac{1}{2}$ in. in diameter, and at the crank end $4\frac{1}{2}$ in. in diameter.

The crank (Fig. 105) is 35 in. in diameter over the large boss, and 25 in. over the small boss, the web being $11\frac{1}{2}$ in. deep. The depth of the large boss is about $13\frac{1}{2}$ in., the large eye being bossed to the front to reduce stresses, and the connecting-rod no more than clears the boss. The large eye is bored to $19\frac{1}{2}$ in. in diameter. The crankpin is of Whitworth steel, 13 in. by 13 in. at bearing, increased to $13\frac{1}{4}$ in. in the boss. The shaft is of Siemens-Martin steel also high in carbon, the length being 13 ft. 7 in. The diameter in the crank eye is $19\frac{1}{2}$ in., while the bearings are 19 in. by 32 in.; at the eccentric sheaves and governor gear the shaft is 20 in. in diameter; at the flywheel boss 22 in., tapering in the after end down to 19 in. The reducing curves are of $1\frac{1}{4}$ in. radius. The flywheel is 25 ft. in diameter, is built up, about 50 tons in weight, and the margin of strength in dowells, cotters, and bolts is very liberal, giving ample security when the wheel is running at the maximum normal speed of 55 revolutions per minute. Knock-out gears prevent any further increase of speed.

The engine framing is illustrated in detail by Figs. 116 to 119. It is composed of two principal castings, and is made exceptionally stiff and strong. The



FIGS. 116 TO 120. FRAMING OF CABLE HAULAGE ENGINE FOR GLASGOW DISTRICT SUBWAY.



FIGS. 121 TO 127. CORLISS VALVES AND DOBSON TRIP GEAR FOR GLASGOW CABLE HAULAGE ENGINE.

forward end has a bearing on the foundation not only under the main pedestal, but continuously to a point well under the guide bars. In addition a strong cast-iron sole-plate placed below this part of the main frame, extended in front to include the crankpit and forward end of guide bars, provided with a raised ledge all round, and made quite oil-tight, prevents the attacks of oil in this important part of the foundations, which, it will be remembered, are all of concrete. Similar precautions are taken under all important pedestals, and extra large oil catchers are provided not only directly under the bearings of pedestals, but at the bases of their sole-plates, so that there is no excuse for allowing the foundations to become saturated. The main bearings are 19 in. in diameter by 32 in. long, the outer pedestal resting on the sole-plate of the main shafting. The bushes are of cast steel, lined with magnolia metal, made in four sections, with double wedge adjustments, bearing on the whole outer surfaces of the side bushes. The oil supply is visible, and continuous by means of circulating pumps.

The valves and the gear are illustrated by Figs. 121 to 127, and that so fully that little description is necessary. They are of the Corliss type, and are double-ported. The steam valves are on the top and the exhaust below, as is usual. They are operated by separate eccentrics to insure the best distribution of steam, and the exhaust begins at 95 per cent. of the admission stroke. In view of the long piston stroke, and to shorten the eccentric-rods, these are worked by gearing as shown on the elevation and plan of the main engines (Figs. 104 and 105). A bevel wheel fitted on the crankshaft drives a pinion on the end of the valve gear shaft; this shaft runs close to, and parallel with, the main frame, driving first the main governor, then the eccentric shaft, both of which are carried in a frame fixed near the cylinder. The second pair of bevel wheels driving the eccentric shaft, are similar to the first, bringing the speed back to that of the crankshaft, and the arrangement, which is now generally used for large horizontal mill engines, takes 20 ft. from the length of transmission by rods, at the same time permitting the eccentrics to be reduced to moderate dimensions. In examining American engines Mr. Morton was particularly struck by the perfect and almost silent action of the Corliss valve gears, and attention was particularly drawn to this matter in his specification. The Dobson trip gear, for which Messrs. Yates and Thom hold the sole license for England, was adopted, and with some minor improvements, gives very satisfactory results in the Glasgow engines. The beauty of the performance is slightly marred by the apparently inevitable noise made by the gearing driving the eccentrics, and this is the one objection to the use of valve gear shafts in place of long eccentric-rods.

The Dobson gear is simple and easily maintained. The steam eccentric drives a well-guided sliding bar, at each end of which is fixed the small tripping frame with its detent, and the usual tripping lever, whose position is determined by the governor. Within the tripping frame slides a square hollow trunk which is one with, and an extension of, the cylindrical trunk of the dashpot piston; the driving stop is secured to the top of the square trunk. The detent for each end falls quietly into gear just before the beginning of the steaming stroke for that end, and the whole gear for that end is driven forward until the angularity of the tripping lever raises the detent, and the valve is closed by the dashpot spring. The detent faces are made very wide; the depth of engagement can thus be reduced to $\frac{1}{16}$ in., and tripping is effected with the smallest possible resistance.

A "knock-out" attachment operated by the main governor prevents the engagement of the detents, entirely cutting off the steam supply and stopping the engine immediately the speed exceeds a desirable maximum; further, lest any derangement of the main governor gear should prevent this knock-out gear from coming into operation, a second small safety governor, shown on the general plan and elevation of the engine, and driven quite independently of the main governor, brings into action a "knock-out" fitted to the throttle valve on the main steam pipe already referred to, so that fair precautions are taken against racing, which might tend to burst the 50-ton flywheels, or to cause trouble on the track.

Provision has also been made for running the main engines backwards. The eccentric sheaves, instead of being keyed up on their shaft, are bolted hard up against a large collar forged solid with the shaft; on this collar double driving stops are provided for steam and exhaust eccentrics. To change the direction by this means, requires only a few minutes' time, but the provision may be useful in the event of a block on the track. Apart from this, however, the barring engines, already described, are powerful enough to turn the main engine machinery and cables either backward or forward at a speed of two miles an hour, and can be brought into use the moment the main engine has been brought to rest.

As already stated, a shaft extended from the main gear of the barring engine, drives a further train of gear engaging with an internal spur ring on each flywheel. By this means the main engines may be brought into position for starting, and the engine which is not in use can be easily handled for examination and repairs while the other is at work.

(*To be continued.*)

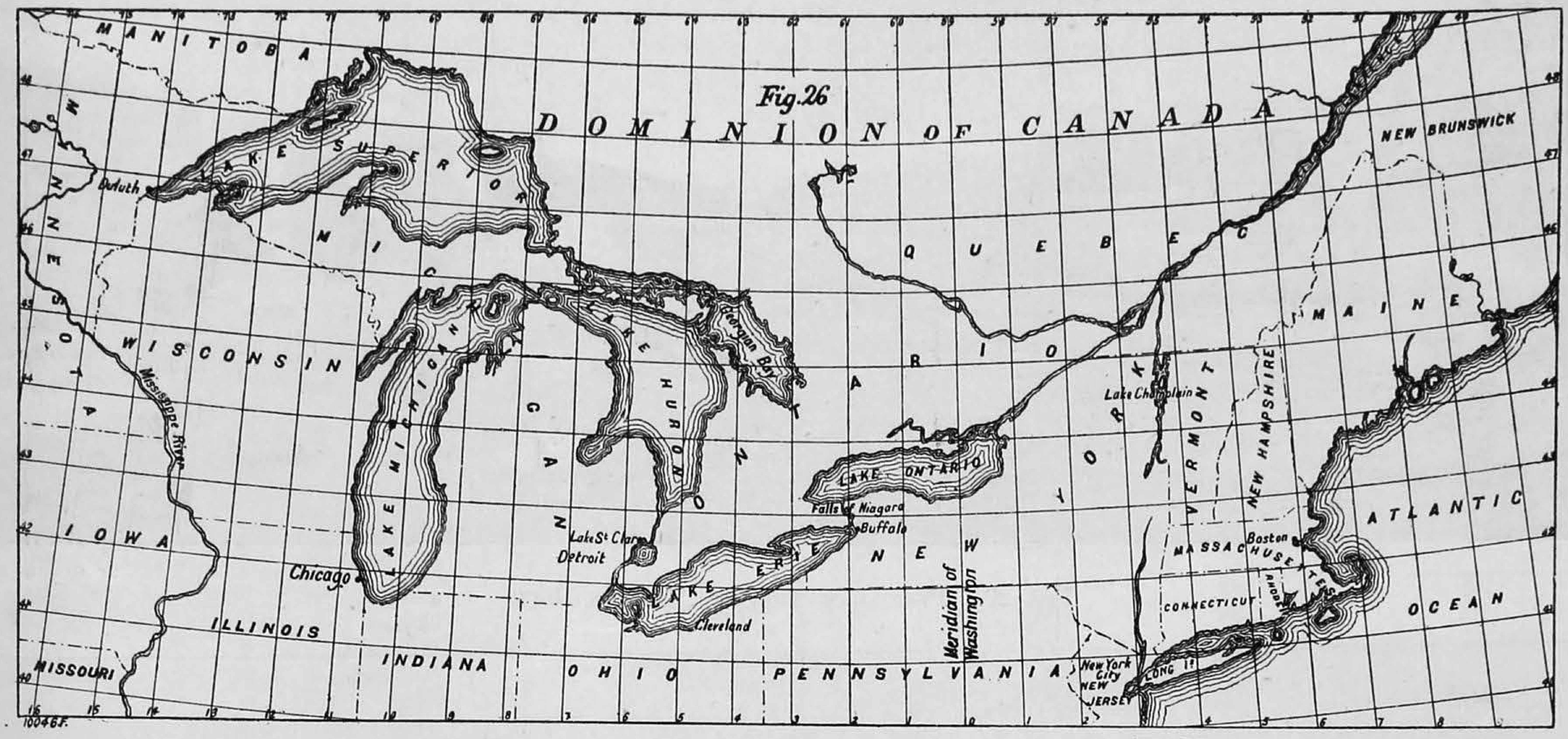
THE CHICAGO DRAINAGE CANAL.

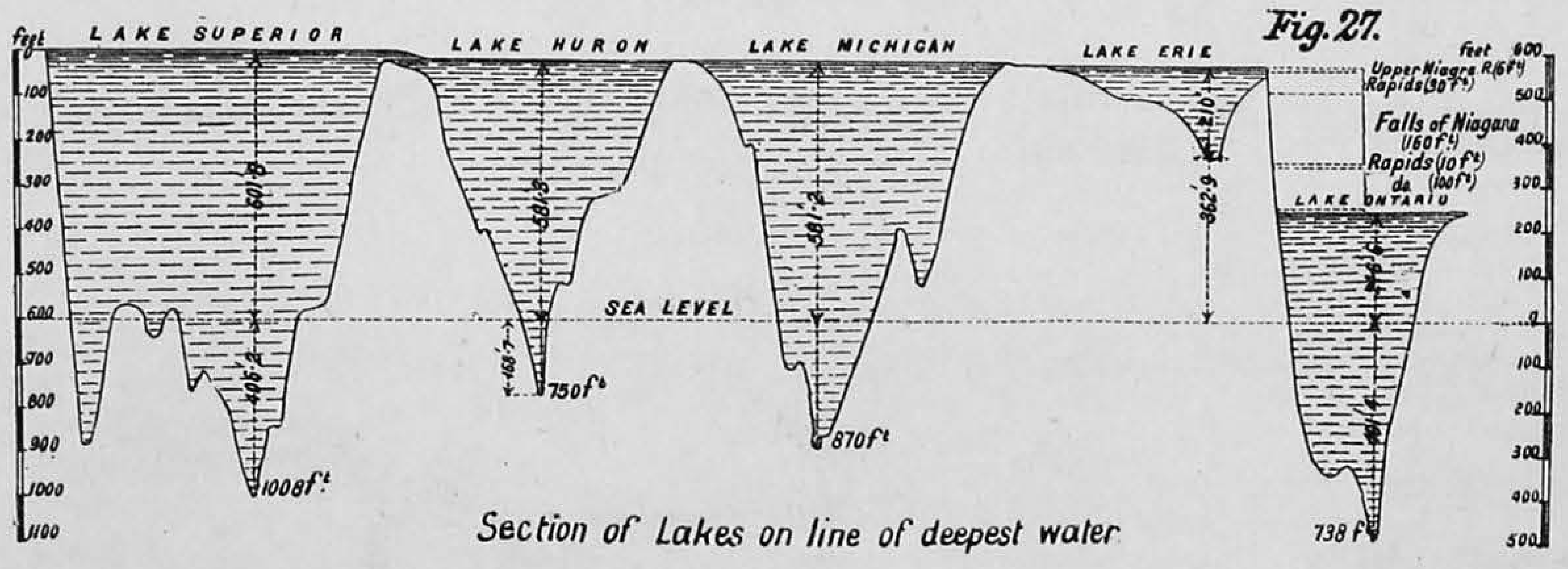
(*Continued from page 44.*)

THE proposal to make a new outlet for the great chain of lakes, or to restore what was possibly the original line of discharge, involved considerations of far more than local interest, of little less indeed than national importance. For the inland seas of the North American continent possess an incalculable commercial value, and anything that could affect their level, and general *régime*, might bring ruin upon vast districts 1000 miles away, paralyse industries built up with prolonged labour and at vast cost, and set restricted limits on the movements of a prodigious mercantile fleet. The question was of special interest to the Niagara Power Company, which has established such great, and is contemplating yet greater, works for utilising the power of the Falls, and though it appeared absurd that any human effort could disastrously affect the stupendous natural power incessantly at work delivering the superfluous water of the higher lakes into the lower Lake Ontario, it was an obvious duty to ascertain, as far as possible, what effect would be produced by the creation of a new discharge, taking water by another channel from the lakes in a volume of 10,000 cubic feet per second. Moreover, there was the scientific aspect of the problem that presented much fascination. In the present article we propose very briefly to summarise the results of investigations on this point made by the United States Corps of Engineers, and by the technical advisers of the Chicago Sanitary Board. The map, Fig. 26, gives a good idea of the chain of lakes, and the section, Fig. 27, taken through their lines of greatest depth, indicates the differences in their levels. Their total coast line is more than 5000 miles in length; their rain area and gathering ground for supply, exceeds 240,000 square miles. The volume of water they contain, if it could be drained off to their lowest depths, over Niagara, is sufficient to maintain the present discharge over the Falls for a century with the actual volume, equivalent to the flow through a river, with a current of a mile an hour, one mile in width, and 40 ft. in depth from shore to shore.

The remarkable difference in the lake levels is seen in the section, Fig. 27. Lake Superior is the highest, and is connected with the three lower lakes of the chain—Huron, Michigan, and Erie—by the Saulte Sainte Marie Canal, the traffic through which greatly exceeds that of the Suez Canal. about 4 per cent. of this, or 10,000 cubic feet per second.

The most interesting set of investigations on the *régime* of the lakes, and especially of the Niagara River, were carried out in November, 1891, by the United States Engineers Corps at the request of the American Society of Civil Engineers. The work was within the special province of that body, as the supreme Government exercises jurisdiction over all internal navigable waters, although it is only of recent years that restrictive measures have from the lakes—the outpouring of Niagara, and evaporation; the former of these varies with an increased or diminished supply from the numerous feeders, and from the varying rainfall; the latter depends to a large extent upon the differences in temperature from one year to another. The *régime* of the lake system is a profound problem, difficult, if not impossible, of solution, on account of the uncertainty of the actual conditions. Differences in level as great as 13 ft. have been recorded on the gauges at Buffalo, though this is regarded as a





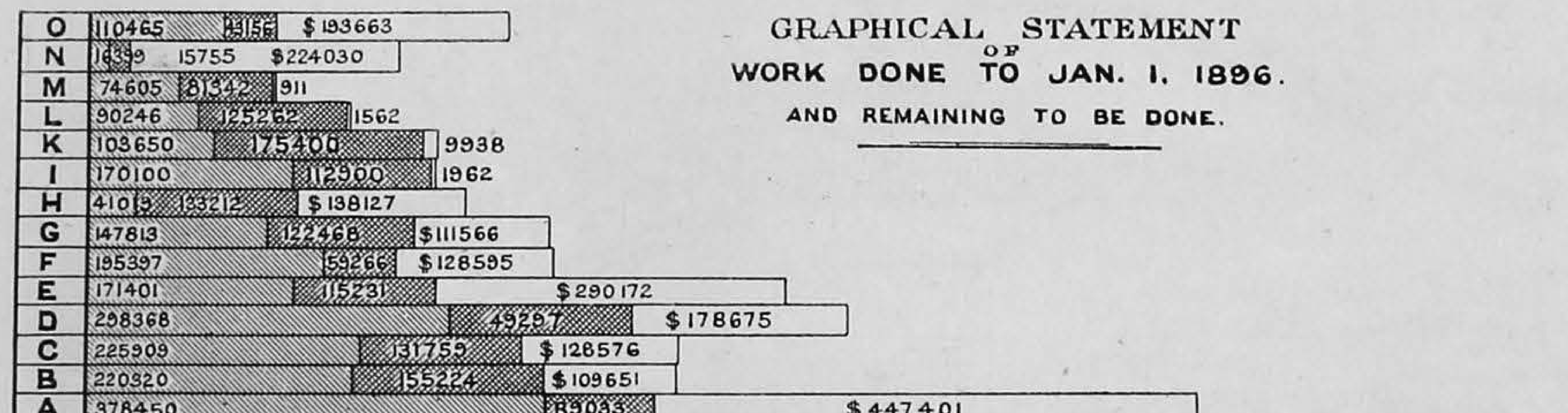


FIG. 28. DIAGRAM ILLUSTRATING THE PROGRESS OF THE CANAL WORKS.

Huron and Erie are connected by the Saint Clair River, through which, when the navigation is open, a constant succession of traffic passes to and fro. The total difference in level between Erie and Ontario is 326 ft., of which the Falls count for 160 ft., and the rapids above and below make up the rest. The volume of water flowing over Niagara is estimated at 265,000 cubic feet per second, and the maximum outfall of the Chicago Canal is to be been put in force for the proper maintenance of such channels. The Chicago Drainage Canal will, therefore, fall under the same control, for although probably many years will pass before it is used for navigation purposes, the abstraction of water from the lakes converts the scheme, which was a municipal necessity, into an undertaking of general importance.

Hitherto only two sources of loss have occurred

probable maximum, induced by exceptional conditions; moreover, the levels vary on different parts of the system, and are largely dependent on wind storms, rainfall, and fluctuations of the barometer. However interesting, therefore, the problem may be from a theoretical point of view, the important question to be decided was whether the loss of water from the lake by the new channel could, under the worst conditions, injuriously affect the shipping interests. As to the extent of this, the United States engineers hold a very decided opinion; they reported that if the question had not been raised as a consequence of the proposed construction of the canal, no one would have been any the wiser or worse off, by reason of the abstraction of the intended maximum amount by the canal. "All lake interests would have been equally oblivious to any injury that might follow; in other words, the effects are so obscure and illy defined as to make their practical detection impossible by the ordinary commercial agencies." The utmost depression in level that could be caused by the flow through the new outlet was assumed by the best authorities at 6 in. as a maximum, and that it would require at least two years to produce this effect. It was considered, however, that a fall of 4 in. was more nearly a practical maximum, and the report of the engineers deals with this figure. They assert that it would be impossible to measure such a change in the lake levels, or to check the amount by a comparison with the records that have been obtained for a century, and they advance several reasons for this assertion, the chief of which are as follows. The average difference in the height of the water at extreme seasons, that is, in the spring and autumn, is:

	Feet.
In Lakes Michigan and Huron	1.34
In Lake Superior	1.2
In Lake Erie	1.55
In Lake Ontario	2.07

THE CHICAGO DRAINAGE CANAL.

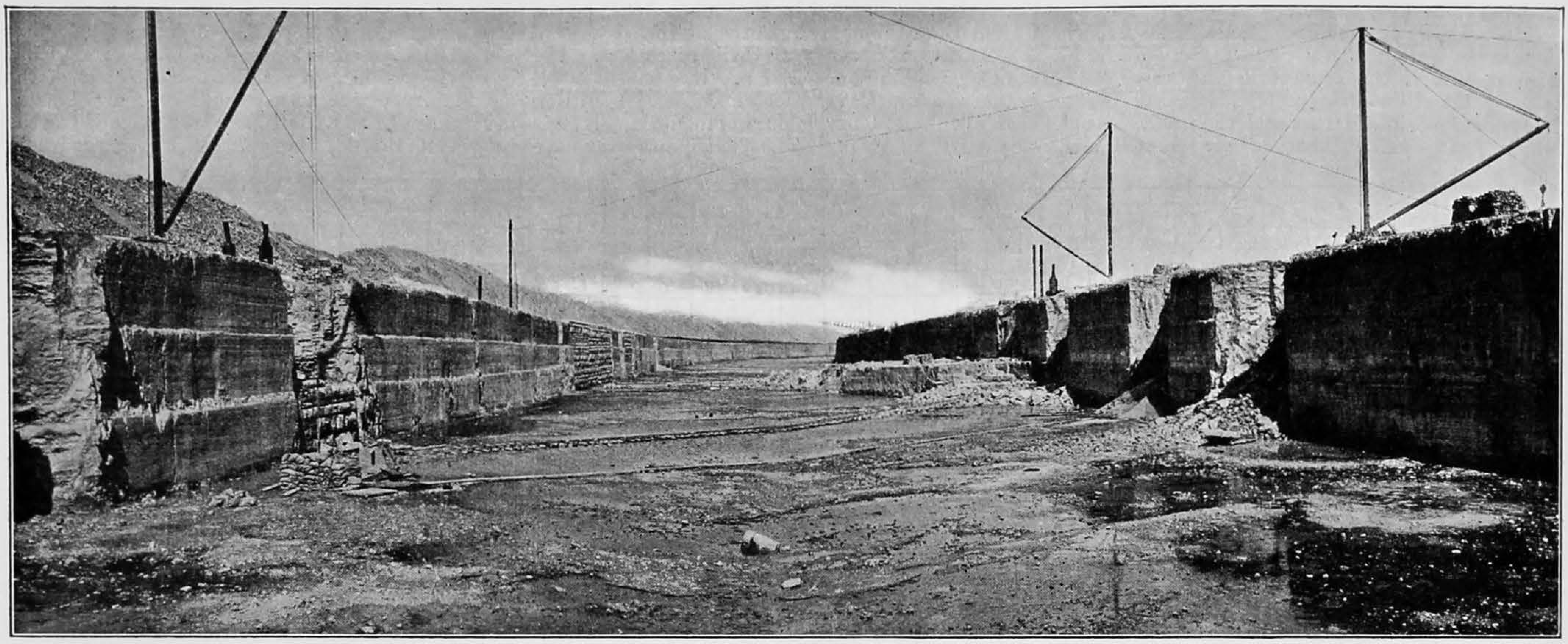


FIG. 29. TYPICAL SECTION OF CANAL IN ROCK.

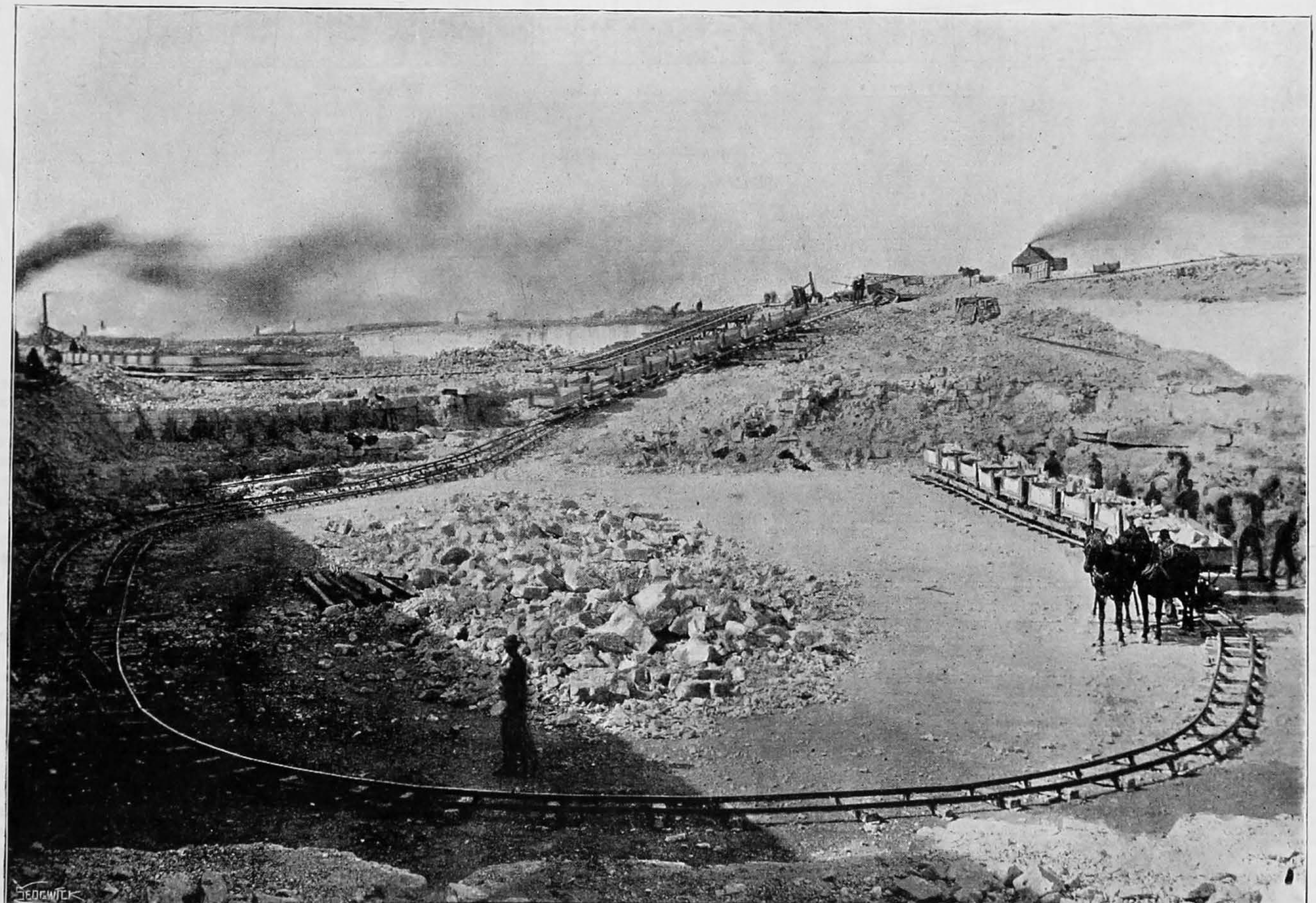


FIG. 30. METHOD OF REMOVING SPOIL BY INCLINES.

But these figures do not represent ranges too frequent to be exceptional, and the fluctuations measured over longer periods are much greater, ranging from 4 in. to 4 ft.; such fluctuations are irregular, but are generally recorded in intervals of from five to seven years. The barometrical influences on the lake levels are remarkable. "A high barometer on Lake Michigan and a low barometer on Lake Huron can easily shift large volumes of water through the Straits of Mackinaw, and make a difference of level of 1 ft. between the two lakes, and there are observations indicating such a result. A high barometer on Lake Huron and a low one on Lake Erie will increase the discharge through the St. Clair and Detroit Rivers, and possibly the discharge of the Niagara River may be varied from this cause." The loss by evaporation is, of course, enormous, and varies greatly, according to the season; it is stated that the difference in loss from this cause, between one year and another, is far greater than the amount to be taken out by the canal. "Ten thousand cubic feet per second would remove from the combined surfaces of Lakes Huron and Michigan in one year 2.97 in. of water, and this is only

THE LUHRIG PROCESS OF WASHING BITUMINOUS COAL.

(*For Description, see Page* 103.)

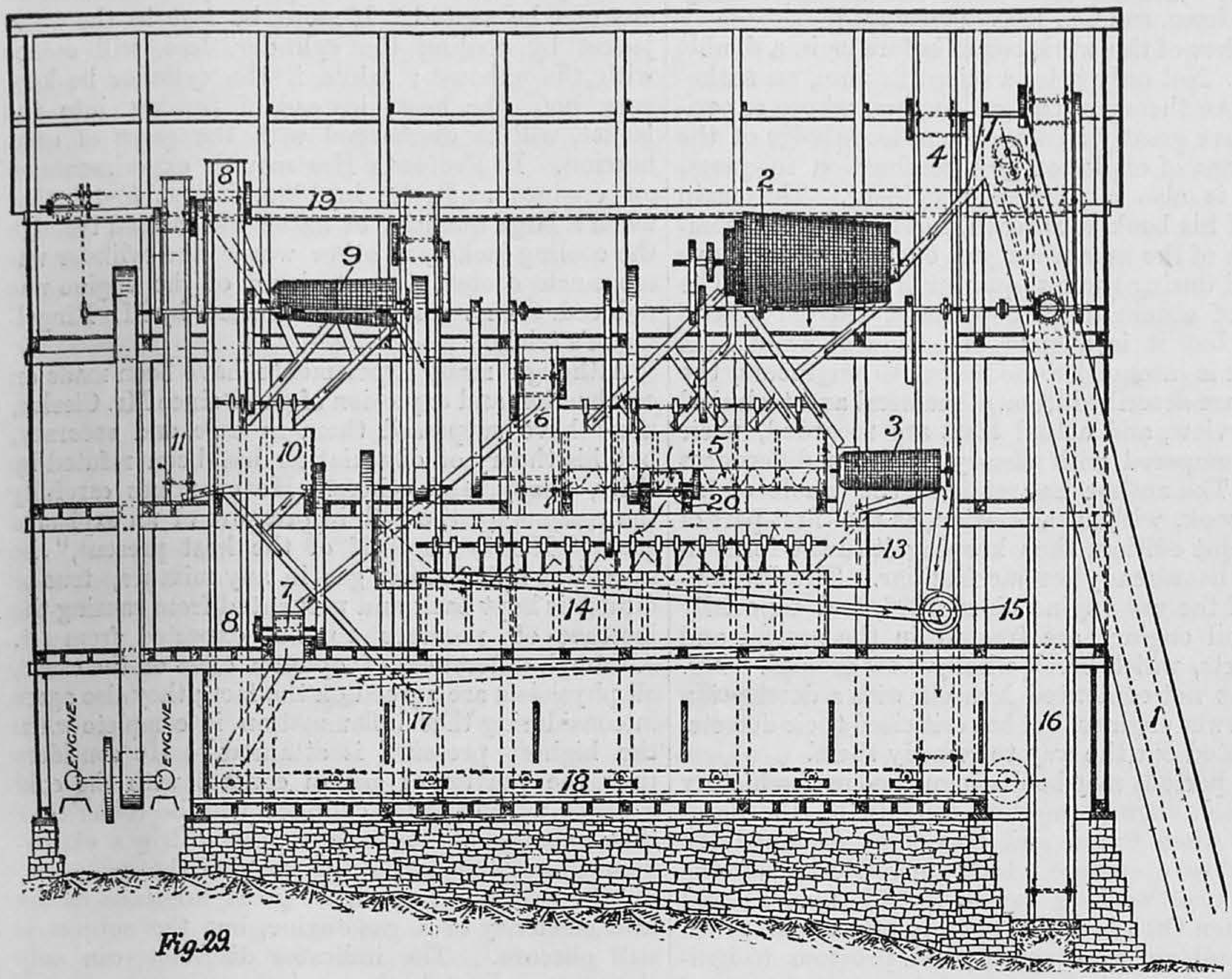


Fig. 29.

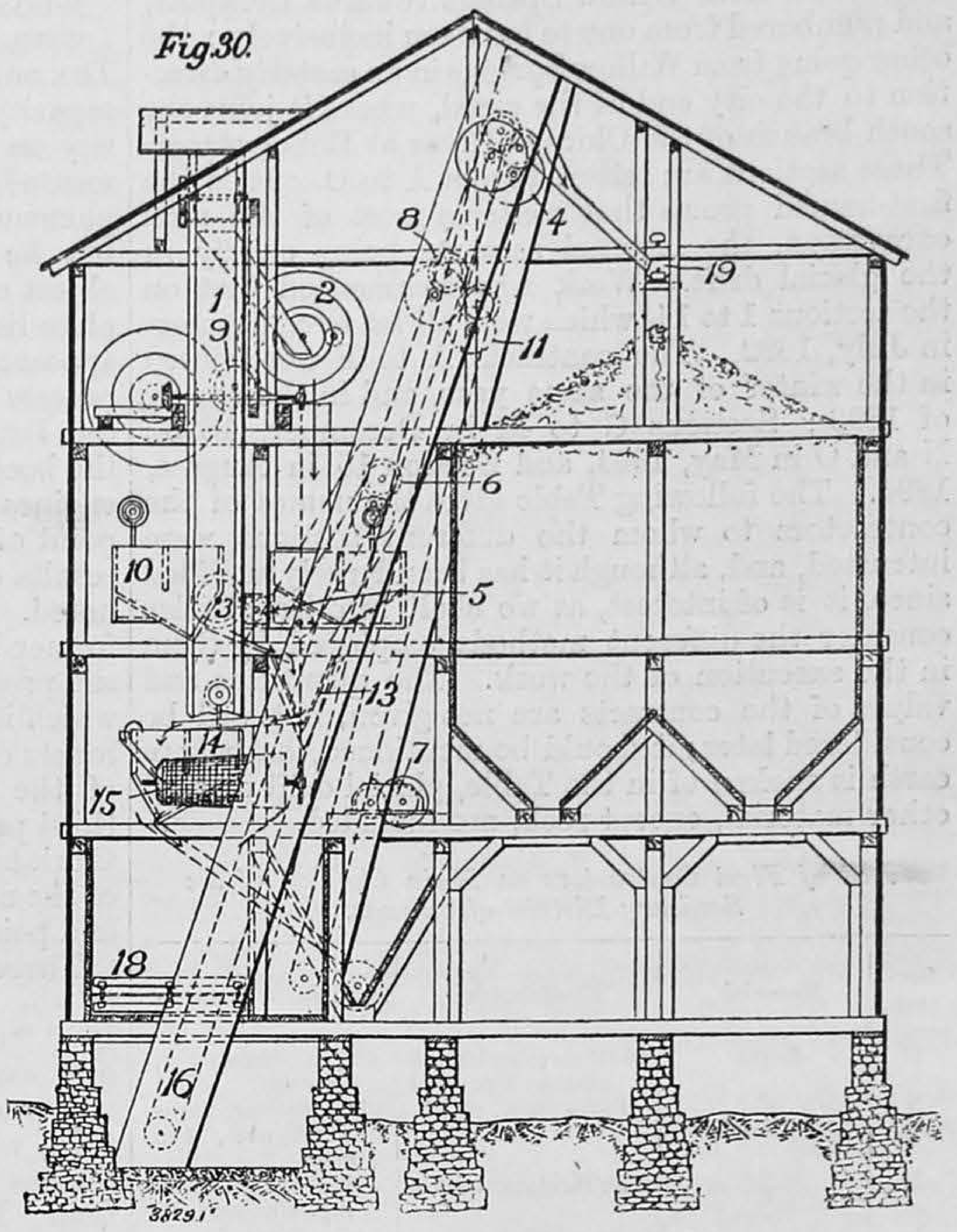
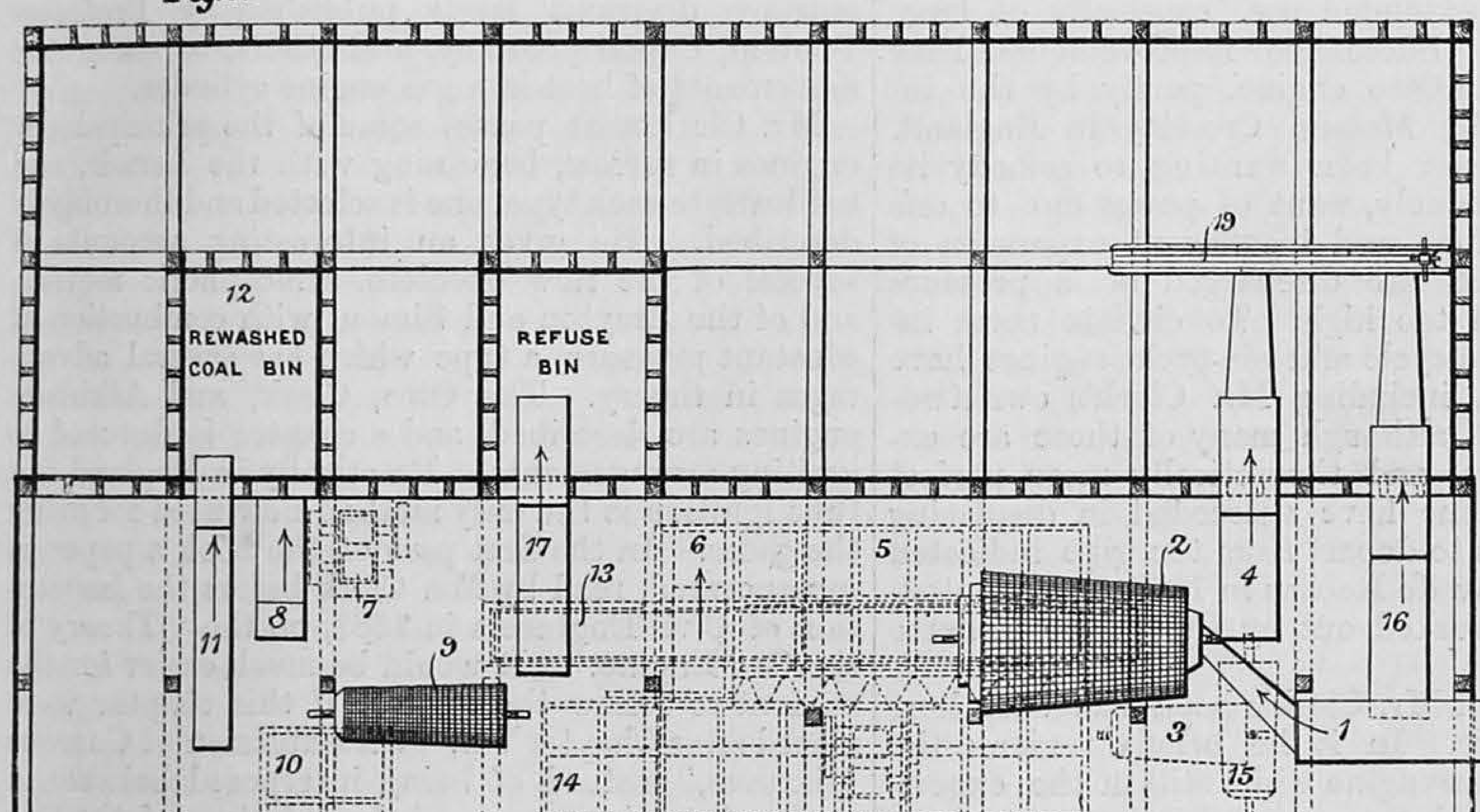


Fig. 30.

Fig. 31.



one-half the difference in evaporation for the years 1867 and 1868, as reported by the Lake Survey." The contention that had been urged against the canal scheme, that navigation would suffer, and that as a consequence important industries would be interfered with, was unanimously negatived by a great weight of technical opinion, as will be seen from the following conclusions of the engineers' report :

1. That the data are insufficient to reach a conclusion as to the specific effects, and the information available indicates limits not less than 0.2 ft., and not exceeding 0.4 ft., between which the final determination will lie.

2. That the magnitude and character of lake fluctuations are such that if the effects were unknown from purely scientific observations, and measurements, and technical analysis, they would never be discerned or appreciated, and, in other words, lake phenomena are so active, and of such amplitude, that results relatively small are entirely masked.

3. That conceding any effect that may be claimed, several remedies are feasible therefor, any one of which can be applied at a cost relatively small as compared to the cost of the sanitary canal of Chicago, and that the expense of such application will be a small part of the benefits which lake interests will ultimately derive through that work.

4. That the future of lake interests, and their seaboard connections, will demand a radical deepening of the shallows of connecting channels, and a control of lake levels, so that the interests in the question raised will reduce to a technical discussion in hydraulics.

5. That a careful remeasurement of the outflow of the several lakes under all conditions is desirable as the only final arbiter of any lingering doubts, and also for the more important purpose of projecting future works of a radical character, and valuing the effects thereof.

As technical opinion was almost wholly in support of the contention that the lake interests could not suffer by the construction of the new outlet, and as there was no doubt that the future existence of Chicago depended upon the formation of the channel, the promoters found no great difficulty in obtaining the necessary legislation, and the Act incorporating the sanitary district, and intrusting to it the requisite powers, was passed by the Legislature of the State of Illinois in 1889 ; the sanitary district was organised on January 18, 1890. The map, Fig. 21 (page 3 *ante*), shows the extent of the district ; it embodies all that part of the city lying to the north of Eighty-Seventh-street, as well as some 43 square miles outside the city limits, so that the area made responsible for the cost of the works is a very large one, and has an estimated value of 2500 million dollars. These great interests were placed in the hands of a body of trustees, so far as the Act permitted them to levy taxes for the execution of the drainage works. This highly important body has an organisation quite independent of the municipal government of Chicago ; its members are elected annually by popular vote, and its powers and privileges are strictly defined. The population over which it holds control is nearly two millions, and the assessed value of the property on which taxes can be levied for the construction works is about 250 million dollars, or one-tenth of the estimated total value. On this amount, or on such a modification of it as shall be decided by the State and county assessments made from time to time, the sanitary district trustees can levy a rate equal to one-half of 1 per cent. on such assessed value, for carrying on the works and for paying the interest on bonds they are empowered to issue under the Act. The extent of these loans is limited, however, and must not exceed 5 per cent. of the total assessed value of the whole property affected ; nor must it, under any conditions, exceed a total of 15 million dollars. Acting under these powers of the Act, the trustees had, at the beginning of 1896, issued bonds to the extent of 12 millions of dollars, and no doubt the whole issue will be made before the completion of the works. Two-thirds of the bonds thus issued bore interest at the rate of 5 per cent., and the remaining third were at 4½ per cent. ; they were redeemable at intervals of from one to 20 years, one-twentieth being called in every year. The taxes already referred to as being levied over the sanitary district are sufficient to pay the interest on the bonds, to meet the necessary redemptions every year, and to provide the sums required to carry out the work. Assuming that the estimate of 29 million dollars is not exceeded, and that the 15 millions of bonds are issued, it will be seen that the taxation has to provide 14 millions for the works, the interest on the bonds, and the sums required for their gradual extinction during 20 years. From this it will be realised that the trustees occupy a highly important and responsible position. The formation of the board, varying as it does from time to time, does not possess much interest for us, but the position of chief engineer is a permanent one, and has been admirably filled by Mr. Isham Randolph, to whom we are much indebted for information. After the passing of the Act, no time was lost in commencing the work ; there was, however, much preliminary labour for the engineer, as well as for the other various departments of the organisation, and it was not till

September, 1892, that ground was first broken. The channel and auxiliary works were divided into 28 sections, each about a mile in length. These divisions are separated into two groups; one running south-west from Willow Springs towards Lockport, and numbered from one to fourteen inclusively; the other going from Willow Springs in an easterly direction to the city end of the canal, where it joins the south branch of the Chicago River at Robey-street. These sections are lettered from A to O. It is the first-named group that contains most of the rock excavation, the lettered sections being chiefly in the glacial drift. Work was commenced first on the sections 1 to 14, which were all let to contractors in July, 1892. The contracts A to F were closed in the winter of the same year, and in the spring of 1893; Sections G to M in December, 1893; N and O in May, 1894, and Section 15 in August, 1894. The following Table gives the names of the contractors to whom the different sections were intrusted, and, although it has been largely modified since, it is of interest, as we shall in other articles consider the different methods employed by them in the execution of the work. The quantities and values of the contracts are not given, but will be considered later; it should be mentioned that where earth is spoken of in the Table, glacial drift and all other material, except rock, are included.

List of First Contractors on Main Channel of the Sanitary District of Chicago.

Section.	Material.	Contractor.	Post Office Address.
O	Earth	McMahon and Montgomery Co. et al.	425, N. Halsted-st., Chicago.
N	,,	Hayes Bros. et al.	32nd-street & Maplewood-ave., Chicago.
M	,,	The Heidenreich Co.	541, Rookery building, Chicago.
L	,,	Ditto.	Ditto.
K	,,	Christie and Lowe	543, N.Y. Life Building, Chicago.
I	,,	Ditto.	Ditto.
H	,,	Gahan and Byrne	4209, S. Halsted-st, Chicago.
G	,,	Ditto	Ditto.
F	,,	Weir, McKechney, and Co.	Summit, Illinois, & 288, E. Ohio-st., Chicago.
E	,,	Angus and Gindele	Summit, Illinois, & Security Building, Chicago.
D	,,	E. D. Smith & Co.	Romeoville, Illinois.
C	,,	Western Dredging and Improvement Company.	Summit, Illinois.
B	,,	Heldmaier and Neu	Mount Forest, Illinois.
A	,,	Ditto	Ditto.
1	Earth and rock	Griffiths and McDermott	40, Lakeside Building, Chicago.
2	,, ,,	McArthur Brothers	820, W. C. T. U. Temple, Chicago.
3	,, ,,	Gilman and Co.	P.O. Box 118, Willow Springs, Illinois.
4	,, ,,	McArthur Brothers	820, W. C. T. U. Temple, Chicago
5	,, ,,	The Qualey Construction Co.	Sag Bridge, Illinois.
6	,, ,,	Mason, Hoge & Co	Romeoville, Illinois.
7	Rock	Ditto	Ditto.
8	,,	Mason, Hoge, King, and Co.	Ditto.
9	,,	Halvorson, Richards, and Co.	Lemont, Illinois.
10	,,	E. D. Smith and Co.	Romeoville, Illinois.
11	,,	Mason, Hoge, & Co.	Ditto.
12	,,	Ditto	Ditto.
13	,,	Ditto	Ditto.
14	,,	Smith and Eastman	Lockport, Illinois, and 302, First National Bank, Building, Chicago
15	,,	Wright, Meysenburg, Sinclair, and Carry	1219, Monadnock Building, Chicago

The great interest that attaches to the Chicago Drainage Canal is to be found in the means adopted by the different contractors for its execution, and which varied on almost all the sections, while in every case the practice showed wide departures from the methods followed in Europe, and the experience gained will undoubtedly be of great value in the execution of other similar works. The two elements of time and cost, are above all others of importance, and a comparison between what has been done at Chicago, with similar works elsewhere, under these headings, cannot fail to be of interest. As bearing on this part of the subject we publish a diagram, Fig. 28, showing the amount of work that had been completed on January 1, 1896, and remained to be completed; the prices given in this diagram are in dollars. Figs. 29 and 30, on page 98, show the canal in a rock cutting, and one of the means employed for removing the spoil by haulage and winding engine.

(*To be continued.*)

LITERATURE.

The Gas and Oil Engine. By DUGALD CLERK. Sixth Edition. London, New York, and Bombay: Longmans, Green, and Co., 1896. [Price 15s.]

THE author of this work comes before us in a double capacity. Not only is he a scientific man, an authority on the theory of the gas engine, whose experiments have greatly advanced our knowledge of the phenomena of explosion and combustion in gases, but he is also a practical engineer. The main object of his book is to teach, not to exhibit a complete list of the numerous gas engines which have appeared during the last quarter of a century. The process of elimination is, perhaps, carried a little too far, but it is a good one to work from. As the book is intended to be useful to engineers, the engines are described from a practical and technical point of view, and actual tests are recorded, their results compared with theory, and the differences noted. The author has retained the whole of his former book, without alteration, as the first part of the present edition, thus keeping it in the form in which it has already become familiar. The developments of the gas engine since 1886, and especially of the oil engine, are treated in the second and third parts, which break wholly new ground. Mr. Clerk has not contented himself with a description of the newer engines, but has criticised their defects, and pointed out the way to remedy them.

Three periods may be distinguished in the history of the gas engine, marked roughly by the dates 1680-90, when Papin and Huyghens designed the first explosive engines; 1860, introduction of the first practical working gas motor by Lenoir; and 1876, when Otto brought out his engine, in which the gas and air were compressed previous to ignition. The latter has remained the general type of modern gas motors. Professor Witz divides their history into the periods of invention, of application, and of general extended use, especially of large power engines. Successive improvements have been made in the Otto engine, partly by the inventors, partly by Messrs. Crossley in England. Attempts have not been wanting to remedy its radical defects, namely, want of power due to one motor stroke in four, and insufficient expansion of the gases, which are discharged at a pressure admittedly much too high. To obviate these inconveniences, two-cycle and six-cycle engines have been introduced, including Mr. Clerk's own two-cycle motor; but although many of these are excellent in design, and theoretically more perfect than the Otto, none have succeeded in displacing it. All attempts to depart from the type indicated in outline by Beau de Rochas in 1862, and adopted, developed, and worked out by Otto, have hitherto failed.

The first part of Mr. Clerk's book has been long before the public. In it he briefly reviews the progress of the gas engine while still in the experimental stage, and traces its development from Papin, 1680; Street, 1794; Brown, 1826; and Barnett, 1838, in whose engines many modern ideas were foreshadowed. He omits all mention of Lebon, the French engineer, whose suggestions, about the year 1800, were so greatly in advance of his age, and who was the first to advocate compression of the gases before ignition. The Lenoir and Hugon, and the curious atmospheric engine by Barsanti and Matteucci, inaugurated the period of practical application. The method in these and all other gas engines is that the working fluid, with the heat it contains, is rejected, and replaced "by a fresh portion taken from the atmosphere at the atmospheric temperature, which is the lower limit of these engines. This is the reason why these cycles can be repeated with almost indefinite rapidity, and why gas engines can be run at speeds equal to steam engines, while the old hot-air engines could not be run fast, because of the very slow rate at which air could be heated and cooled by contact." But this process is now recognised as exceedingly wasteful, and it is one of the chief objects of engineers to provide some means by which the heat shall be economised, instead of wasted.

In the theory of the gas engine, and study of the phenomena produced by ignition of the gases, the author is on ground he has made his own, especially in his valuable tables of theoretic efficiency, but he does not draw a sufficiently clear distinction between the various efficiencies. Nor does he lay down with certainty whether a gas engine cylinder should be kept hot or cold. If it is as cold as the surrounding air, much heat will be lost by the cooling of the gases; if it is kept hot, the range of temperature will be small and the efficiency less. Modern research, especially the experiments of M. Richard, have shown that a certain quantity of heat must in any case be wasted. If more be lost to the water jacket by cooling the cylinder, less will escape with the exhaust; while if the cylinder be kept very hot, the heat, instead of passing into the jacket, will be discharged with the gases of combustion. In Professor Hartmann's experiments on oil engines at Berlin in 1894, it was found that when a large quantity of water was passed through the cooling jacket, in other words, the cylinder was too much cooled, the efficiency of the engine was reduced. This was also confirmed by M. Ringelmann's trials.

Although many experiments have been made on combustion and explosion of gases since Mr. Clerk's, none have surpassed them in care and accuracy, but his theory of dissociation has been refuted by Witz, Slaby, and others. He examines carefully the reasons for the fall in pressure of an explosive gas. "Nearly one-half of the heat present," he says, "as inflammable gas in any mixture, true or dilute, is kept back and prevented from causing the increase of pressure to be expected from it. Although differences of opinion exist on the cause, all physicists are agreed on the fact; they also agree in considering that inflammation is complete when the highest pressure is attained." He considers that the portion of gas in contact with the cold walls of a gas engine cylinder will be colder than that existing at the centre. Dr. Slaby's experiments have shown that the speed of the engine, or, in other words, time, has a great influence on the heat efficiency of a gas engine, but the subject is still obscure. The indicator diagrams can only show approximately the variations in temperature due to pressure. It is now known that all the heat is not evolved at once, and hence the value of the entropy diagrams lately published by Professor Boulvin, Captain Sankey, and others, to study the movements of heat in a gas engine cylinder.

Mr. Clerk next passes some of the principal gas engines in review, beginning with the Lenoir, and to illustrate each type, one is selected and thoroughly described. He gives an interesting account of several of the now obsolete atmospheric motors, and of the Brayton and Simon, with combustion at constant pressure, a type which has several advantages in theory. The Otto, Clerk, and Atkinson engines are described, and a chapter is devoted to igniting arrangements. Practically in England hot tube ignition is the only method now used for firing the gases. In the first part of the book a paper is incorporated, read by Mr. Clerk before the Institution of Civil Engineers in 1882, on the "Theory of the Gas Engine." It would be much easier for the student to follow the subject if this chapter were placed after Chapter VI., "On Explosion of Gaseous Mixtures," instead of being interposed between a study of starting gear and the "Future of the Gas Engine." Mr. Clerk's object is, of course, to present the first edition of his book consecutively as Part I., but as the order is already broken by introducing this chapter, there seems no reason why it should not have come after the theoretical part, and the whole subject be thus presented to the reader at once. The author's remarks on the "Future of the Gas Engine" should be compared with Mr. Atkinson's paper on the same subject, read before the Institution of Civil Engineers. "Practically," Mr. Clerk says, "the compression gas engine at present converts [into heat] half of what theory allows; therefore with the greater expansion it may be expected to give half of 50 per cent., that is, expansion only will raise the practical efficiency from 18 per cent. to 25 per cent." Mr. Atkinson claims to have demonstrated that greater economy, and a nearer approach to theoretical efficiency, may be obtained by improving the purity of the charge, that is, by scavenging the cylinder of the gaseous products before introducing the fresh mixture. Mr. Clerk is, however, of opinion that at present no means exist of checking to any large extent the loss of heat to the jacket, which carries off from 40 to 50 per cent. of the total heat evolved.

In Part II. the author considers the gas engines produced since 1886. During the last decade the Otto patent has expired, and a great impulse has thus been given to the manufacture of gas engines. Nine-tenths of these motors working in England and on the Continent use this cycle, and many firms formerly manufacturing engines of a different type, have adopted it exclusively. In one respect this is a disadvantage. For large engines it appears to the author that "the Otto cycle is inherently defective, and he still considers impulse every revolution, or two impulses per revolution, as much preferable, and as certain to prove the type of the future for really large power engines. It is, therefore, much to be regretted that for the present engineers have practically ceased their efforts in the direction of more frequent impulses, and have devoted themselves entirely to the development of the Otto type." The disappearance of the Clerk and Atkinson engines is certainly a matter for regret, and the same may be said of some foreign motors. In the later Atkinson type the four-cycle was adopted, but greater expansion was obtained by means of a link and toggle motion. The Campbell, Trent, Midland, Day, Fawcett, and Acme engines had all originally a separate pump or arrangement of the stroke to compress the charge before ignition, and obtain an impulse every revolution, but all these engines have either been remodelled on the Otto type, or withdrawn. Mr. Clerk describes with excellent drawings the Crossley-Otto, now one of the leading types in England, and gives a description of the new Crossley-Atkinson scavenging engine, on which he made a trial in 1894. In a 4 brake horse-power engine the consumption of Manchester lighting gas was reduced to 17 cubic feet per brake horse-power hour; and in a test made by the inventor, Mr. Atkinson, on a scavenging engine indicating about 47 horse-power, it fell to 13.55 cubic feet per indicated horse-power hour. Mr. Atkinson attributes this economy wholly to the purity of the charge, but the author considers that the greater compression obtained has much influence on the result. Other engines using the Otto cycle are the Stockport, Barker's, Tangye, Burt's, Robey, Wells, and Fielding and Platt.

With the introduction of large power engines a demand arose for a cheaper gas to drive them than town gas, though for engines under 15 to 20 horse-power no better power agent than lighting gas can be desired. The Dowson generator has the disadvantage of requiring anthracite to feed it; with coke its performance is not, in the author's opinion, entirely satisfactory. The gas produced is a mixture of CO, H, and N, and a small unavoidable quantity of CO_2; it is also fairly rich in marsh and olefiant gas. The Lencauchez producer, which makes gas from small and poor coal, is much used with the "Simplex" engine in France, where anthracite is dear and difficult to obtain. The author thinks, however, that "with such fuel it will be found that the system of destroying the tar and coking the fresh fuel is not sufficiently perfect, and that dirtier gas of irregular composition will be fed to the engine." Other producers he dismisses in a few words, as they are all more or less of the Dowson or Lencauchez type.

A valuable chapter on the progress made, and the present position of gas engine economy, completes this part of the book. Taking the Crossley-Otto as a standard of comparison, Mr. Clerk shows that in 1882 an engine of this type gave a consumption of 23.7 cubic feet of lighting gas per hour per indicated horse-power, and a heat efficiency of 17 per cent. In 1888, at the Society of Arts' trials, this engine consumed 20.55 cubic feet of London gas per indicated horse-power hour, with a heat efficiency of 21 per cent., while in 1894 a 12 brake horse-power engine gave 14.5 cubic feet of gas per hour per indicated horse-power, and a heat efficiency of 25 per cent. All this additional economy he attributes to increased compression, the pressure having risen from 38 lb. above atmosphere in 1882 to 61 lb. in 1888, and 87 lb. in the latest type. Even in the new scavenging engine he credits only 5 per cent. of the economy obtained to the induced current of fresh air, and the rest to increased compression. In proof of this assertion he cites experiments made by Mr. Bellamy on an engine with two different compression chambers successively applied, showing with a compression of 60 lb. per square inch a consumption of 19 cubic feet of lighting gas per indicated horse-power hour, and with 90 lb. compression a consumption of 17.6 cubic feet of the same gas per indicated horse-power hour. Other things being equal, the efficiency of an engine may be raised by increasing the dimensions, but not the ratio of the compression space. Mr. Clerk is of opinion that the limit of useful compression is considerably below 200 lb. per square inch, and has already been nearly reached, efficiencies of 45 per cent. of the whole heat given to the engine being now attainable by an engineer. In very large gas engines the compound principle, already often attempted but without success, will probably be found desirable.

On the subject of oil motors the author has naturally less to say than on gas engines, which he has studied for many years, but coming from so good an authority, his remarks are worthy of attention. Oil engines are still in their infancy, and have many defects. In the earlier motors air was drawn over a surface saturated with gasoline or other light oil, and a mixture of inflammable vapour and air thus produced; in modern engines heavy lamp oil or paraffin, with or without a vaporiser, is used. The latter system is more common in England, foreign countries still preferring lighter oils to drive engines. Crude American or Russian petroleum, or Scotch shale oil, consist of various hydrocarbons, divided into the paraffin and olefine series. Of these the lightest are marsh gas or methane, which predominates in American oil, and ethylene, forming one of the principal constituents of Russian petroleum. The composition of these oils is very complex, and constitutes the main difficulty in dealing with them. The different constituents are given off according to the temperature, but if a heavy hydrocarbon be exposed to a temperature above its own boiling point, it is cracked, that is, decomposed into lighter hydrocarbons. In this way the heaviest oils may be ultimately split up into marsh gas and solid carbon. The flashing point of ordinary illuminating oil is taken by the Abel test, its specific gravity by a viscometer, and the range of temperature at which it distils off has been determined by Professor Robinson's and Mr. Boverton Redwood's experiments.

Beginning with the Hock (1870) and other early types, Mr. Clerk classifies oil motors according to the quality of the oil used, and the method of preparing it for combustion. At present all petroleum engines are four-cycle. In the Priestman and Samuelson the oil is broken up by spraying it into the combustion chamber, but in most others, as the Hornsby, Trusty, Capitaine, Daimler, and other well-known engines, it is admitted in a liquid state into the cylinder, combustion chamber, or vaporiser, and decomposed by the heat into a highly inflammable gas. Mr. Clerk notices the curious fact that in several oil motors it has been found possible to dispense with an igniting lamp or hot tube, and to fire the mixture of oil vapour and air by the pressure of the compression stroke. Even a gas engine may be made to ignite with great regularity without any form of ignition, "if some portion of the interior surfaces of the cylinder or combustion space be so arranged that the temperature can rise moderately; then, although that temperature may be too low to ignite the mixture at atmospheric pressure, yet when compression is complete the mixture will often ignite in a perfectly regular manner." With heavy oils at a low temperature ignition is more easily obtained than with light oils. In most oil engines, however, though an igniter may be dispensed with, it is found best to maintain the vaporiser at a proper heat by means of a lamp. Care must also be taken to regulate the quantity of air admitted, or premature explosions may occur. The Crossley, Tangye, Fielding and Platt, and other oil engines are described, with good drawings, but it is to be regretted that the author does not bestow the same attention on foreign motors, especially the German, which have made such great advance during the last 10 years. "These are," he says, "without exception, of the ordinary gas engine type, using gasoline or other light oils, which require no special precautions, and are not interesting as bearing on the question of safe heavy oil engines," a point which is at least open to question. Such engines as the Simplex and Koerting ought surely to find a place in any book dealing with gas engines, and the Daimler oil engine, now so universally used, is dismissed in a few lines. Mr. Clerk's method of description is excellent as far as it goes, but it is a great pity he ignores nearly all Continental gas and oil engines.

The last chapter contains some pregnant remarks on the difficulties of oil motors. Foremost among these is that they are not so economical from a heat engine point of view as gas engines, that is, they do not convert so large a proportion of the heat given them into work. On the other hand, their mechanical efficiency is higher. Mr. Clerk considers that electric methods of ignition are very objectionable, and the incandescent tube igniter far preferable. This may be true as long as the engines are stationary and under cover, but during the recent competitive trip of 1000 miles from Paris to Marseilles and back, it was found that the lights were frequently blown out when exposed to a high wind and rain. Unless electricity be used to fire the charge, the shielding of the light is always a trouble in portable oil engines and motor carriages. Of the different types of lamp the author gives the preference to the Crossley. The chief difficulty in all oil engines is the method of treating the oil to make it explosive. The spray system of vaporising is the least desirable, but in all petroleum motors there are troubles in governing, the consumption is relatively high, the pressure comparatively low to avoid premature explosions, and the oil is usually vaporised instead of being gasified, as supposed.

Mr. Clerk is to be congratulated on having produced a scholarly and valuable work, and within the limited space to which he has confined himself the subject is well and thoroughly treated. The book is illustrated by more than 200 engravings, but these, we regret to say, are not so well executed as we should like to see in a work of this class. The typography also leaves much to be desired. In conclusion, we may add that the book has a copious index, and the appendices contain much useful information, including a list of British patents, relating to gas and oil motors, for the last hundred years.

BOOKS RECEIVED.

The Stock Exchange Year-Book for 1897. By THOMAS SKINNER. London: 1, Royal Exchange Buildings. [Price 25s.]

Electric Tramways and Railways, Popularly Explained. By H. SCHOLEY. London: H. Alabaster, Gatehouse, and Co. [Price 2s.]

Colliery Surveying. By T. A. O'DONAHUE, M.E. London: Macmillan and Co., Limited; New York: The Macmillan Company. [Price 2s. 6d.]

The Local Government Annual: An Official Directory, 1897. Edited by S. EDGECUMBE-ROGERS. London: *The Local Government Journal* Office. [Price 2s. 6d.]

The Public Health (London) Act, 1891: *Abstract of the Clauses of the Act (with Index).* London: S. Edgecumbe-Rodgers. [Price 2d.]

A Manual of Elementary Seamanship. By D. WILSON-BARKER. London: Charles Griffin and Co., Limited.

Getting Gold: A Practical Treatise for Prospectors, Miners, and Students. By J. C. F. JOHNSON, F.G.S. London: Charles Griffin and Co., Limited.

The Mechanics of Pumping Machinery. By Dr. JULIUS WEISBACH and Professor GUSTAV HERRMANN. Authorised translation from the second German edition by KARL P. DAHLSTROM, M.E. With 197 illustrations. London: Macmillan and Co., Limited; New York: The Macmillan Company. [Price 12s. 6d. net.]

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

(BY OUR NEW YORK CORRESPONDENT.)

(*Continued from page* 71.)

200-FT. GANTRY CRANE.

MR. JOHN W. LEAVER described a "200-Ft. Gantry Crane" erected by the Wellman-Leaver Engineering Company for the Cambria Iron Company, of Johnstown, Pa.

It consists of two main girders of the Pratt type, with vertical posts and diagonal tension braces, the bottom chord being straight, and the top chord parallel to the bottom chord for about one-half its length, and then inclining to the end posts at such an angle that the depth of truss at the ends is one-half that at the centre. These two main trusses are framed together at an angle of 60 deg. The top chords have their parallel portions connected with splice and tie-plates. The bottom chords are parallel to each other, and separated a distance of 20 ft. The main trusses are 18 ft. deep at centre and 9 ft. deep at the ends.

The illustrations on pages 102 and 103 clearly show the construction of this gantry.

The loads and strains adopted for this crane were as follows: A live load for trolley equal to 20,000 lb. To this was added, for impact, 25 per cent., or 5000 lb. The weight of the trolley was estimated at 23,000 lb.—making a total of 48,000 lb. distributed on four wheels, spaced about 9 ft. centres, bringing a reaction upon each stringer support of 18,000 lb. To still further provide for any sudden application of a live load, it was assumed to be equal to 22,000 lb. applied at any panel point of bottom chord of each truss.

The dead load, weight of trusses and floor, was assumed at 88,000 lb. per truss, or 8000 lb. at every point of bottom chord of each truss.

In order to provide for a very large factor of safety in the bottom lateral system, a wind pressure of 20 lb. per square foot was assumed, or a load of 5000 lb. at each panel point of bottom chord. To resist these combined loads, the following limitations of strains were adopted:

200-FT. GANTRY CRANE; CAMBRIA IRON COMPANY, JOHNSTOWN, PA.

(*For Description, see Page* 101.)

Fig. 11.

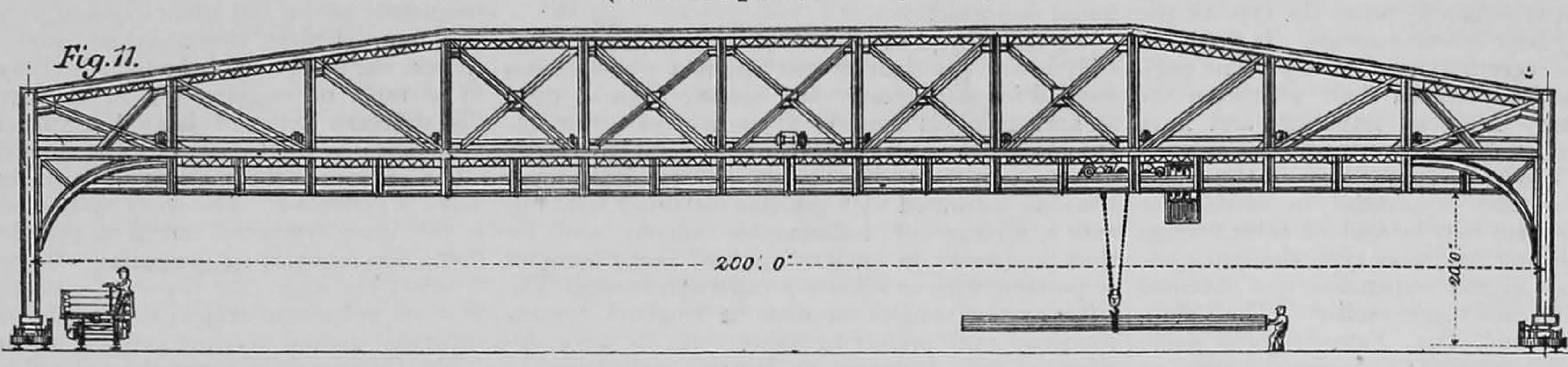


Fig. 12.

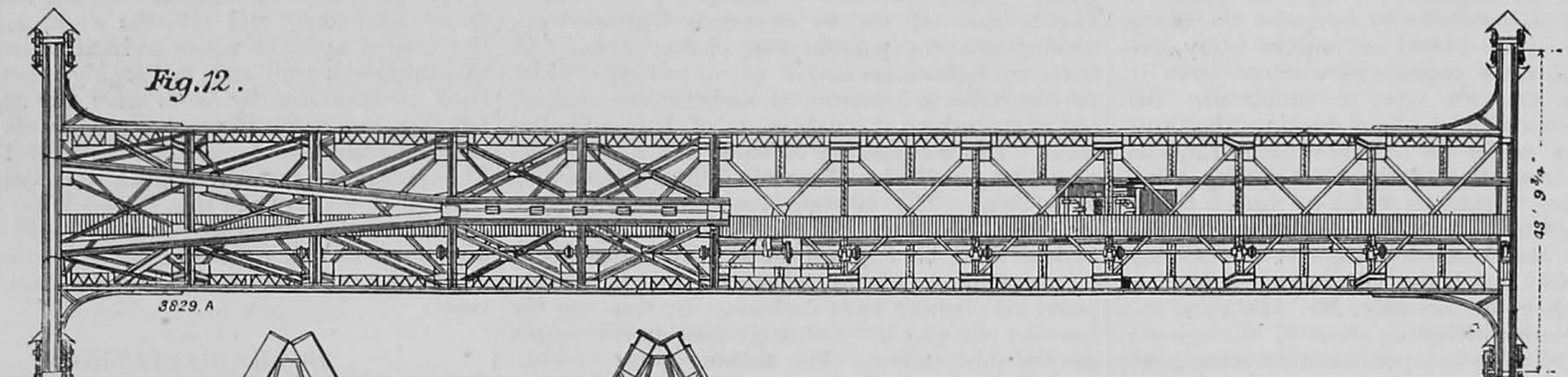


Fig. 13.

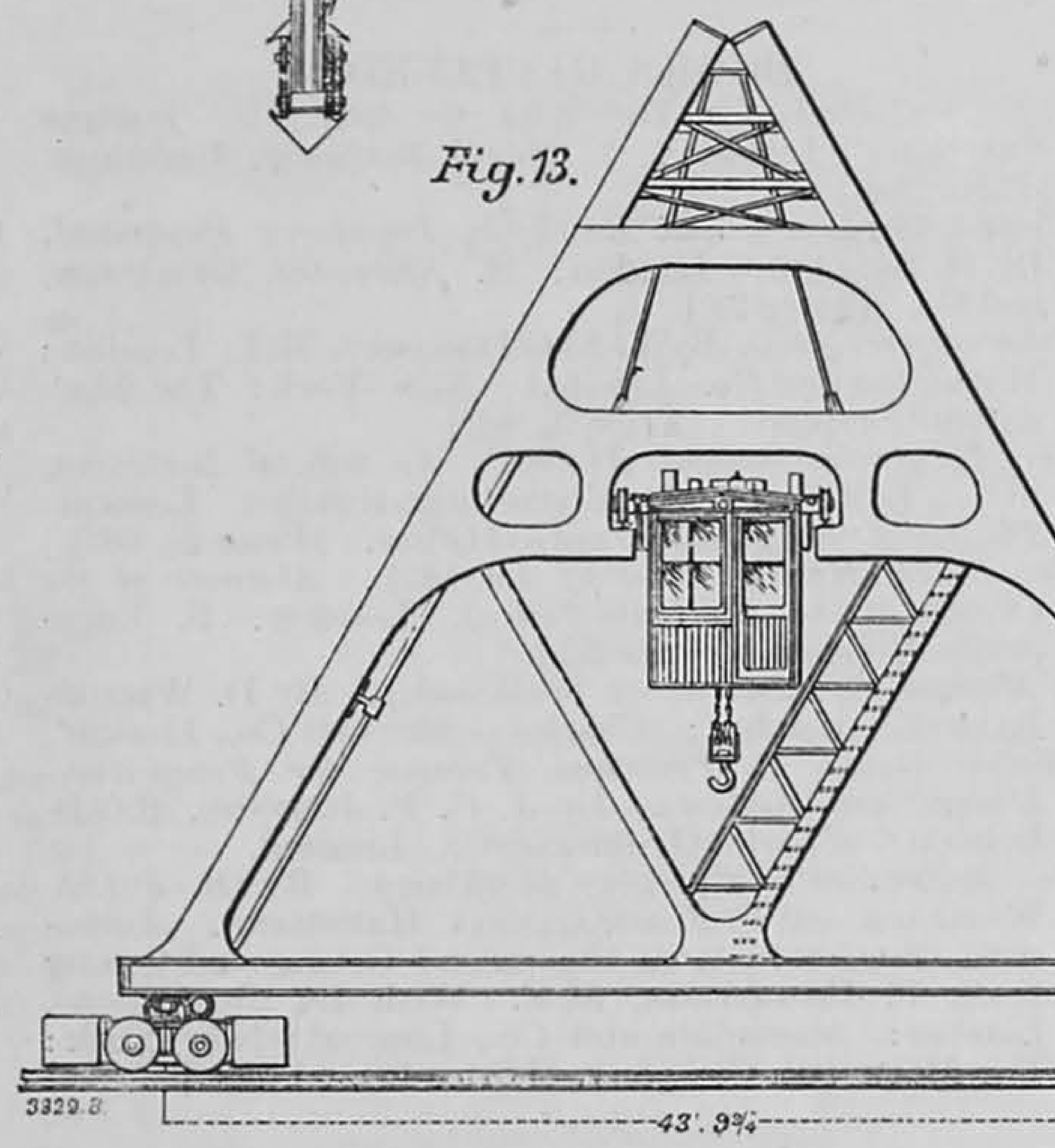


Fig. 14.

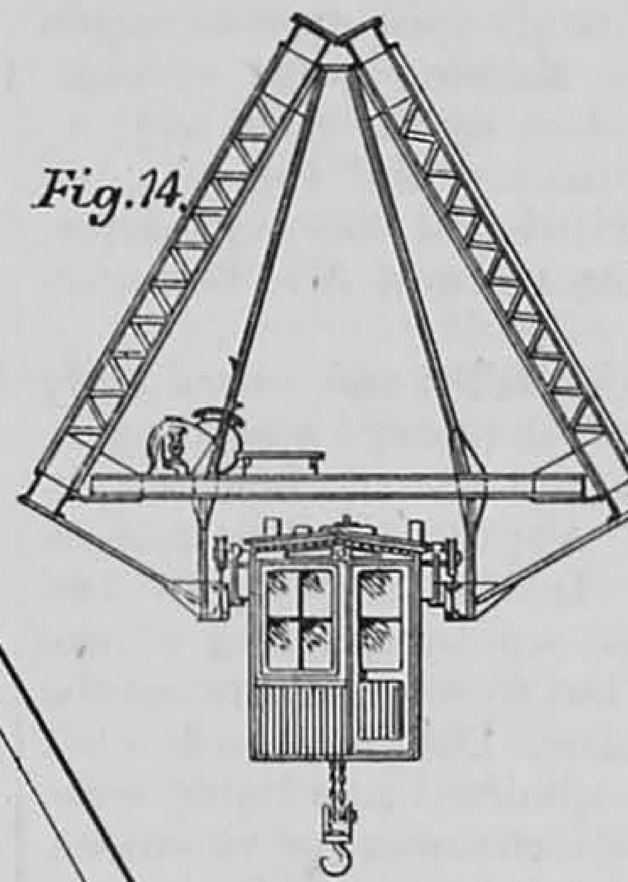
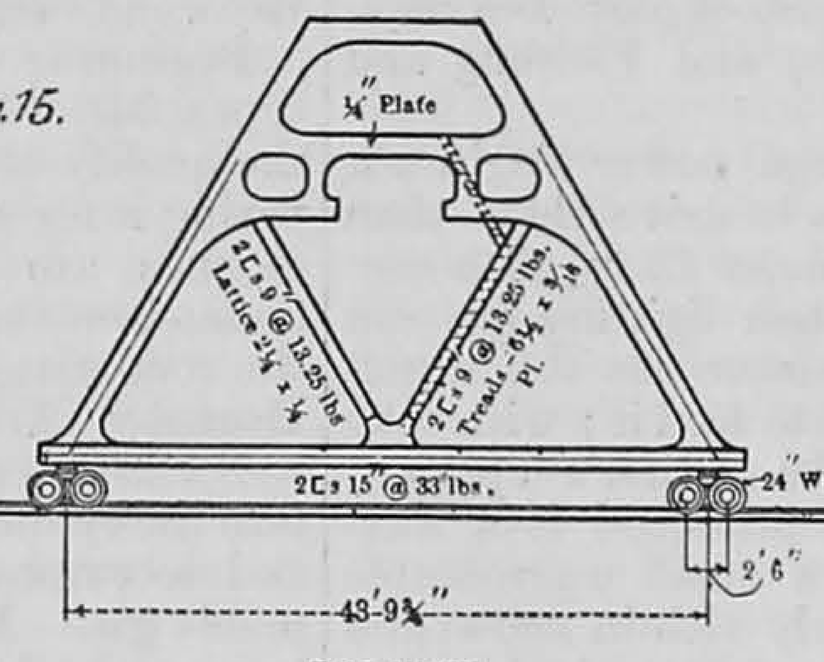


Fig. 15.



END VIEW

Fig. 16.

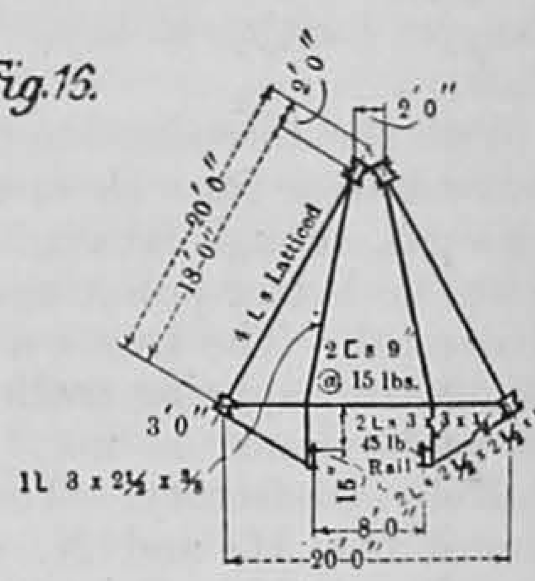
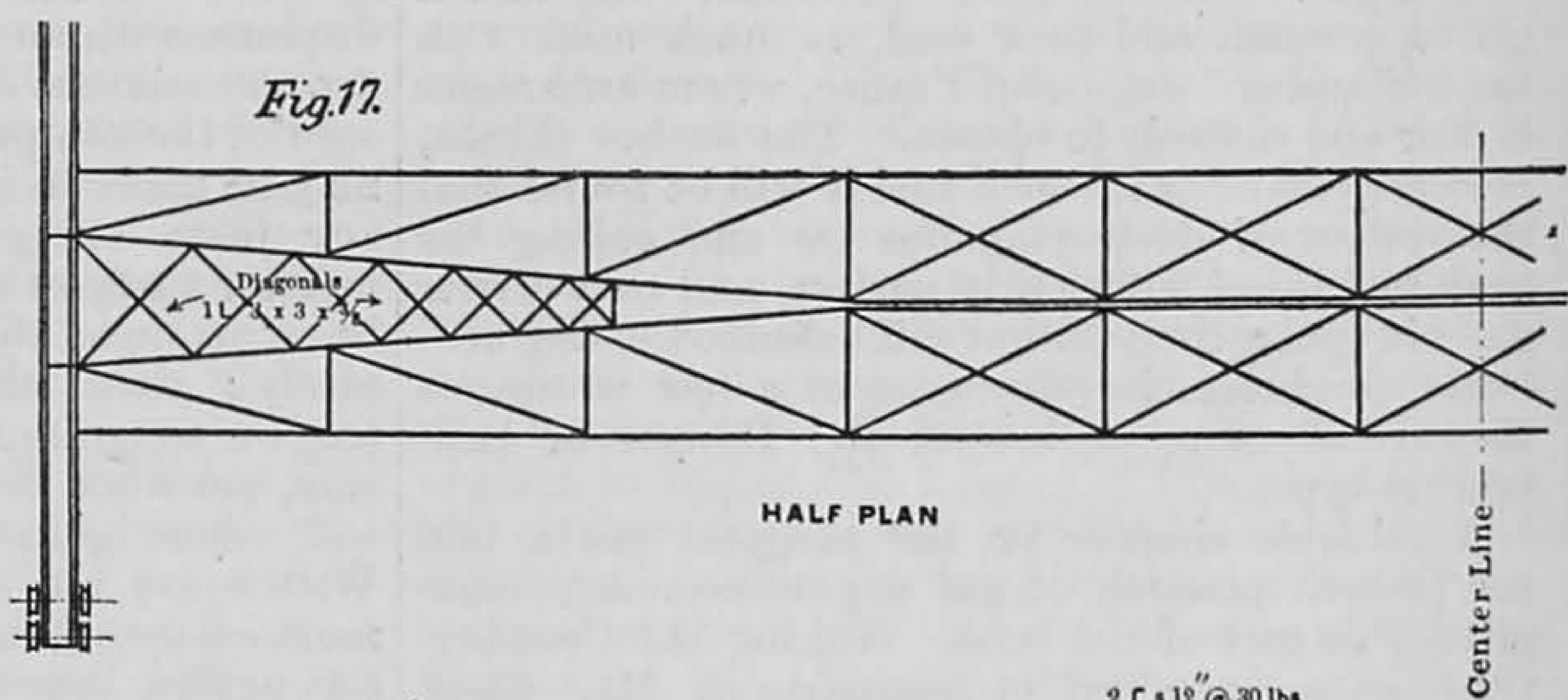
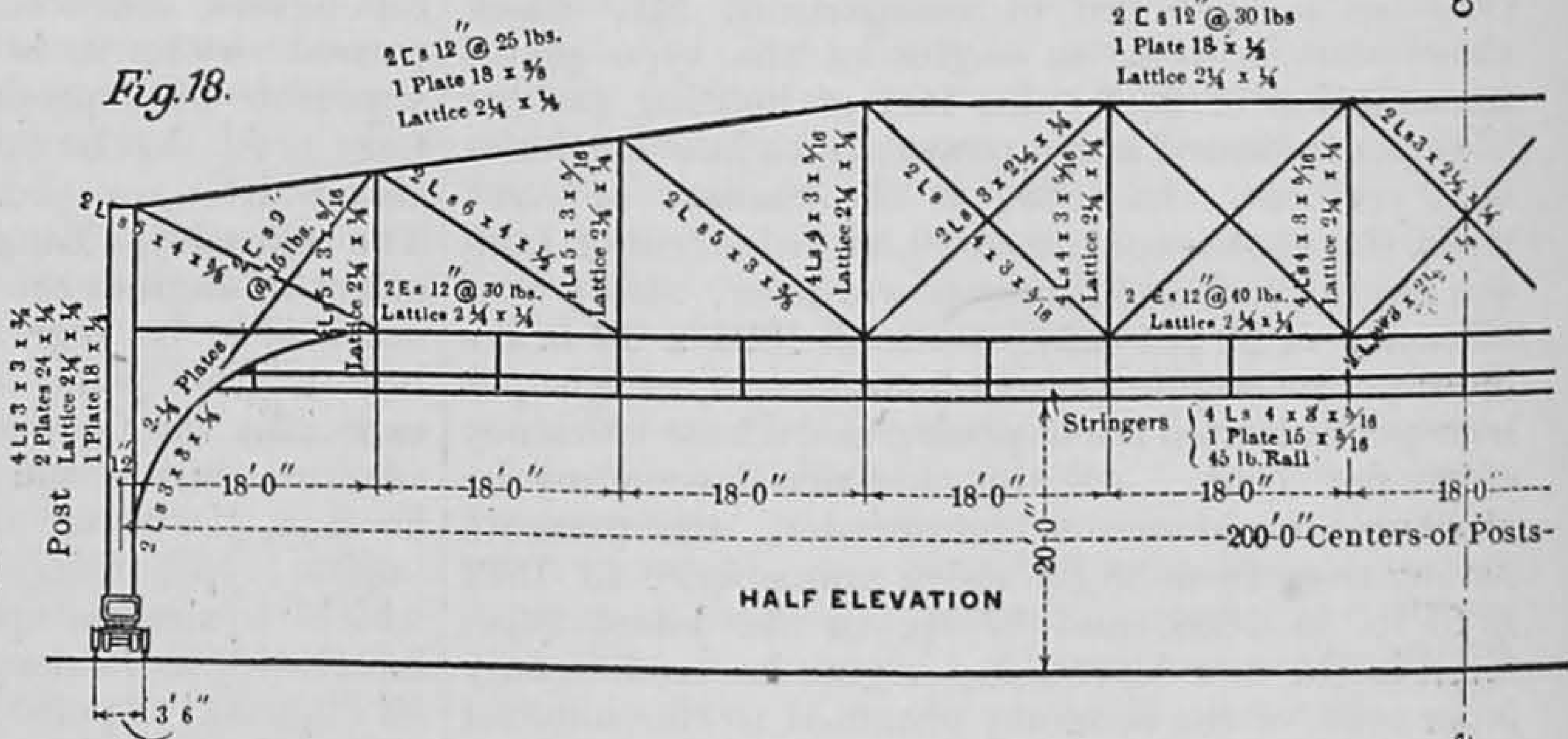


Fig. 17.



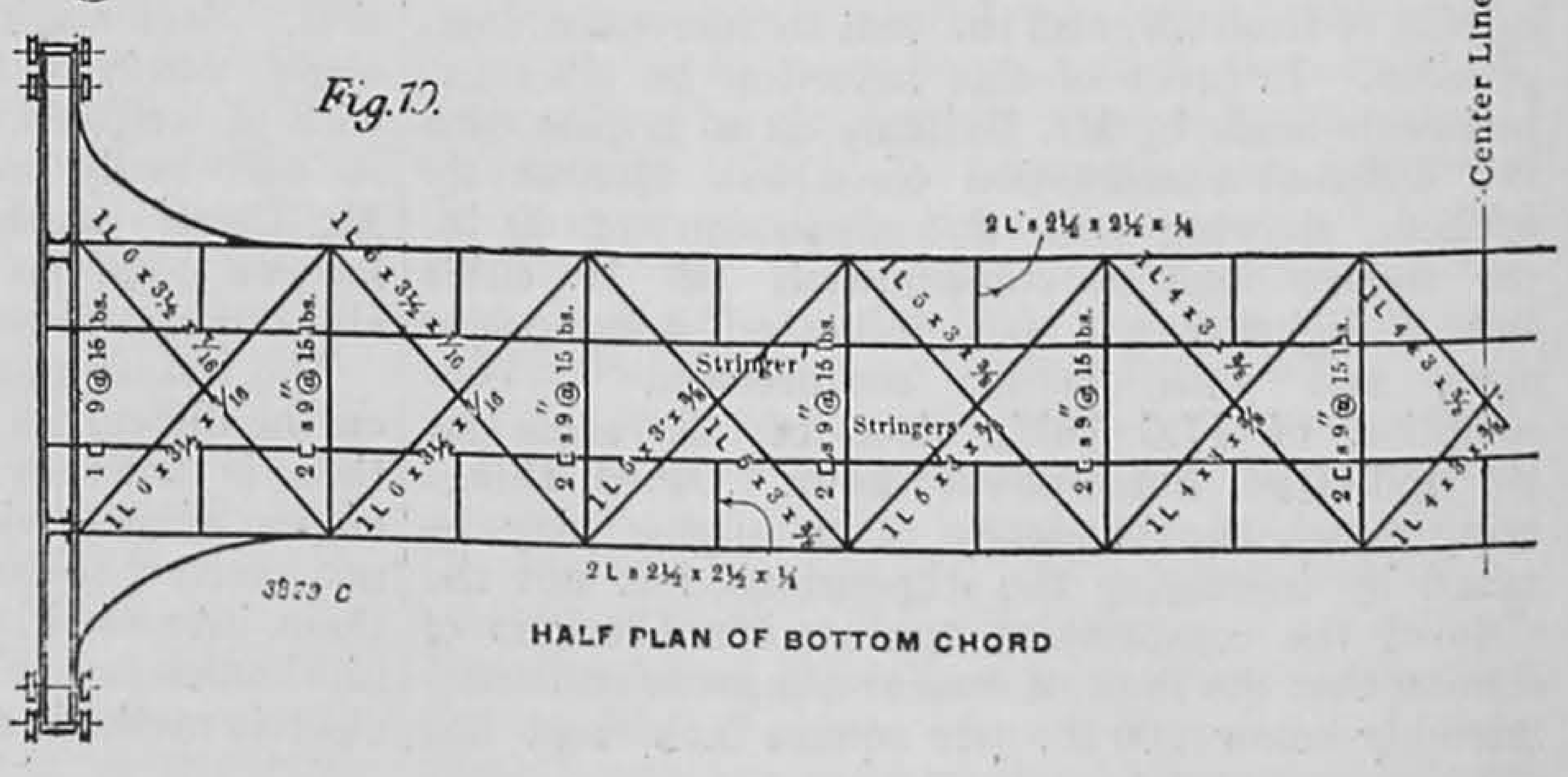
HALF PLAN

Fig. 18.



HALF ELEVATION

Fig. 19.



HALF PLAN OF BOTTOM CHORD

Fig. 20.

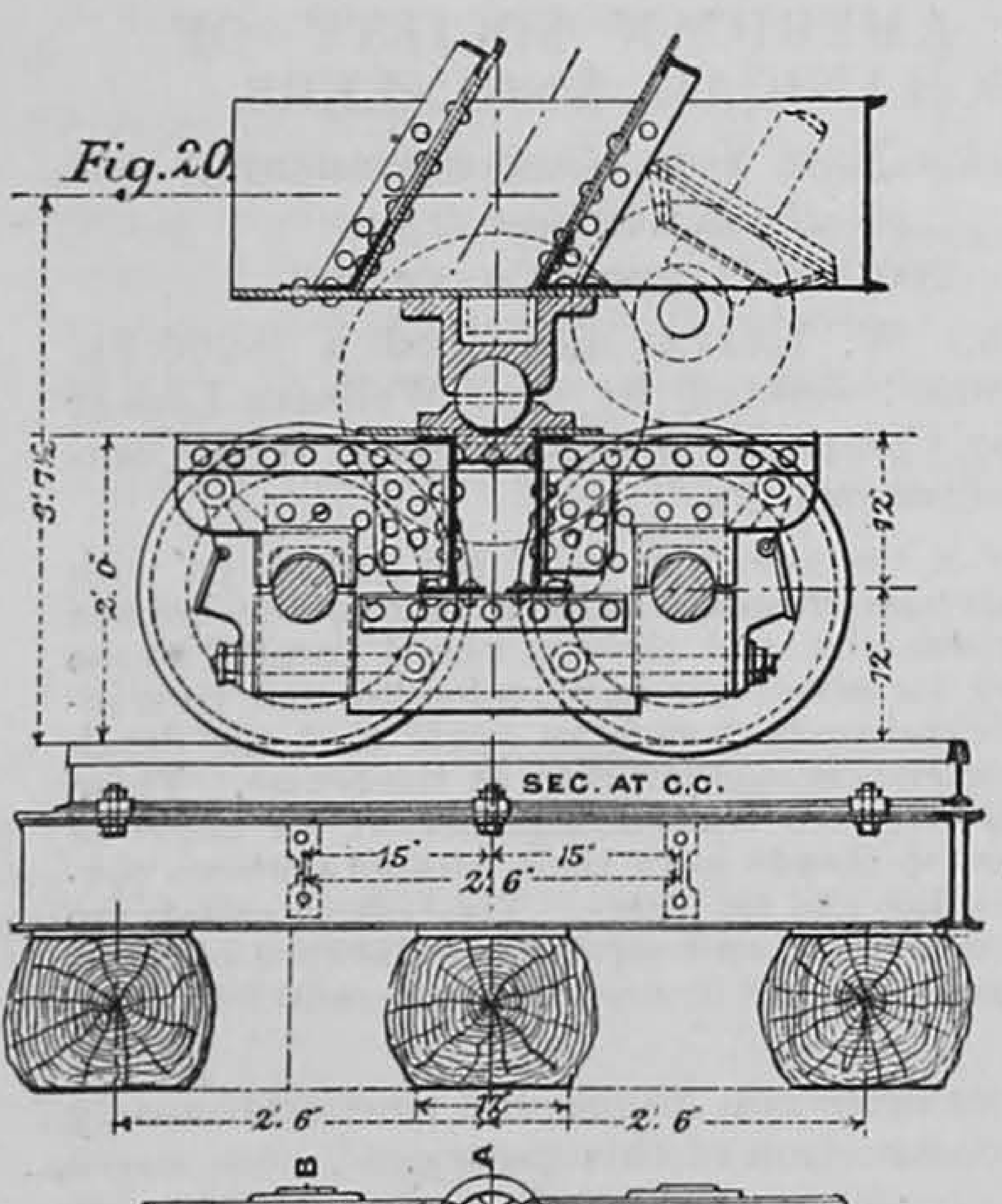


Fig. 21.

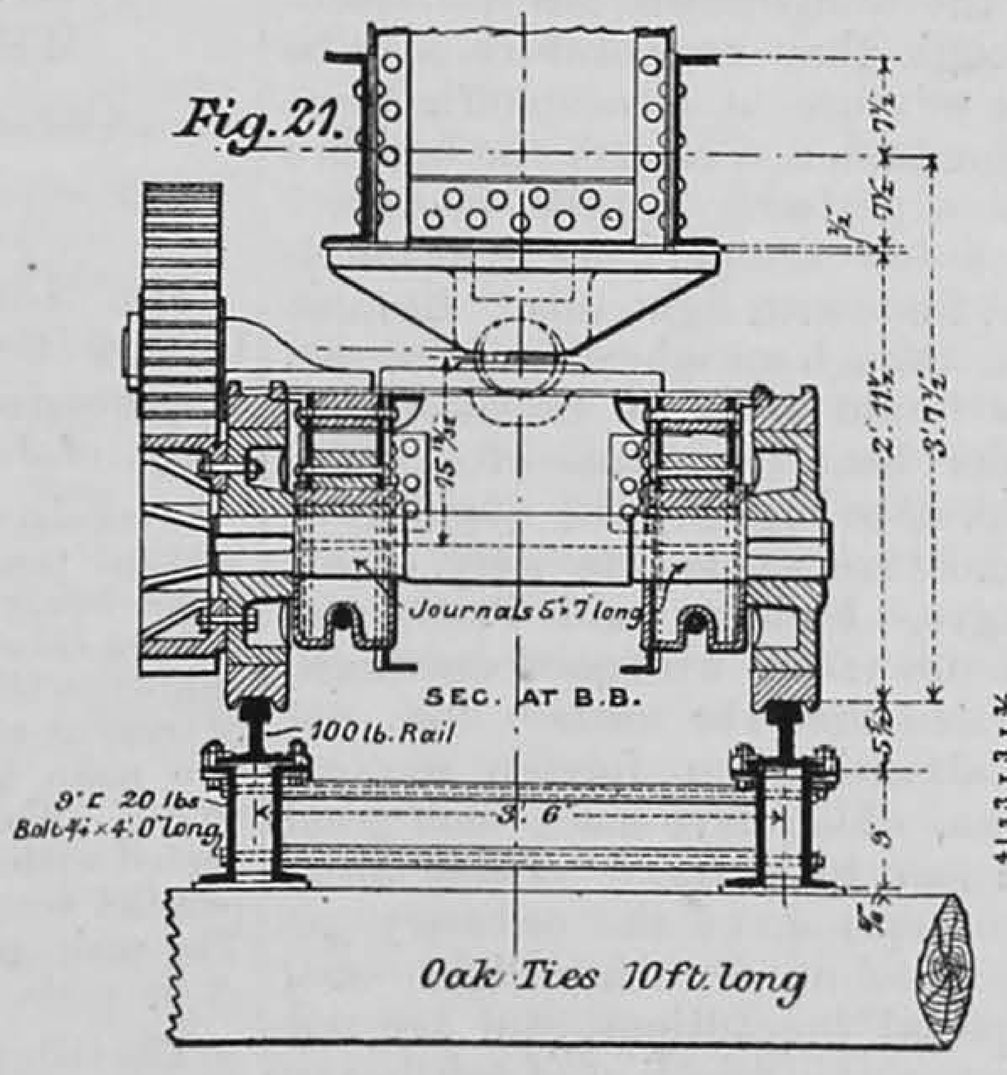


Fig. 22.

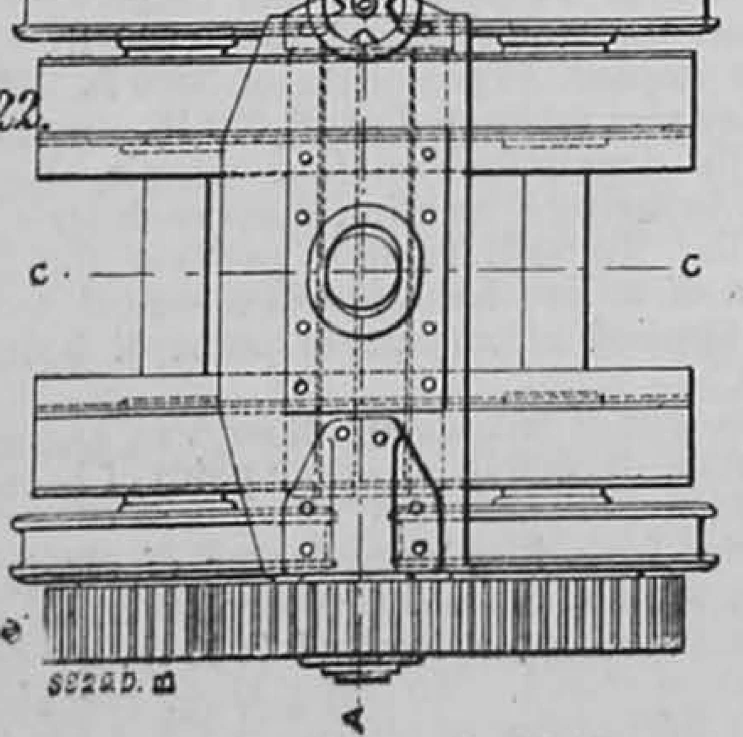
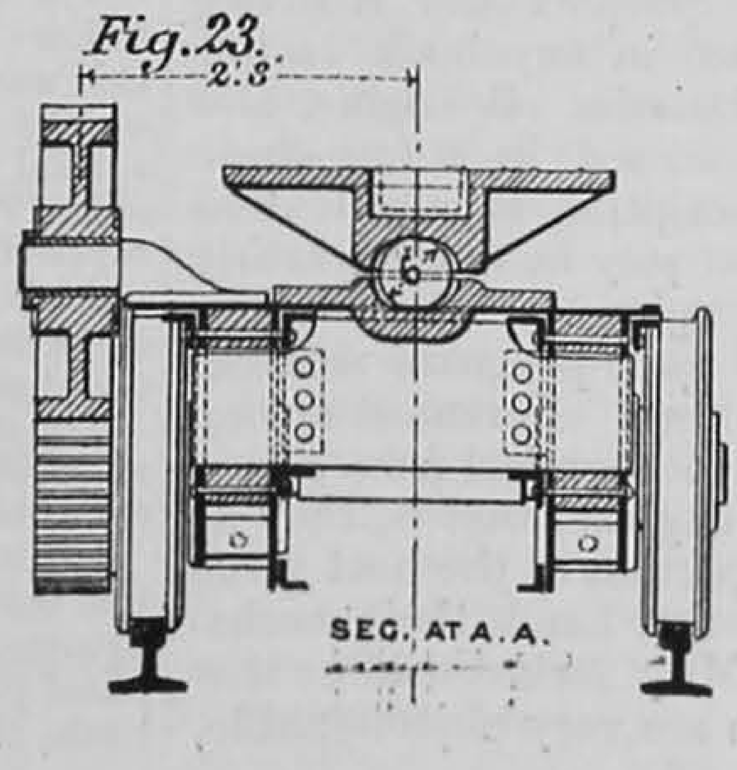


Fig. 23.



200-FT. GANTRY CRANE; CAMBRIA IRON COMPANY, JOHNSTOWN, PA.

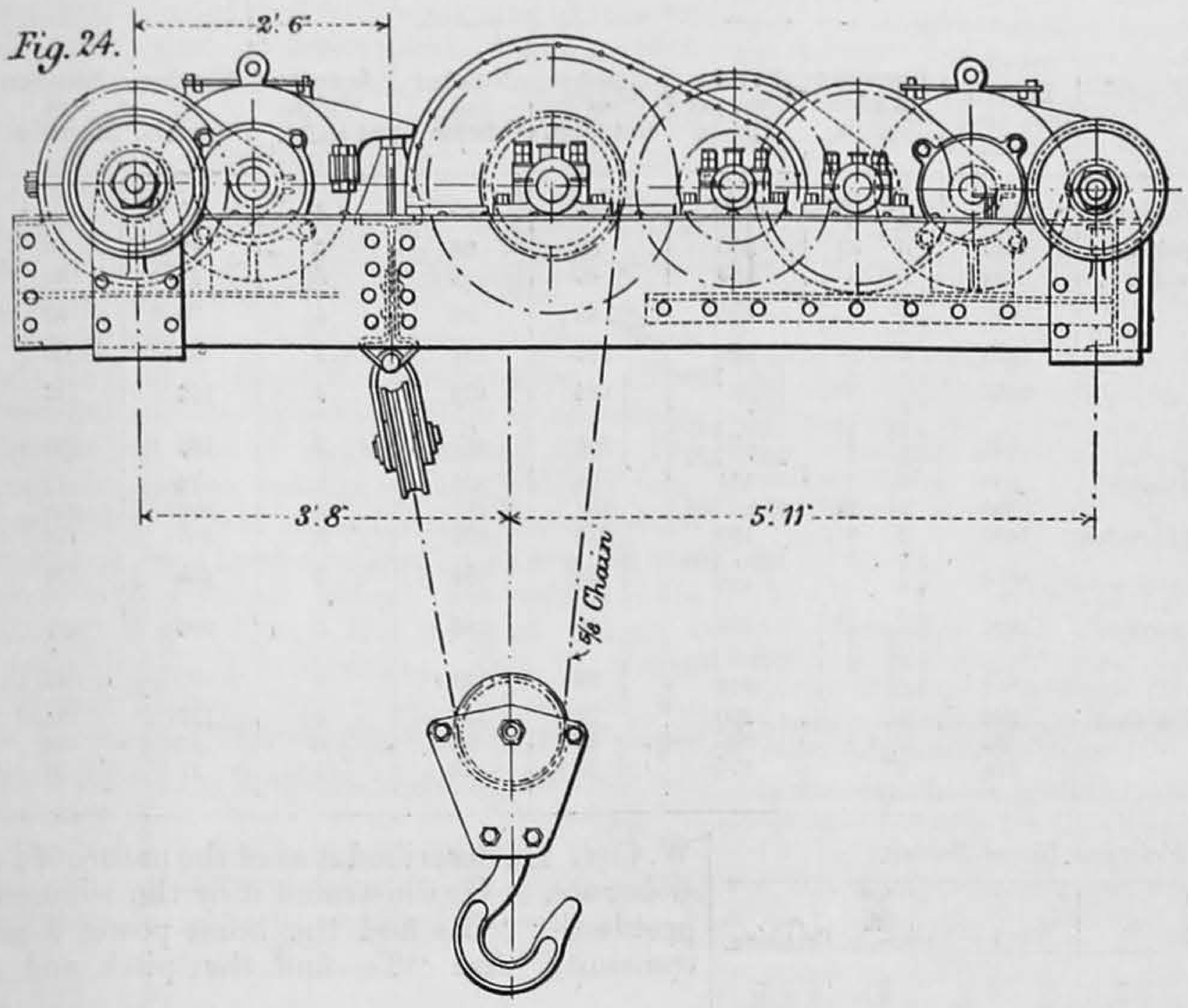


Fig. 24.

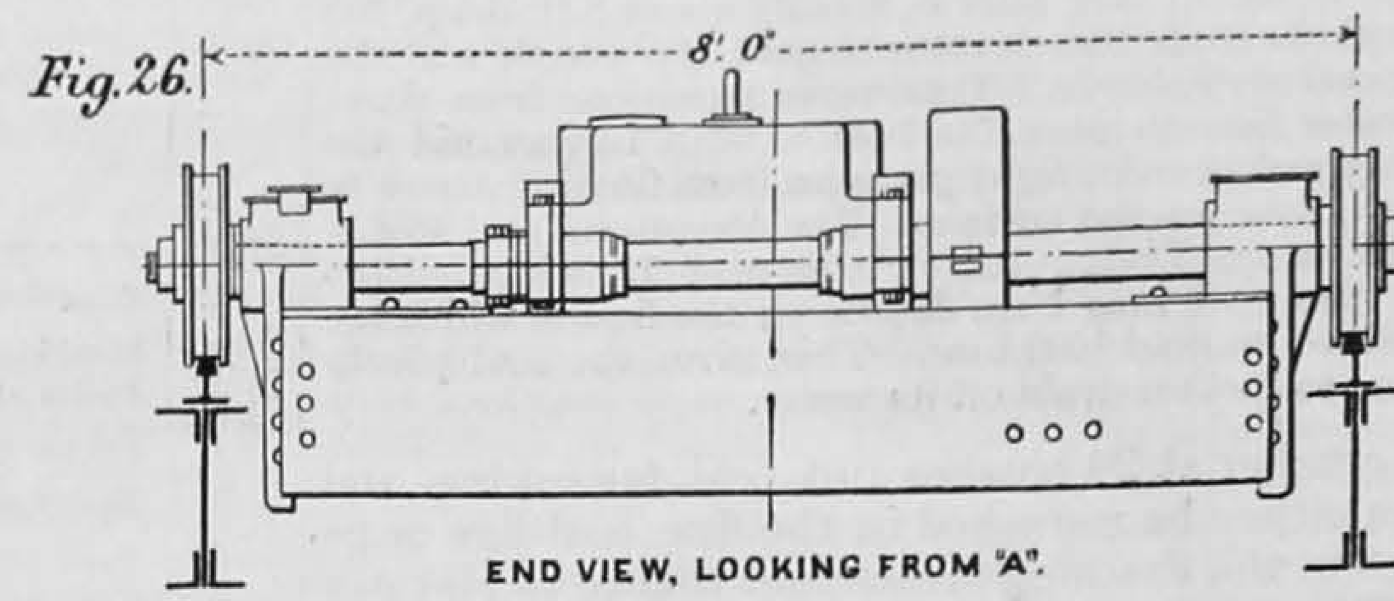


Fig. 26.

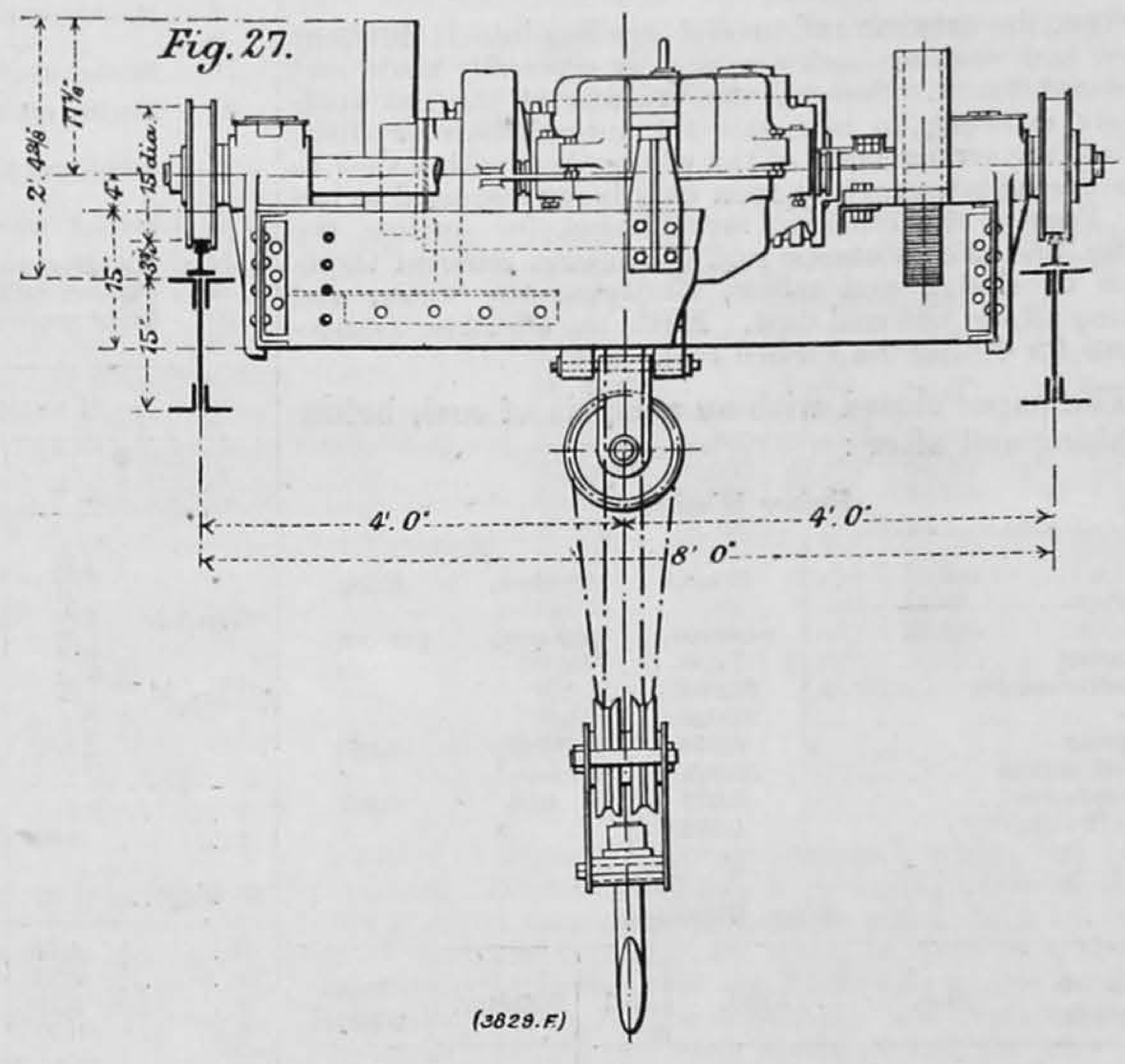


Fig. 27.

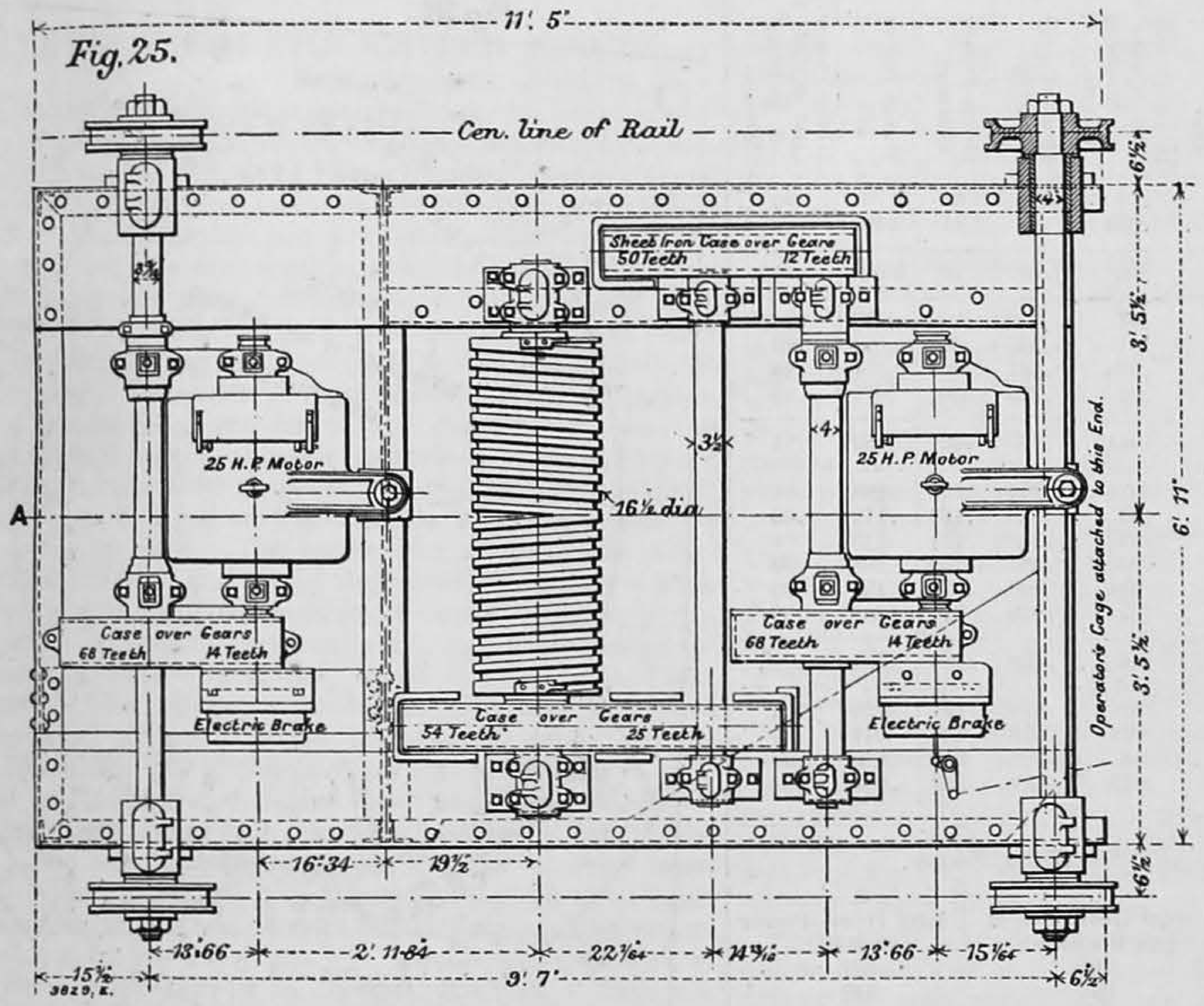


Fig. 25.

For live loads:

Tension	... 12,000 lb.	per sq. in. of net section.	
Shear	... 6,000 ,,	,,	,,
Compression	10,000 ,,	,,	gross section.
Bearing on rivets and bolts	... 12,000 ,,	per square inch.	

For dead load:

Tension	... 15,000 lb.	per sq. in. of net section.	
Shearing	... 10,000 ,,	,,	,,
Compression	12,000 ,,	,,	gross section.
Bearings on rivets and bolts	... 15,000 ,,	,,	

In all the compression members a proper reduction of the strains was made in all long members, so as to insure the same general factor of safety throughout, and the strains in the bottom lateral system were still further reduced to 10,000 lb. per square inch in tension and 8000 lb. per square inch in compression.

The writer stated that the strains were largely in excess of those he would recommend for ordinary crane construction. The crane is very completely illustrated by the figures on this and the opposite pages.

The minimum speeds of the various motions of the crane are as follows:

	ft. per min.
Traverse of main bridge	200
,, trolley	400
Hoist with full load	20

The top of each truck carries a steel socket or cup, and in this socket is placed a hard steel ball, 6 in. in diameter. The bottom of the end supports are also provided with corresponding cupped sockets. The ball rests in a slightly elongated groove, the major diameter of the groove being crosswise to the centre line of the truck, and the minor diameter being parallel to the track on which the truck rests. By means of this elongation of the groove, the ball is allowed a slight motion at right angles to the centre line of the track on which the truck travels, and this permits of the expansion and contraction of the main girders of the crane. It also allows the trucks upon which the crane travels to be slightly out of alignment, as the balls form universal joints between the trucks and the crane. The arrangement of the gearing connecting the driving shafts to the trucks is such that the vibrations of the trucks around the centres of the balls do not disturb the alignment of the gearing to an appreciable amount, as the centres of the main driving spurwheels are on the same lines as the centres of the balls.

A 50 horse-power electric motor in the centre is connected directly to the main shaft with one reduction of steel gearing, while two 25 horse-power electric motors do the traversing of the trolley and the hoisting. All the motors are wound for 220 volts. There was little discussion on this paper, but the opinion seemed to be it was well adapted for its purpose.

WASHING BITUMINOUS COAL.

"The Washing of Bituminous Coal by the Luhrig Process" was the next paper. The author was Mr. J. V. Schaefer. After referring to the conditions of the coal and its impurities, Mr. Schaefer described the apparatus. The coal, crushed to the nut size, flows from a 500-ton bin into elevator 1 (see illustrations on page 99), which takes the raw coal to the top of the washery.

This elevator delivers to the triple-jacketed screen 2, which is approximately 15 ft. long by 8 ft. in diameter, and grades all the coal into four sizes, Nos. 1, 2, and 3 nut, and fine coal. On the third floor of the building are six nut-coal jigs, two for each of the three sizes of nut coal. These jigs are so adjusted that only the very clean nut coal goes over as coal, and is sluiced to the draining screen 3. This screen has ⅜-in. openings, thoroughly drains the coal, and delivers it into elevator 4. This elevator runs slowly, and has perforated buckets so as to further drain off the water and deliver the coal into the washed coal storage bins as dry as possible.

All material going into the nut-coal jigs that does not flow out as clean coal passes out on a lower level as refuse. This refuse is automatically collected by a screw conveyor 5, and delivered to the perforated bucket elevator 6, which lifts it out of the water and delivers it to the crusher 7.

It is then raised from the crusher by elevator 8 to screen 9, where it is again graded and then rewashed in two special feldspar rewashing jigs 10. The cleaned coal flows into the perforated bucket elevator 11, and, after draining, falls into bin 12 to be used for fuel. The advantage of washing before crushing is to get rid of the impurities. Sectional views are shown on page 99, with reference numbers.

The fine coal passing through the openings in the outer jacket of screen 2 is met by the stream of water from the draining screen 3 and washed into the hydraulic grading box 13. This is a V-shaped box having six compartments corresponding to the six fine-coal jigs. Herein the fine coal automatically grades itself into six different sizes. Each of these sizes is washed by itself in one of the six feldspar jigs 14. All jigs are driven by adjustable eccentrics, so that they may be very accurately adjusted to wash the particular size and kind of material which goes to them. The clean coal from the fine-coal jigs 14 is sluiced to the draining screen 15, having ¼-in. openings. From here the coal passes to elevator 4. The water and fine coal dust passing through the openings of this screen flow to the sludge elevator 16. The final refuse from the fine-coal jigs 14, and from the rewashing jigs 10, passes to the final refuse elevator 17. This delivers it to a bin from which it is drawn from time to time and carted to the dump.

The elevator 17 has perforated buckets. Its foot rests in a V-shaped water-tight box. Lying full length along the bottom of this box is a screw conveyor. The water carrying refuse is discharged directly into the buckets of the elevator, so as to catch as much of the refuse as possible. What flows over with the water settles gradually to the bottom and is taken to the elevator by the screw conveyor. The water overflows at the farther end of the box into the pump tank, to be used over again. The water from the fine-coal draining screen 15 flows in a very similar manner to the buckets of the sludge elevator 16; the fine coal or sludge held in suspension is very light, however, and does not settle so readily as the fine refuse. In order to recover this sludge, which it is very desirable to have in the coking coal, and at the same time to clarify the water the sludge recovery 18 is used. A section 11 ft. wide by 75 ft. long on the lower floor is sheathed up water-tight. In the bottom of this tank an endless series of scrapers moves very slowly toward the sludge elevator. As the water in this tank is usually about 8 ft. deep, the water flows from the elevator toward the overflow at the other end very slowly. Transverse partitions from above the water line to near the bottom, still further aid the settling and prevent light particles from floating across to the overflow on the surface. The elevators 4 and 16 discharge into a Dodge scraper conveyor 19, which distributes the coal into bins, shown on the figure, which are calculated to hold 1000 tons. This gives the coal plenty of time to further drain off its water.

A crusher at 20 crushes nut coal for coking, and it can either be rewashed in the fine coal jigs or go direct to the draining screen and thence to elevator 4. The principal features of the process are :

First, the extreme and careful grading into 11 different sizes, and washing each size in a jig especially made and adjusted for it. Second, the washing of the nut coals before crushing to take out the intermediate product. Third, the arrangement of the whole plant with a view to minimising labour, three men only being required to run it. Fourth, the effective arrangement for settling the water, and the automatic and continuous removal therefrom of sludge and refuse, clarifying the water, and saving all the fine coal dust. Fifth, the effective arrangements for drying the washed coal.

The paper closed with an analysis of coal, before washing and after :

Before Washing.

—	Bone.	Pyrites.	Slate.
	per cent.	per cent.	per cent.
Moisture	1.150		
Volatile matter	26.900		
Ash	21.080		
Sulphur	0.549	28.28	1.098
Fixed carbon	50.321		
Phosphorus	0.072	0.05	0.017
Specific gravity	1.552		

After Washing.

No. of Sample.	Size.	Kind.	Ash.	Sulphur.	Phosphorus.
			p. c.	per cent.	per cent.
1	$\frac{1}{8}$ in. to $\frac{3}{8}$ in.	Unwashed	10.35	1.098	0.032
2	Do.	Washed	6.88	0.604	0.025
3	$\frac{1}{16}$ in. to $\frac{1}{8}$ in.	Unwashed	10.60	1.139	0.027
4	Do.	Washed	6.213	0.617	0.025
5	Under $\frac{1}{16}$ in.	Unwashed	12.400	1.606	0.033

	Per Cent.
Specific gravity of bone coal..	1.39
,, ,, pure selected coal	1.27
Fixed ash in pure selected coal	2.54

Mr. Shaefer said they expected to reduce the ash in the coke made from the washed coal to less than 10 per cent., and the sulphur below 1 per cent.

Friction Horse-Power in Factories.

"Friction Horse-Power in Factories," by C. H. Benjamin, detailed the results of a series of experiments made in 16 different establishments and tabulated.

Table II., below, shows how the horse-power was divided between the machinery, shafting, and belts :

TABLE II.

Number.	1. Total Horse-Power.	2. Horse-Power to Drive Machines.	3. Horse-Power to Drive Shafting.	4. Per Cent. to Drive Shafting.	Running at what Capacity.
1	400	243	157	39.2	One-half.
2	74	17	57	77	One third.
3	38.6	13.3	25.3	65.6	Two-thirds.
4	59.2	11.3	47.9	80.7	Nearly full.
5	112	48	64	57	Full.
6	168	77	91	54.2	,,
Average, heavy machine work ..	..	..	..	62.3	
7	40.4	19.7	20.7	51.2	,,
8	74.3	34.3	40.0	53 8	,,
9	47.2	22.7	24.5	51.8	,,
10	190	82	108	56.9	,,
11	107	32.5	74.5	69.7	,,
12	241	127	114	47.3	,,
Average light machine work	..	..	..	55.1	
13	117	100	17	14.5	One-fourth.
14	91.6	45.9	45.7	49.9	Full.
15	39.2	10 6	28.6	73	,,
16	8.28	4.26	4.02	48.6	One-half.

Friction horse-power alone is shown in Table III. The large loss by friction the author explained by saying that economising in quantity or quality of oil appears on the bills, while a corresponding increase in coal and water consumption may be unnoticed.

TABLE I.—DATA.

No.	Nature of Work.	1. Total Length Line Shaft Feet.	2. Diameter of Line Shafts.	3. Revolutions per Minute.	4. Number of Bearings.	5. Number of Belts.	6. Average Width of Belts.	7. Number of Counters.	8. Number of Machines.	9. Number of Men.
1	Wire drawing and polishing	1130	{$2\frac{1}{2}$ $2\frac{3}{4}$ / 4 6}	170	115	89	4	69		
2	Steel stamping and polishing	580	3 $3\frac{1}{2}$	200	68	28	6	27	18	78
3	Boiler and machine work ..	530	$2\frac{1}{2}$ 3	150	46	53	$5\frac{1}{2}$	47	43	152
4	Bridge machinery	1460	{$2\frac{1}{2}$ 3 / 4}	110	142	92	$4\frac{1}{2}$	79	69	80
5	Heavy machine work ..	1120	3	190	110	141	4	96	68	300
6	,, ,, ,, ...	1065	{2 3 / 4}	180 150 / 150	}114	192	4	152	123	225
7	Light machine work	748	{$1\frac{1}{2}$ $1\frac{3}{4}$ / 2 3}	135 135 / 135 150	}101	217	3	133	250	200
8	Manufacture of small tools ..	500	2 3	114	58	335	3	314	313	226
9	,, ,, ,, ..	990	$2\frac{1}{2}$ $1\frac{3}{4}$	175 136	102	217	3	202	258	100
10	Sewing machines and bicycles	2490	2 6	150	274	521	3	403	454	400
11	Sewing machines	1472	{2 3 / 4}	160 160 / 125	}184	484	3	435	179	350
12	Screw machines and screws..	1800	{2 $2\frac{1}{4}$ / $2\frac{1}{2}$ 3}	180	180	486	3	392	428	320
13	Steel wood screws	674	{$1\frac{1}{2}$ 2 / 3}	175 160 / 175	} 96	131	4	89	392	140
14	Manufacture of steel nails ..	988	$2\frac{1}{2}$	200	74	187	4	175	184	58
15	Planing mill	165	3	267	19	55	6	40	53	8
16	Light machine work	275	2	175	37	48	4	27	30	

TABLE III.—*Friction Horse-Power.*

Number.	1. Horse-Power per 100 Ft. of Shafting.	2. Horse-Power per 100 Lb. of Shafting.	3. Horse-Power per 100 Square Feet of Shafting per Minute.	4. Horse-Power per Bearing.	5. Horse-Power per Counter.	6. Horse-Power per Belt.	7. Horse-Power per 100 Square Feet of Belting per Minute.
1.. ..	14	.580	.10	1.37	2.28	1.76	.50
2.. ..	9.84	.352	.059	.84	2.11	2.40	.33
Average..	11.92	.466	.08	1.10	2.19	2.08	.415
3.. ..	4.77	.205	.04	.550	.538	.477	.10
4.. ..	3.28	.137	.04	.337	.606	.521	.20
5.. ..	5.70	.233	.038	.581	.665	.453	.10
6 . ..	8.55	.306	.06	.799	.600	.475	.15
Average..	5.57	.22	.044	.567	.602	.481	.14
7.. ..	2.75	.276	.034	.204	.155	.095	.04
8.. ..	8	.400	.09	.689	.127	.119	.06
9.. ..	2.49	.233	.03	.240	.121	.113	.04
10.. ..	4.36	.430	-.05	.397	.269	.208	.09
11.. ..	5.08	.134	.034	.406	.172	.154	.05
12.. ..	6.33	.381	.05	.633	.291	.235	.09
Average..	4.83	.309	.048	.428	.189	.154	.062
13.. ..	2.53	.109	.02	.178	.191	.130	.04
14.. ..	4.62	.278	.035	.615	.260	.244	.07
15.. ..	17.34	.729	.08	1.52	.715	.636	.08
16.. ..	1.46	.138	.015	.109	.749	.084	.02

TABLE IV.—*Useful Horse-Power.*

No.	1. Useful Horse-Power per Machine.	2. Useful Horse-Power per Man.
3..	.310	· .877
4..	.164	.142
5..	.707	.160
6..	.627	.342
Average.. ..	.452	.380
7..	.790	.099
8..	.109	.152
9..	.881	.227
10..	.180	.204
11..	.181	.093
12..	.296	.396
Average.. ..	.406	.195
13..	.256	.717
14..	.251	.792
15..	.200	1.326
16..	.142	

This he called saving at the spigot and wasting at the bunghole. The paper closed with a few rules which the author thought would effect a saving :

1. Use pulleys of large diameter on counters and narrow fast-running belts.
2. Use nothing but the best oil and plenty of it, catching all drip, and either purifying it or using it for some other purpose.
3. Have all the shafting and counters oiled regularly, and do not depend too much on automatic oiling.
4. Inspect line shafts from time to time, and see that they are in line and can be turned easily.

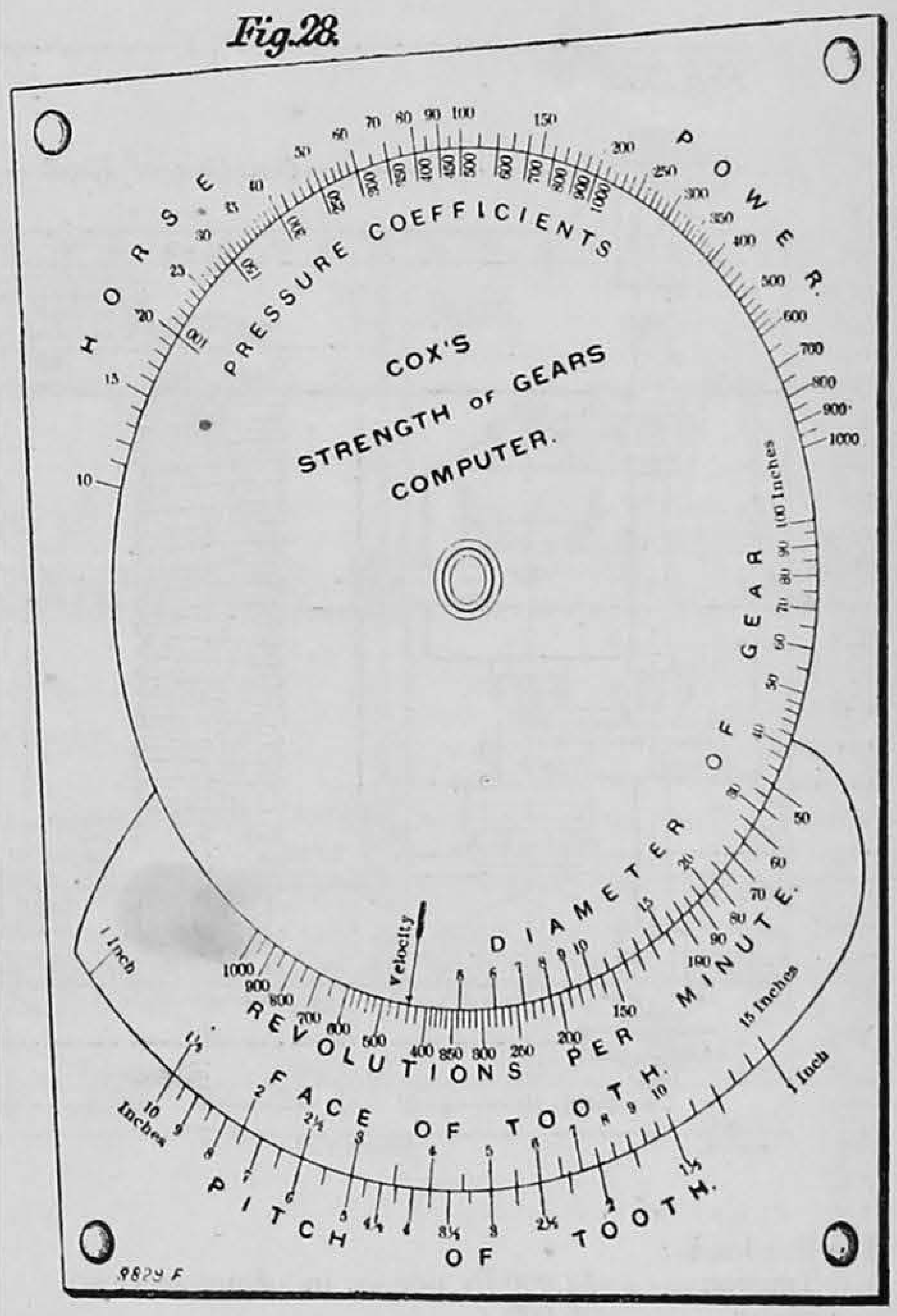
Many line shaft boxes bind at the sides when screwed down, sometimes increasing the turning moment 100 per cent.

The eminently practical character of the paper, drew fixed attention from many who operate manufactories.

Mechanical Computers.

"Some Special Forms of Mechanical Computers," by F. A. Halsey, was the following paper. This was a description of a computer made by Mr. W. Cox. He described it as of the nature of a circular slide rule. He illustrated it by the solution of two problems : "To find the horse-power a gear will transmit," and "To find the pitch and face of

Fig. 28.



tooth to transmit a given horse-power." An illustration of this computer is annexed, and the description is as follows :

In their simplest form the computers consist of a foundation plate in the centre of which a disc revolves. If the formula contains four factors, the scales representing two of them are placed around the upper and lower edges of the disc, the other two being similarly placed on the plate. When there are five or six factors in the formula, an extra piece of segmental shape revolves between the disc and the plate, and on this piece are laid off two more scales. All these are arranged and combined so that the values of the known factors can be placed opposite each other, when the value of the unknown one, or the solution of the problem, is at once read off.

The material used is the best Bristol board, the foundation plate being often attached to a board of wood or other strong material. Small computers are often put up in cloth or leather cases. The sizes vary from $4\frac{1}{4}$ in. by $5\frac{3}{4}$ in. to 12 in. by 14 in., the larger ones being more suitable for the draughting-room or office.

Rustless Coatings for Iron.

Mr. M. P. Wood contributed a fourth paper to those already presented by him on "Rustless Coatings for Iron and Steel." He called attention to the dangers of using oxide of iron in any form for the protection of metallic structures from corrosion. An inspection of some of the high buildings in process of erection had shown a slight improvement over the practice of two years previous. Although carefully painted, the condition of the metallic surfaces before applying the paint had not received any attention. In no case had the parts been washed with soda-ash or lye-water to remove the grease, and then pickled with weak acid to remove the mill scale, and a subsequent washing with lime-water to neutralise the acid bath, warming the work before painting it, and care taken to apply the paint only on clear, bright days, when no sweating can occur, or applying the paint in warm paint-rooms. Nor had this been done in the minor parts, where the light grillage and ornamental partitions demanded it imperatively.

The new suspension bridges around New York required the most careful consideration. The author recommended a reliable carbon or plumbago paint instead of raw or boiled linseed oil. The latter could be just as readily applied, would take no longer to dry, would resist friction and moisture far better, and be a good foundation to receive the final protective coating before the cables were finished and covered in. He cited at length a paper appearing in ENGINEERING, July 31, 1896, by Mr. Hector Maccoll, respecting the case of the steamer Glenarm. The discussion on this paper took the form of personal experience. Mr. Boyer cited the case of a chain bridge at Newburyport, Mass., exposed to salt air, which was built 104 years ago, and painted 30 years since with black paint. This bridge to-day showed no signs of oxidation.

(*To be continued*).

NOTES FROM THE UNITED STATES.

PHILADELPHIA, January 15.

UNSETTLING influences are checking the usual covering of midwinter and spring requirements at this time. The excitement following the collapse of the billet pool has disappeared, and business has fallen to a very low state. The trade has not yet quite sized up the outcome of the new ore combination, by which the Carnegie interests score advantages over all other steel producers. The billet pool is buried, but two or three parties are trying to dig it up. Prices are 15 dols. at Pittsburg. Bessemer is more active. Furnace managers are looking out for future supplies of ore. In that direction everything is unsettled. All hands are waiting on the 1897 demand. Naturally there is great anxiety us to what sort of an iron and steel year we are going to have. The banks take conservative views of the situation, and guard their limited resources with extreme care until the volume of business begins to increase. The tariff question is up, and a moderate increase of duties will be asked for by the Committee. The silver interests in Congress have not announced what position they will take, but it is likely to be antagonistic. A great many railroad confederations desire to make large expenditure this spring on bridges, roadbed, new rails, &c., but the managements do not see a clear road yet. The plate mills have been picking up more business than any other class. Big structural iron orders are now under consideration. Rails are too high at 25 dols., with billets at 15 dols. and less. Bars are sold at 1 cent a pound in some western mills. There are enterprises enough to assure great and profitable activity to the iron trade if they, or half of them, are entered upon. Electric lines lead. Municipal improvements constitute another source of demand. The railroads could give the iron trade a boom if they could afford to buy what they want and need. Our gold reserve is at its highest point since two years. Deposits are increasing and are gaining on the loans. The general circulation has increased 71,000,000 dols. during the year. The increase in the production of pig iron is of such magnitude as to point to corner prices. Blast-furnace managers are turning out iron, confident that the early spring demand will sweep it all into broadening consumptive channels.

ROYAL METEOROLOGICAL SOCIETY.

THE annual general meeting of this Society was held on Wednesday, the 20th inst., at the Institution of Civil Engineers, Great George-street, Westminster, Mr. E. Mawley, F.R.H.S., President, in the chair.

The Secretary read the report of the Council, which showed that the Society had made steady progress during the past year, there being an increase of 17 in the number of Fellows.

The President then delivered an address on "Shade Temperatures," in which he stated that of all meteorological observations there were none approaching in importance those made of the temperature of the air, generally known as "shade temperature." Indeed, the first question invariably asked in regard to almost any climate was as to its temperature. Mr. Mawley traced the history of the different methods of exposing thermometers since the time that regular observations of the weather had been made in this country. For many years open screens were most favoured by meteorologists, that devised by Mr. J. Glaisher, F.R.S., and the late Astronomer Royal (Sir G. B. Airy) being the pattern principally used. In 1864 Mr. T. Stevenson, C.E., invented an admirable form of closed screen with louvred sides, which was considered preferable to the open type of screen, and has now almost entirely superseded the Glaisher stand. In 1883 the Stevenson screen was considerably improved by a committee of the Royal Meteorological Society. Mr. Mawley then described his own experiments at Croydon and Berkhamstead, as regards this improved screen, known as the Royal Meteorological Society's pattern. He showed that the only two defects which had been attributed to this form of thermometer exposure were virtually non-existent, and therefore advised its general adoption both in this country and on the Continent. Mr. Mawley had recently made observations in the Stevenson screen, and also in the screens used in France and Germany, and the conclusion he had come to was that the results obtained in the Stevenson screen were not only the nearest to the true air temperatures, but also more likely to be strictly comparable with temperatures taken in a similar screen, but with different surroundings, elsewhere.

MISCELLANEA.

IN connection with the forthcoming Stockholm Exhibition it has caused much disappointment in Finland that the Russian authorities have decreed that Finland is to show together with Russia, and will not be allowed to have a separate building.

Some remarkable performances in the matter of drilling steel have recently been accomplished in the States with drills in the bodies of which have been inserted tubes conveying oil under pressure to the point. With such a drill a hole $\frac{3}{4}$ in. in diameter has been drilled through steel to a depth of 12 in. in 15 minutes. The speed of rotation was 1000 turns per minute, and the oil was supplied at the rate of 2 gallons per minute.

A recent report of the trustees for the Brooklyn Bridge states that up to December 1 last 10 hauling cables had been in use, of which eight had been worn out and removed. Seven of the eight cables had lives of from 356 to 607 days, the other, having had lighter work to do, lasting 1140 days. The two last removed had hauled average loads of 323.3 and 308.7 tons respectively, the mileages being 111,136 and 100,268 miles.

Mr. Sarre, the director of the Government Railways in Alsace-Lorraine, is proposing to use a sandbank to prevent buffer-stop collisions. If the train runs too rapidly into a terminal station, he suggests that it should be automatically switched on to one of these sandbanks, which will quickly and quietly bring it to rest. Hydraulic buffers with an 8-ft. stroke have sometimes proved unequal to doing this, whilst they are doubtless much more expensive than the substitute proposed.

"Dynamo Design, Construction, and Working up to Date" will be dealt with in the second special course of lectures arranged by the Institution of Junior Engineers. To deliver them, the Council have secured the services of Mr. F. A. Nixon, of the Westminster Electric Supply Corporation, and previously with the Brush Electrical Engineering Company. The lectures are being prepared with a special view to the every-day requirements of those engaged in practical work in drawing office, workshop, and electric installation. The fee for the course is—members, 10s. 6d.; non-members, 12s. The dates of delivery are Tuesdays, February 2 and 16; March 2, 16, and 30; April 13; from 8 p.m. to 9.30 p.m., at the Westminster Palace Hotel.

Forty-eight torpedo-boat destroyers, which are under construction, are to be delivered at the various ports during the next naval year, and are all intended to be completed and ready for sea by March, 1898. They will be distributed among the different ports as follows: To Portsmouth; the Brazen, Recruit, Electra, Vulture, Star, Whiting, Bat, Chamois, Crane, Flying Fish, Bullfinch, Dove, Cheerful, Mermaid, Fawn, Flirt, Violet, and Sylvia. To Chatham; the Desperate, Fame, Foam, Mallard, Angler, Ariel, Avon, Bittern, Arab, Kestrel, Albatross, Coquette, Cygnet, Cynthia, and Express. To Devonport; the Quail, Sparrowhawk, Thrasher, Virago, Earnest, Griffon, Locust, Panther, Seal, Wolf, Otter, Leopard, Fairy, Osprey, and Gipsy.

In a recent number of the *Electricien* M. N. Fradin claims to have obtained a deposit of carbon electrolytically. M. Fradin wished to verify the statements of Bartoly that electrolysis through sulphuric acid between electrodes of carbon results in the formation of carbonic oxide and carbonic acid. His results tend to show that at low temperatures a disaggregation of the carbon occurs, the acid becoming charged with particles of carbon in solution. At higher temperatures the acid takes a yellow colour, which deepens into brown. From this he concluded that the carbon actually dissolved in the acid under the influence of the electric current. To test this he plunged in the acid a cathode of platinum, and after some time found, he states, thereon a compact layer of carbon.

Great efforts are being made on the Continent with regard to comfort, speed, and easy or "sweet" running of a number of the more important trains, and it must be owned that very laudable results are, in many cases, obtained. One of the best, if not the best, train on the Continent is the one recently put on between Vienna and Carlsbad. The distance is 285 miles, the total time of the train 419 minutes, of which about 40 minutes are absorbed in stoppages, &c., making an average of 37 miles an hour —an excellent result, when it is taken into consideration that more than half the distance has gradients of 1 : 100, in a couple of places even 1 : 60. In addition to this there are frequent curves of 1580 ft., or even 1270 ft. Yet these curves have been compassed at a speed of 53 miles without the least inconvenience; the stiffest gradients have been negotiated at a speed of 40 miles or more. The train weighs 220 tons, and the engine has about 900 horse-power.

Some interesting experiments on the effect of repeate stresses have been made at the Watertown Arsenal, and are described by Mr. H. K. Landis in the *American Manufacturer*. Bars of metal 1 in. in diameter were loaded at the centre with weights hung from a carriage resting, at the middle of the bar, on two sets of friction rollers placed 4 in. apart. The bending moment was accordingly uniform for this distance of 4 in. The bars thus arranged were caused to rotate at a speed of 400 revolutions per minute. The loads were arranged so that the calculated fibre stress at the middle of the bar was from 40,000 lb. to 50,000 lb. per square inch. After having run a large number of revolutions the bars were then cut up into test pieces, one being taken from the end and another from the middle of each bar. A hole was then bored through each of these test pieces so as to leave a shell of metal only $\frac{1}{16}$ in. thick. When broken in a testing machine, the following results were then obtained:

Kind of Metal.	Fibre Stress.	No. of Rotations.	Tensile Strength.		Difference. Gain.
			Middle.	End.	
	lb. per sq. in.		lb. per sq. in.	lb. per sq. in.	lb. per sq. in.
Mild steel ..	40,000	60,000	91,630	60,770	+ 30,860
(Hot rolled) ..	40,000	87,900	67,070	61,000	+ 6,070
" ..	40,000	100,000	67,070	64,240	+ 2,830
" ..	40,000	124,000	64,620	61,120	+ 3,500
" ..	40,000	173,400	(broken).		(– = loss)
Cold rolled iron	40,000	250,000	53,750	73,420	– 19,670
" "	40,000	150,000	62,610	72,390	– 9,780
" "	45,000	80,000	57,720	71,960	– 14,240
" "	50,000	40,000	56,000	66,850	– 10,850
" "	50,000	50,000	61,000	64,000	– 3,000
" "	40,000	325,300	(broken).		
" "	45,000	192,500	"		
" "	45,000	116,500	"		
" "	50,000	47,050	"		

The Great Eastern Railway Company, which has been doing some smart work of late in replacing some of their bridges which span rivers in a single night, beat its own record on Saturday night last, when, in spite of a severe snowstorm, the bridge over the River Lea to the south of Tottenham Station, on the main line, was replaced by a new bridge, the old one being removed and the new one placed *in situ* in nine hours. The old bridge was removed and the new one put in its place by the same process and at the same time. Mr. Wilson, the chief engineer, with a large body of officials, and gangs of men to the number of 70, were on the bridge soon after 12 o'clock with a huge crane, several crabs, a couple of 100-ton jacks, and several 50-ton jacks in reserve. At 12.30 a.m. operations were commenced. The first thing to do was to strip the rails from the old bridge, taking up the planking as well as the permanent way in order that the lifting apparatus could be attached to the girders to raise the whole bridge bodily to the extent of 18 in. This was to allow of trolleys being placed underneath resting on transverse girders, which had been erected so that the bridge, being elevated on wheels, could be drawn away. The old bridge was 77 ft. in length. The new bridge, 84 ft. 9 in. in length, had been erected beside the old one, complete even to the rails and its final coat of paint. It had already been provided with temporary wheels to facilitate shifting. The preliminary part of the work—the raising of the old bridge and placing it on wheels—was the most arduous part of the task, and occupied the men incessantly until a quarter to seven. Then, by means of powerful crabs and winches attached to the new bridge, this was slowly pulled into the place of the old, the latter being at the same time pushed out of the way. It was a dead weight to move of 250 tons, but it was accomplished in an hour. At a quarter to eight the new bridge was in its place, and the old bridge was by its side. The next thing to be done was to remove the trolleys or wheeled carriages from under the new bridge and lower it into its final position flush with the permanent way. The completing of this occupied the remainder of the morning, and then the levelling up and adjusting was gone on with; but at 2.20 the engineer's train was able to cross the new bridge, and the work was practically completed.

THE SOCIETY OF CIVIL ENGINEERS OF FRANCE.—Following the example of the Institution of Civil Engineers, the Society of Civil Engineers of France has built itself a magnificent house, which was opened with great ceremony on January 14 by the President of the French Republic. A large number of guests were present at the soirée, including representatives of the various French technical societies. The only English society represented was the Iron and Steel Institute, who sent Professor Roberts-Austen. The new building, which is situated in the Rue Blanche, Paris, was designed by Mr. F. Delmas, and was erected in 262 days. It comprises in the basement engine-rooms and store-rooms, on the ground floor the meeting-room, on the first floor reception-rooms for the members, on the second floor the secretary's offices and the council-room, and on the third floor the library. Access to the various floors is obtained by means of an electric lift. The meeting-room contains seats for 500 persons, and the floor is so arranged that it may be horizontal for receptions or inclined so as to convert the room into an amphitheatre for the meetings. The floor weighs 30 tons, and its transformation from a horizontal to an inclined position is effected with great rapidity by means of hydraulic machinery.

BARSI LIGHT RAILWAY; DETAILS OF PRESSED STEEL BOGIE.

CONSTRUCTED BY THE LEEDS FORGE COMPANY, LIMITED, LEEDS.

Fig. 6.

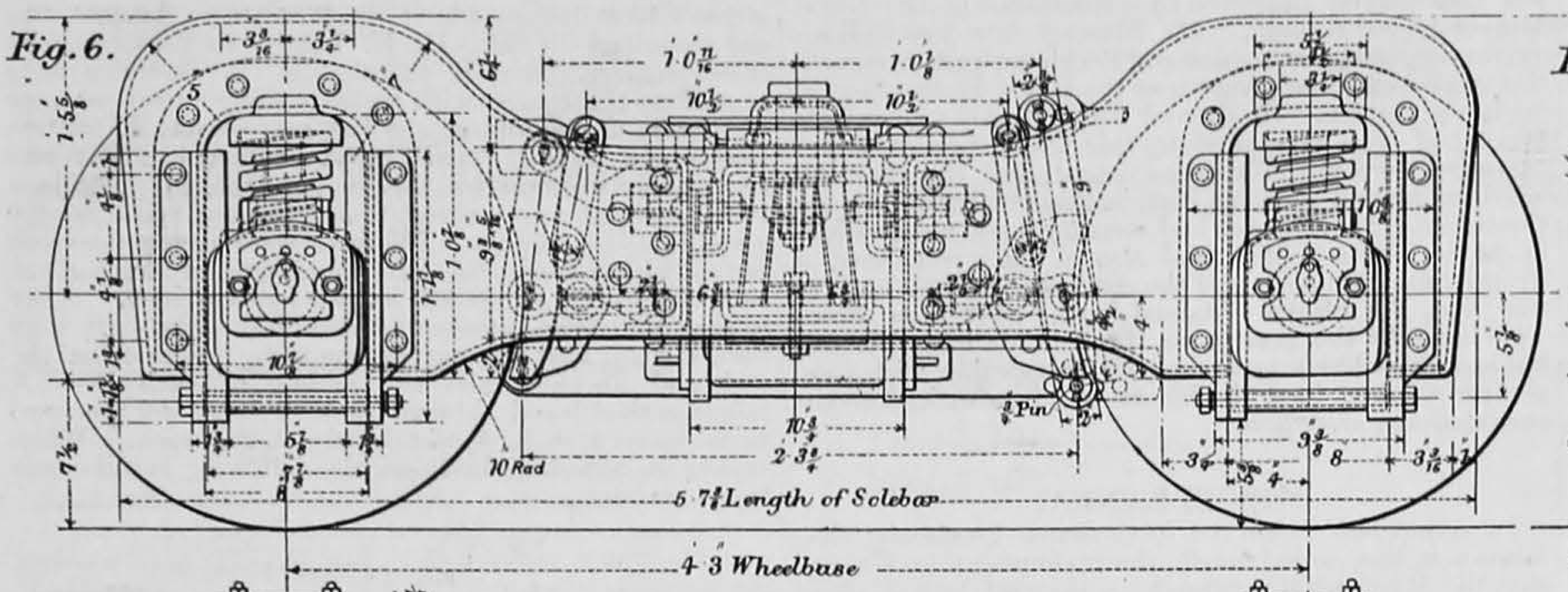


Fig. 8.

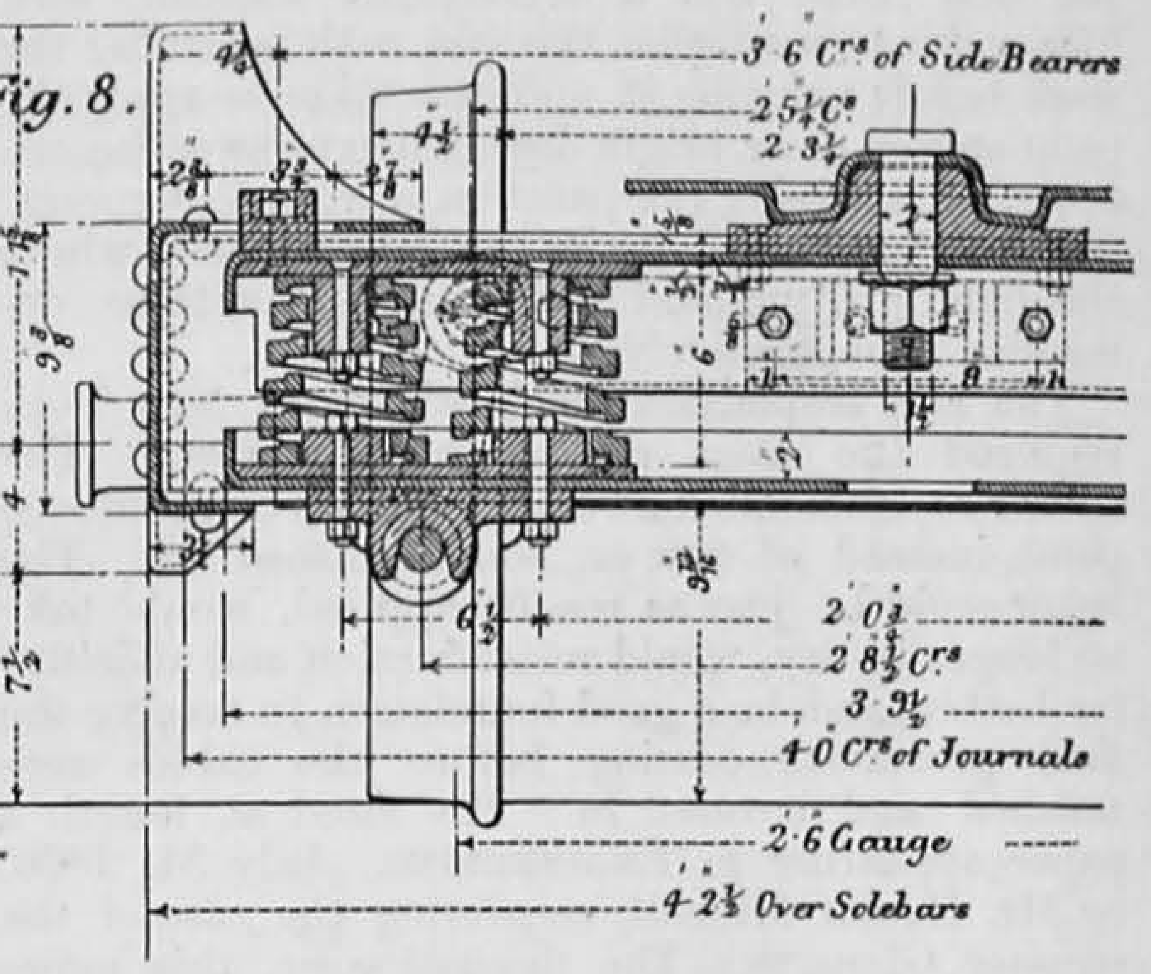


Fig. 7.

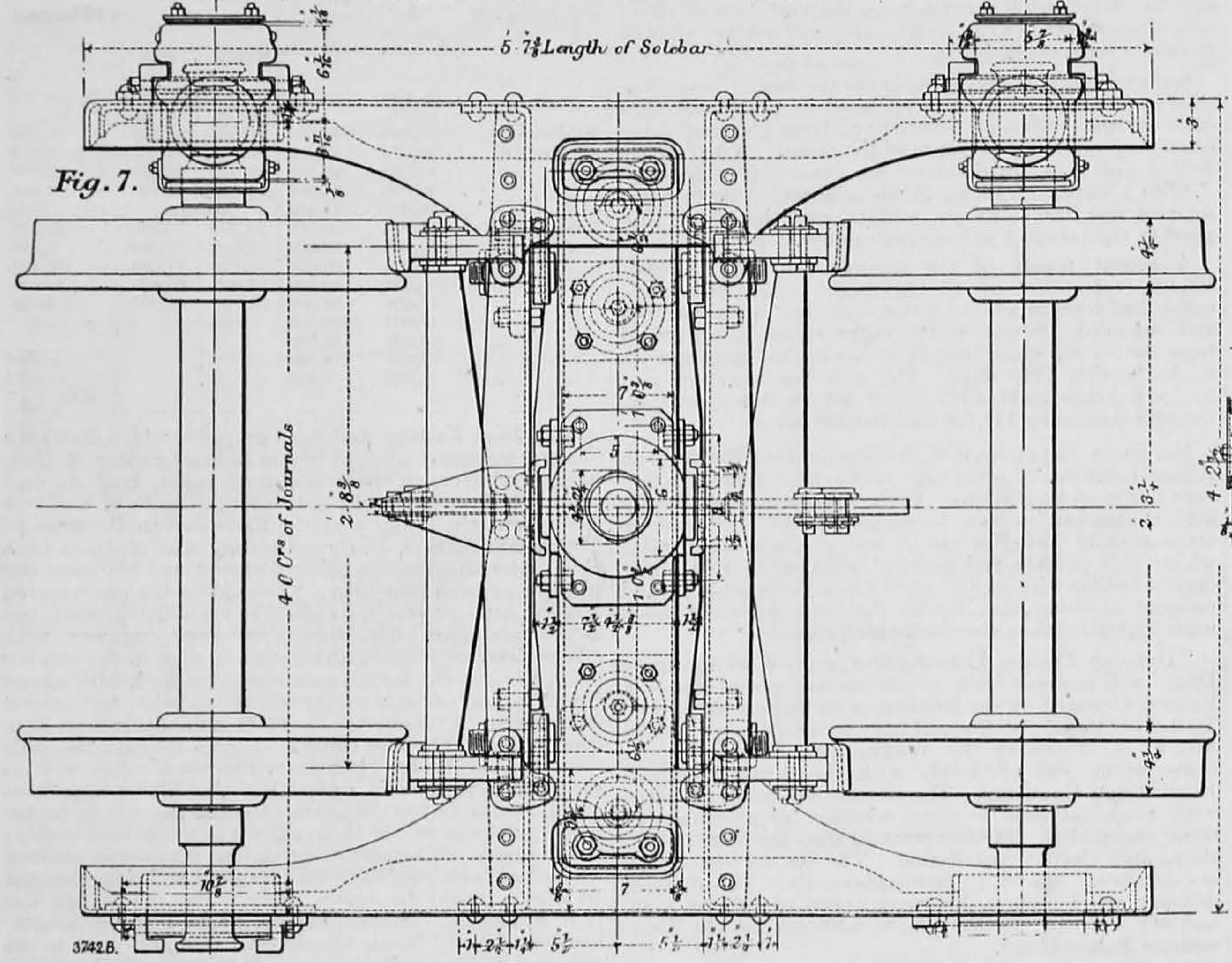
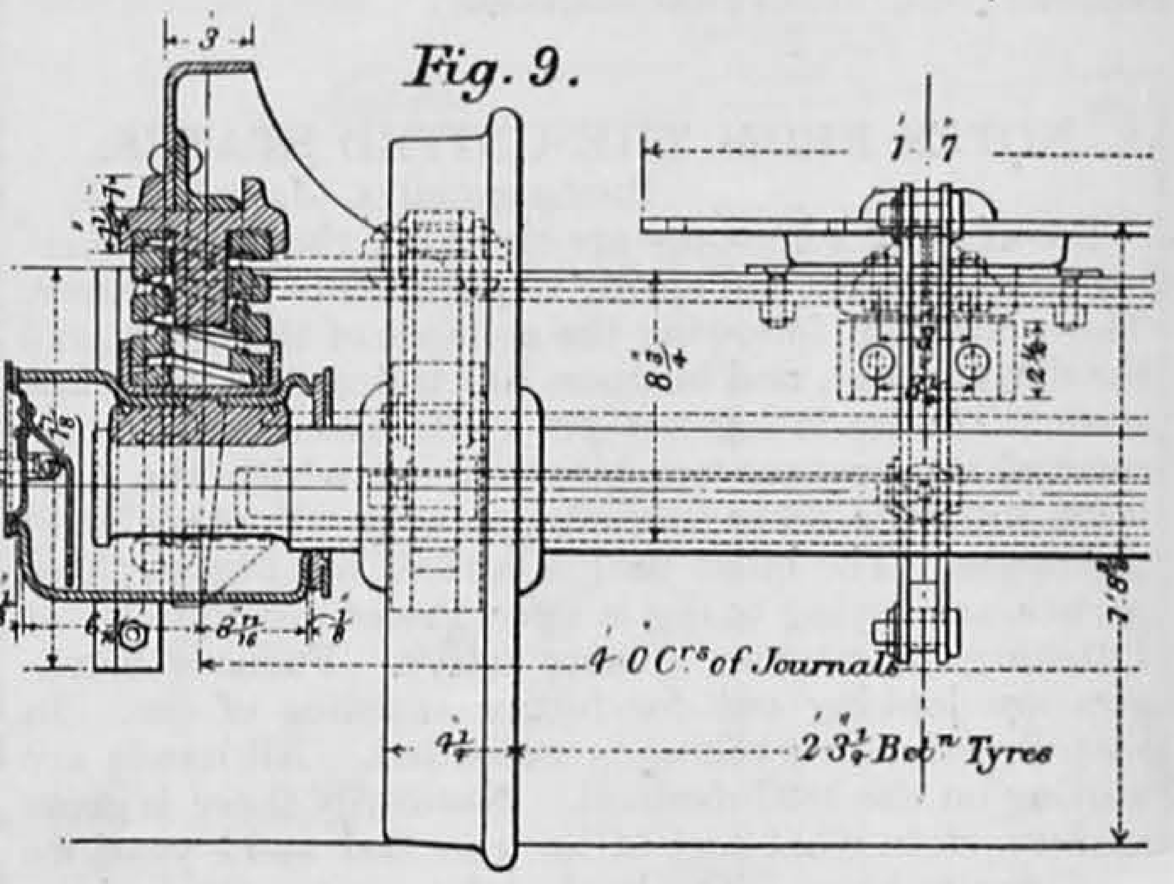


Fig. 9.



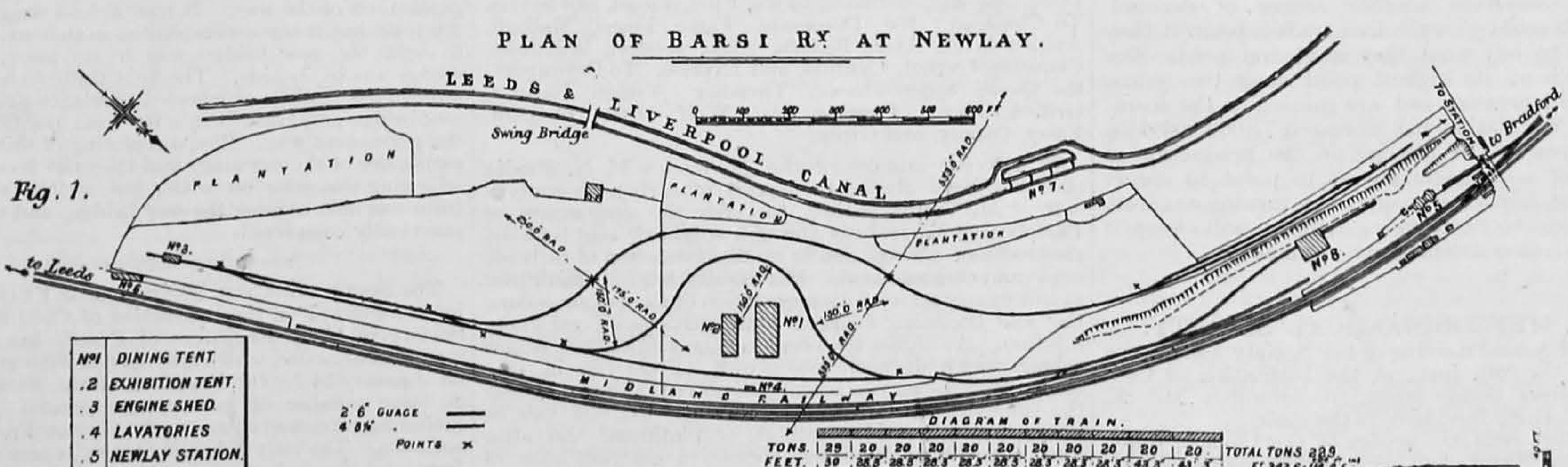
3742.B.

IN our issue of October 30, 1896, we gave an account of an experimental line of light railway which had been constructed at Newlay, near Leeds, for the purpose of illustrating by actual examples the method of working adopted on the Barsi Light Railway. The exhibition had been organised by the Leeds Forge Company, whose pressed steel bogies and underframes were used in the construction of the rolling stock. Our account was based on an inspection of the installation, which was necessarily of a more or less superficial nature, and upon information supplied to us at the time. We have since made further inquiries into this system, and as a result are now able to give illustrations of the rolling stock. We have already illustrated the locomotive.*

We also give on the present page, in Fig. 1, a plan and profile with mean elevation of the experimental line, from which our readers will be able to form an idea of the complete manner in which the Leeds Forge Company carried out their investigation of thfs system. The line was of substantial construction, and carefully graded in order to illustrate the efficiency of the locomotive and practicability of the general arrangements. The curves and grades are marked on the plan. It will be seen that on the loop round the dining and exhibition tents there is a curve first of 150 ft. radius and then of 175 ft. radius, next to which is a reverse curve of 150 ft. radius, the gradient being 116 ft. 6 in. The steepest gradient on the main line was 1 in 57.1, and the sharpest curve 175 ft. radius, the 250-ft. curve being altered to that. By the train diagram it will be seen that the length of train was 342 ft. 6 in., and the total weight 229 tons; but this does not appear to represent the train actually in use on the occasion of our visit. The gauge was 2 ft. 6 in., the rails 30 lb. to 35 lb. per yard, and stamped steel sleepers were used. As we stated in

PLAN OF BARSI RY AT NEWLAY.

Fig. 1.



3869. E.

* See ENGINEERING, vol. lxii., page 612.

BARSI LIGHT RAILWAY; DETAILS OF PRESSED STEEL BOGIE.

CONSTRUCTED BY THE LEEDS FORGE COMPANY, LIMITED, LEEDS.

Fig. 10.

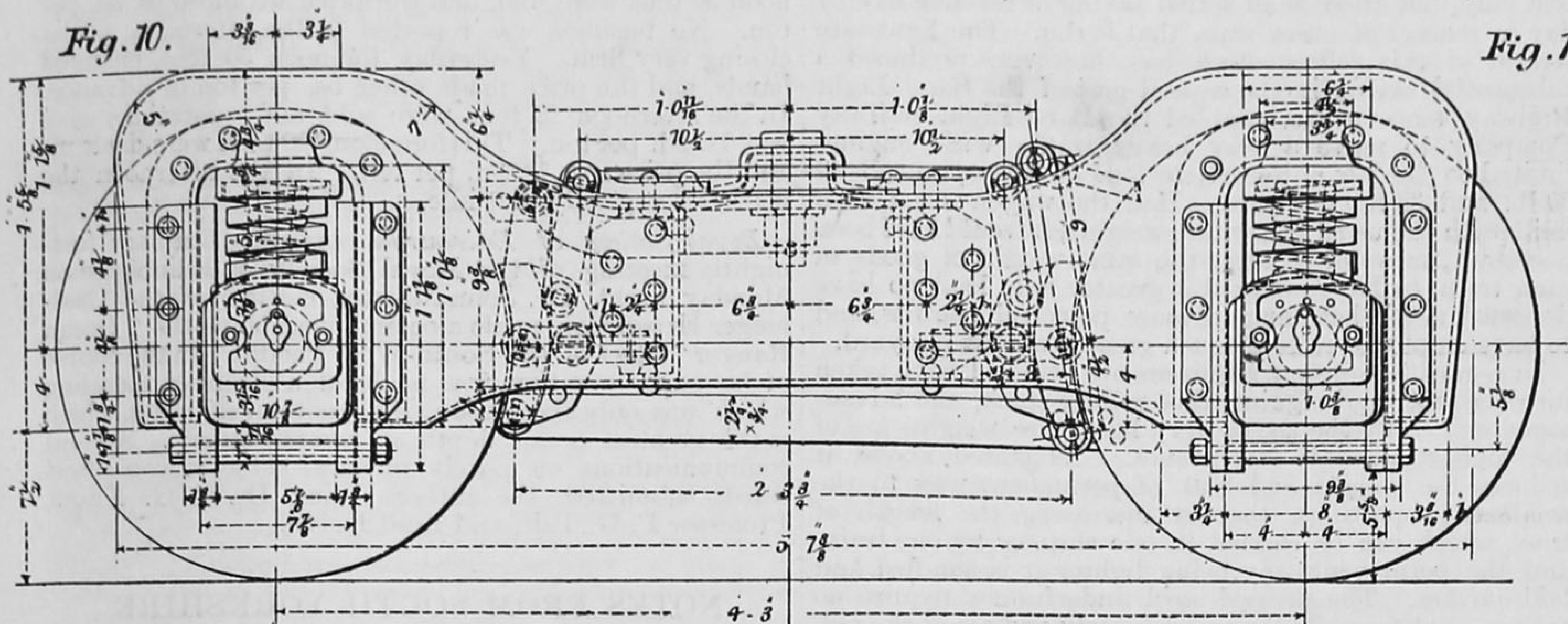


Fig. 11.

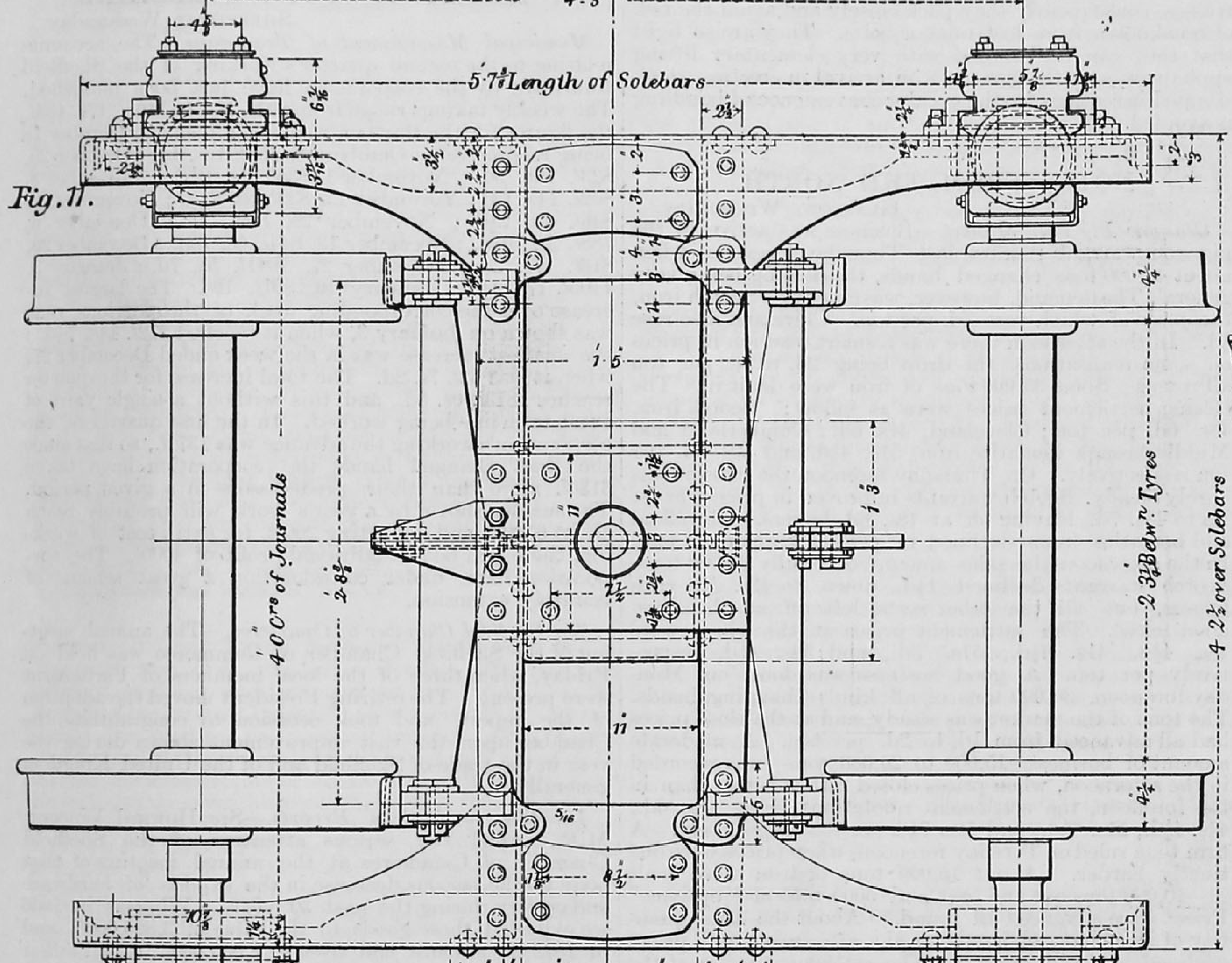
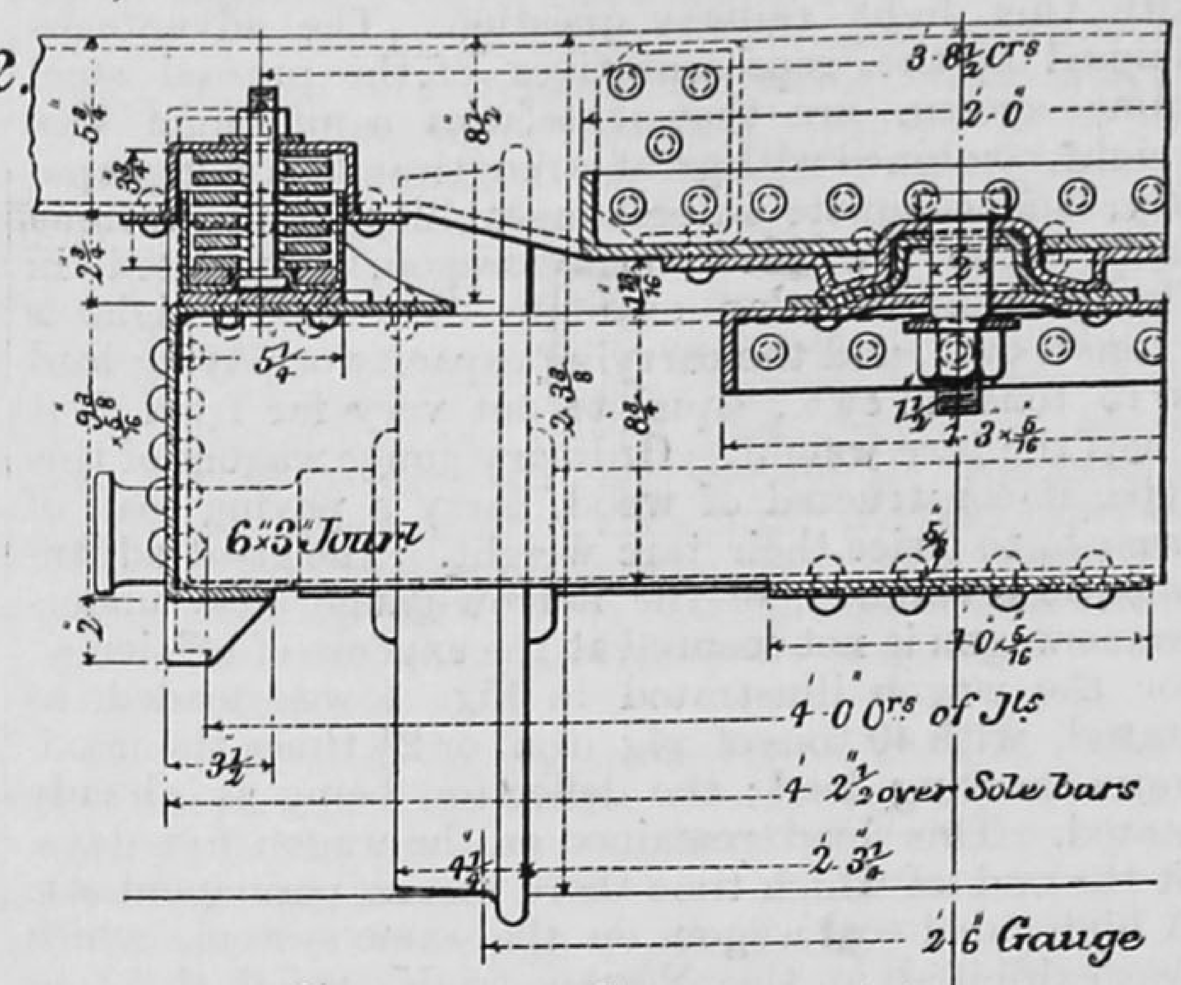
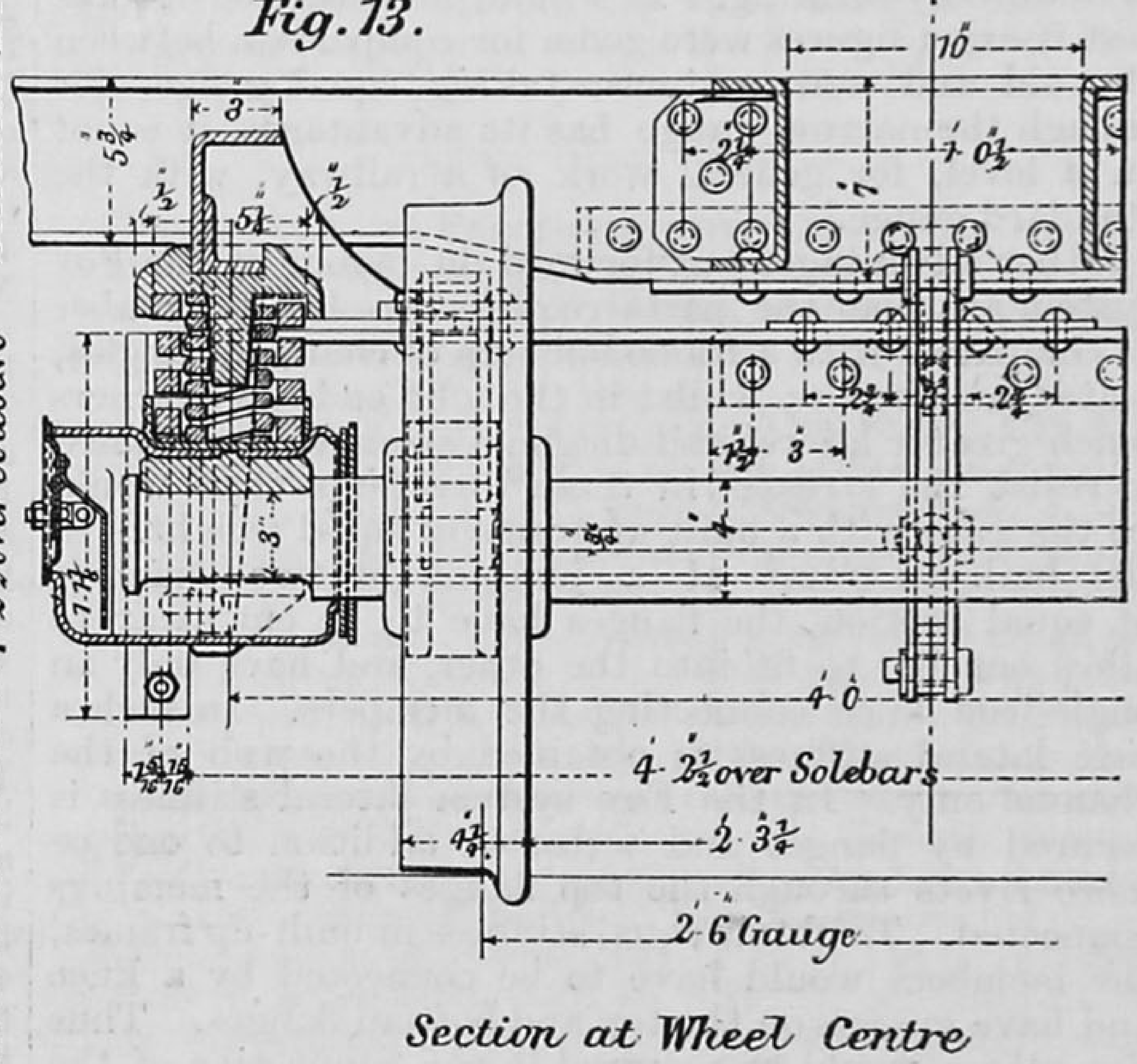


Fig. 12.



Section at Centre

Fig. 13.



Section at Wheel Centre

our previous notice, the experimental train was, on the occasion of our visits, run over this line at a fair speed, which we estimated at from 12 to 15 miles per hour. The rails were wet and slippery. It is fair to say, however, that others present put the speed much higher, and it is quite possible they were right. We were also informed that on previous occasions a quicker rate of running had been accomplished, a fact that may be easily credited. However, the nature of the tests, with a large crowd of people all over the grounds, made it desirable that no great speed should be attempted, on the score of safety. It is astonishing how inconsiderate people are when they get in a crowd, not only of their own safety, but of the convenience of other people.

The locomotive was constructed by Messrs. Kitson and Co., of Leeds, and was specially designed for the work. It has eight wheels coupled and a four-wheel trailing bogie. The cylinders are 13 in. in diameter and 18 in. stroke. The weight in working order is 29 tons 8 cwt. An illustration of this engine was given in our issue of November 13, 1896.

Turning to the engravings of rolling stock given in the present issue, Fig. 2, page 110, is a special saloon car as supplied to the Barsi Light Railway. The body and fittings are by the Lancaster Railway Carriage and Wagon Company, whilst the underframe and bogies, as in all the other stock, are composed of the pressed steel members made by the Leeds Forge Company. The underframe is 40 ft. 6 in. long by 6 ft. 8 in. wide, the length over the buffers being 43 ft. 3 in. The centres of bogies are 28 ft. and the wheel base of the bogies is 4 ft. 3 in. The gauge, as stated, is 2 ft. 6 in. A hand brake is fitted to both bogies, which gives equal pressure on every wheel both on the straight and curves. Curves of 150 ft. radius can be taken by this carriage. The total weight on rails when fully loaded is 20 tons, and the carriage is tested to twice the working load. The car comprises a main saloon, smoking compartment, entrance vestibule, lavatory, kitchen, and servants' compartment. It is provided with sleeping accommodation, and is illuminated by gas. It has double roofs and sunshades suitable for tropical countries, the width over sunshades being 7 ft. 6 in. It is surprising what a deal of accommodation there is in this car considering the narrow gauge of the line. The upholstering and fittings are excellent.

In Fig. 3, on the same page, will be found an illustration of the standard covered goods wagon constructed by the Leeds Forge Company. The length over body is 25 ft., the width 7 ft., and the height inside 6 ft. 6 in. The length over buffers is 28 ft. 3 in. The load is 14 tons 2 cwt., and the capacity 1000 cubic feet. The total weight on rails is 20 tons. The wagon is fitted with hand brake, which can be applied or taken off from either side of the vehicle. Fig. 4, on the same page, is a low-sided wagon, also constructed by the Leeds Forge Company. The length over headstocks is 25 ft., the width 7 ft., and the length over buffers 28 ft. 3 in. The length between bogie centres is 16 ft. 8 in., and the wheel base of bogies 4 ft. 3 in. The tare weight is 4 tons 2 cwt., and the normal load 15 tons 18 cwt., giving a total weight on rails of 20 tons. A hand brake is fitted which can be worked from either side. The wagon has been tested by the Leeds Forge Company with a load of 40 tons distributed uniformly, when the deflection of the underframe in the centre was found to be $\frac{5}{16}$ in., and the deflection of the bogie $\frac{1}{32}$ in. There was, of course, with these slight deflections no permanent set.

All these examples of narrow-gauge stock have, as already stated, Fox pressed steel frames, and in Fig. 5, on page 110, we illustrate a standard carriage underframe, with bogies, for this description of rolling stock. This underframe is 40 ft. 6 in. long by 6 ft. 8 in. wide, the length over buffers being 43 ft. 3 in., and between centres of bogies 28 ft. The wheel base of bogies is 4 ft. 3 in. A hand brake, which gives equal block pressure on every wheel, on straight road or curves, is fitted as shown. This underframe is the same as that fitted to the car shown in Fig. 4, and will take curves 150 ft. radius. The test is twice the working load. In Figs. 6 to 13, on the opposite and present pages, we give illustrations of two types of bogie used for this description of narrow-gauge stock by the Leeds Forge Company. The details are clearly shown on the drawings, and the leading dimensions are marked on, so that it is unnecessary to repeat them. The distinction between the two is that the bogie shown in Figs. 6 to 9 has a swing bolster, whilst the other is not so provided, but has spring side bearings and double coil axle-box springs specially arranged for light stock, the outer coil being longer than the inner, so that the vehicle when unloaded rides on the outer coil only, but when the load is put on both sets of springs are brought into action. In connection with this matter it may be stated that Mr. Calthrop, the consulting engineer to the Barsi Light Railway, considers the absence of vibration in the running of the carriage and wagon stock to be due in a great measure to the Timmis system of coiled springs which have been employed throughout the whole track. He also attaches importance to the fact that the steel sleepers used were spaced at distances so arranged as regards rail joints that there is equal resilience throughout. This practice of placing sleepers was first determined by theoretical considerations, the correctness of which has been demonstrated by a series of lever experiments, conducted on the permanent way by means of a lever testing machine, and finally by practice. We are also asked to state that the photographs, from which the engravings now published have been taken, were taken by Mr. J. Wormald, of Leeds.

In our issue of April 6, 1894, we gave a full description of the Fox system of pressed steel frames for rolling stock, and refer those of our readers who require to refresh their memories on the subject to our earlier issue. There are, however, a few words that may be further said here on the subject in connection with this light railway question. The advantages claimed by the representatives of the pressed steel frame system are that it secures a minimum tare weight, combined with great strength and carrying capacity, and complete interchangeability of the various parts. The low-sided bogie wagon, illustrated in Fig. 4, is taken as an example. The tare weight is 4 tons 2 cwt., and the carrying capacity or paying load is 15 tons 18 cwt., equal to not very far from four times the tare weight. Ordinary gauge wagons of this type, if constructed of wood, carry a paying load of from 1½ to twice their tare weight. The great advantage, it is claimed, of the narrow-gauge steel underframe wagon is not secured at the expense of efficiency, for the wagon illustrated in Fig. 4 was loaded, as stated, with 40 tons of pig iron, or 2½ times the maximum carrying load; the deflection being as already stated. This load remained on the wagon five days, at the end of which time there was no permanent set. A high-sided coal wagon on the same system, which was exhibited at the Newlay trials, weighed 5 tons 7 cwt., and would carry a load of 14 tons 13 cwt. The tare of the covered goods wagon, Fig. 3, was 5 tons 18 cwt., and this, as stated, would carry 14 tons 2 cwt. These figures, the Leeds Forge Company claim, show "that the whole of the above-mentioned stock far exceeds in proportion of paying to non-paying load anything that can be obtained by any other form of construction."

We take these statements from a report which has been furnished us by the company, and they are undoubtedly striking. It would, however, be of interest if exact figures were given for comparison between the old and new systems, taking equal gauge, for though the narrow gauge has its advantages, it is not on a level, for general work of a railway, with the standard gauge.

Other advantages put forward in favour of the Fox system are that the parts required are less in number as compared with a frame built up of channels, angles, plates, and knees; whilst in the solid ends and corners much greater lateral and diagonal strength is obtained to resist the stresses in these directions than would be the case with a built-up frame of equal weight. In the built-up frame at a junction of two channels of equal section, the flanges have to be cut away to allow one bar to fit into the other, and have only an angle-iron knee connecting the members. In such a case lateral stiffness is obtained by the web of the channel only. In the Fox system lateral stiffness is secured by flanges and webs, in addition to one or more rivets through the top flanges of the members connected. To obtain equal stiffness in built-up frames, the members would have to be connected by a knee and have gussets on the top and bottom flanges. Thus five pieces would be required in the connection of the two members. We give the claims put forward by the manufacturers of the steel pressed frames in practically their own words, and leave our readers to draw their own moral, which, however, should be a striking one.

To the above details we may, in concluding our notice, add some particulars, as they are the result of actual experience, taken from a report of Mr. Everard R. Calthrop, the consulting engineer to the Barsi Light Railway Company:

In reducing the capital cost of railway communication to its lowest possible figure compatible with efficiency, the adoption of the principle of narrow gauge—such as the 2 ft. 6 in. selected for the Barsi Light Railway—unquestionably stands pre-eminent as regards the reduction in prime cost, in consequence of the greater flexibility of alignment and its sequelæ in respect of the avoidance of heavy cuttings, embankments, and other costly works. In India the saving has been shown to amount to no less than four-fifths of the total cost of permanent way, which means that for a given amount of money a narrow-gauge line can offer five times the traffic area.

When once this principle of narrow gauge has been adopted, the most important reduction in capital cost that it is possible to make is in the direction of reducing the dead weight of the train to the lowest possible proportion, compatible with a proper reserve of strength and a due regard to the cost of maintenance and repairs. By means of pressed steel frames I have been able, while working to a uniform maximum axle load of only 5 tons, to place on the Barsi Light Railway open wagons 25 ft. long over headstocks with a paying load of 15 tons 18 cwt., and a tare weight of only 4 tons 2 cwt., the percentage of tare to the total weight being only 20.5 per cent. This low side wagon has been placed under a test load of 40 tons, with a temporary deflection of $\frac{5}{16}$ in. and without a trace of any permanent set. The high side open wagons weigh 5 tons 7 cwt., and carry 14 tons 13 cwt. of goods. The covered wagons weigh 5 tons 18 cwt., and carry 14 tons 2 cwt. The carriages are 46 ft. 6 in. long over bodies, and are capable of seating 64 passengers each. I know of no system which can produce such results as these while maintaining the same reserve of strength.

The necessity of light tare weight on light railways of narrow gauge assumes an aspect of the highest possible importance when it is remembered that it effects a permanent economy in working expenses, by making it possible to carry, on a given maximum axle load, a greater quantity of goods per train at the same cost of coal, oil, and wages. This is not a matter affecting capital cost only, but there is an actual saving of revenue day by day in respect of every train that is run. The light tare weight of this rolling stock has, however, produced a substantial saving in the capital cost of the Barsi Light Railway, since it has enabled the Barsi Light Railway Company to move a very heavy traffic with engines limited to the low uniform axle load of 5 tons, on rails of 30 lb. and 35 lb. per yard. Had the wagon stock been built with the usual heavy tare weights, it would have been necessary, in order to carry the same weight of goods in each train, to have adopted a greater axle load, to have designed much heavier and more powerful engines, and to have employed rails of much greater weight per yard.

In regard to military requirements, which I have taken into account in designing this rolling stock, the advantages gained by the use of very light tare weights are of the highest possible importance. As stated above, it reduces the weight and bulk of permanent way to the smallest proportions, thereby increasing the length of track which can be carried in one ship, or by one train, and the permanent way being lighter it is handled and laid quicker. The pressed steel underframes require no trusses, consequently they pack closely and avoid the risk of breakdown from lost nuts or bolts. They are so light that they can be handled with very elementary lifting appliances, and the time lost on arrival in erecting stock shipped in sections for the greater convenience of handling is avoided.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Business was active in the pig-iron warrant market last Thursday forenoon, when about 40,000 tons changed hands, the dealing being very general. The demand, however, was chiefly for Scotch iron, the price of which rose ½d. per ton. Cleveland also rose ½d. In the afternoon there was a smart reaction in prices on some realisations, the drop being 2d. to 3d. per ton all round. Some 35,000 tons of iron were dealt in. The closing settlement prices were as follow: Scotch iron, 48s. 6d. per ton; Cleveland, 41s. 6d.; Cumberland and Middlesbrough hematite iron, 51s. 4½d. and 50s. 6d. per ton respectively. On Thursday forenoon the market was barely steady. Scotch warrants improved in price a little, up to 48s. 7d., leaving off at 48s. 6d. buyers. Cleveland and hematite irons declined in price a copper or two. In the afternoon the sales amounted to fully 30,000 tons. Scotch warrants declined 1½d., down to 48s. 5d. cash buyers, but all the other sorts left off at the forenoon close. The settlement prices at the close were 48s. 4½d., 41s. 4½d., 51s. 3d., and 50s. 4½d. respectively per ton. A good business was done on Monday forenoon, 30,000 tons of all kinds changing hands. The tone of the market was steady, and at the close prices had all advanced from ½d. to 2d. per ton. A moderate amount of business—15,000 to 20,000 tons—was recorded in the afternoon, when prices closed rather better than in the forenoon, the settlement quotations being 48s. 6d., 41s. 4½d., 51s. 4½d., and 50s. 7½d. per ton respectively. A firm tone ruled on Tuesday forenoon, when prices were distinctly harder. About 15,000 tons of iron were dealt in—10,000 tons out and out and 5000 tons of "options." Prices were advanced all round. About the same quantity of iron changed hands in the afternoon, and prices declined ½d. to 1d. per ton. The settlement prices at the close were 48s. 6d., 41s. 6d., 51s. 6d., and 50s. 10½d. per ton respectively. The market was very dull this forenoon. About 30,000 tons were sold. Some of the sales were engaged in by weak holders, and prices had a sharp break—1½d. to 2½d. per ton. Further flatness developed itself in the afternoon, owing to weakness in the speculative account, but the legitimate trade is as good as ever. On the day Scotch iron lost 4d. per ton. Afternoon sales 30,000 tons. The settlement prices were, respectively, 48s. 3d., 41s. 3d., 51s. 1½d., and 50s. 7½d. per ton. The following are the quotations for several No. 1 special brands of makers' iron: Clyde, 51s. 6d. per ton; Summerlee, 52s.; Calder, 52s. 6d.; Gartsherrie, 53s.—the foregoing all shipped at Glasgow; Glengarnock (shipped at Ardrossan), 51s. 6d.; Shotts (shipped at Leith), 52s. 6d.; Carron (shipped at Grangemouth), 53s. per ton. There are now 80 blast-furnaces in actual operation in Scotland, as compared with 77 at this time last year. Hematite pig iron is in good demand, and some of the makers of it are confident that the prices now ruling will not only be maintained, but that they will improve still further. The stock of pig iron in Messrs. Connal and Co.'s public warrant stores stood at 362,962 tons yesterday afternoon, against 362,982 tons yesterday week, thus showing a reduction for the past week amounting to 20 tons.

Finished Iron and Steel.—Makers of finished iron, who are generally well supplied with orders, are quoting from 2s. 6d. to 5s. per ton of advance on recent prices, the prospects of good trade in the early future being very decided. Marked bars are 5s. per ton up in price. The price of steel is likewise showing a firmer tendency, as the good tone that prevailed at the close of last year is being well maintained. There is an abundance of work on hand, and many fresh inquiries are being reported.

Glasgow Copper Market.—No transactions in copper were reported last Thursday forenoon, but the price of the metal was advanced 2s. 6d. per ton. In the afternoon 100 tons were dealt in, and the forenoon gain was lost. The market was firm, but idle, on the following forenoon, when only one lot of 25 tons changed hands at last price, 50*l.* 2s. 6d. per ton cash, with buyers over. The market continued firm in the afternoon, but dealing was again limited to one lot of 25 tons at 50*l.* 2s. 6d. per ton cash. A year ago copper was selling at 41*l.* per ton, or fully 9*l.* lower than it now brings. In the interval the demand and consumption have grown enormously. On Monday forenoon 50 tons were sold, and the price advanced 6s. 3d. per ton. No business was reported in the afternoon, prices closing very firm. Yesterday forenoon 50 tons changed hands, and the price made other 5s. per ton of advance. In the afternoon 25 tons were sold, and quotations gave way 1s. 3d. per ton. This forenoon 100 tons were dealt in, and the price rose 1s. 3d. per ton. In the afternoon the market was steady, but idle.

Royal Society of Edinburgh.—At the ordinary fortnightly meeting of the Royal Society of Edinburgh on Monday night, Dr. John Murray, F.R.S., of the Challenger Expedition, made a communication on the "Ocean Ranger" Reef of the South-West Pacific. In the course of his paper mention was made of a deep-sea sounding which was only about 260 yards less than six miles, which is the greatest ocean depth at present known. Several communications on purely physical subjects were afterwards submitted, the authors being Dr. C. G. Knott, Professor P. G. Tait, and Lord Kelvin.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Municipal Management of Tramways.—The accounts relating to the second quarter's working of the Sheffield tramways by the corporation have just been published. The weekly takings range from 801*l.* 16s. to 1105*l.* 17s. 4½d., the figures for the thirteen weeks commencing October 18 being respectively: October 18, 865*l.* 15s. 1d.; October 25, 823*l.* 16s. 5d.; November 1, 830*l.* 1s. 0½d.; November 8, 802*l.* 14s. 1d.; November 15, 839*l.* 9s. 2½d.; November 22, 846*l.* 1s. 2½d.; November 29, 819*l.* 1s.; December 6, 788*l.* 2s. 10½d.; December 13, 844*l.* 0s. 10d.; December 20, 816*l.* 11s. 2d.; December 27, 1041*l.* 5s. 7d.; January 3, 1105*l.* 17s. 4½d.; January 10, 801*l.* 16s. The largest increase over the corresponding week of the previous year was shown on January 3, when it reached 272*l.* 14s. 7½d.; the smallest increase was in the week ended December 27, when it was 62*l.* 7s. 2d. The total increase for the quarter reaches 1813*l.* 0s. 5d., and this without a single yard of extra tram line being worked. In the first quarter of the corporation's working the advance was 1371*l.*, so that since the lines changed hands the corporation have taken 3180*l.* more than their predecessors in a given period. The surplus shown by a year's work will probably reach about 6500*l.*, and deducting 2000*l.* for extra cost of working, there will be an additional profit of 4000*l.* The corporation have under consideration a great scheme of tramway extension.

The Sheffield Chamber of Commerce.—The annual meeting of the Sheffield Chamber of Commerce was held on Friday, when three of the local members of Parliament were present. The retiring President moved the adoption of the report, and took occasion to congratulate the Chamber upon the vast improvement shown during the year in the trade of Sheffield and of the United Kingdom generally.

Decrease in Cutlery Exports.—Sir Howard Vincent M.P., called the serious attention of the Sheffield Chamber of Commerce at the annual meeting of that body to the serious decrease in the exports of hardware and cutlery during the past 30 years. Whereas in 1866 we exported those goods to the value of 3,826,000*l.*, and in 1872 the amount had risen to 5,000,000*l.*, it had fallen in 1891 to 2,500,000*l.*, in 1895 to 1,856,000*l.* (or 3,200,000*l.* less than in 1872), and in 1896 to 2,121,000*l.*, or very little more than half the amount exported 30 years back. The matter was, he contended, most serious, looked at in the light of the efforts made by the manufacturers of Sheffield and Birmingham to bring their machinery and plant up to the latest date. Then as to iron and steel, 23,800,000*l.* worth was exported last year, as compared with 37,000,000*l.* in 1873, and 31,000,000*l.* in 1890. Side by side with our diminished exports came enormously increased imports of foreign competing goods, and this, he argued, was most serious. The Right Hon. A. J. Mundella, M.P., was more optimistic. While he did not think everything was quite as satisfactory as it might be, he believed that the trade during the present year would be probably as good as that which was experienced during the past 12 months

Iron and Steel.—Trade in nearly all departments of engineering work maintains its position, the only notable exception being the manufacture of textile machinery. The depression in this branch of industry is doubtless due to the great falling off in American exports. Locomotive builders and electrical and hydraulic engineers are busy. In the Sheffield district the satisfactory demand for all kinds of railway material, which we have chronicled for several months past, continues, and the works engaged in this line are fully employed, with ample orders on their books. Indian orders have been the most conspicuous ones from abroad, but small contracts from all parts of South America are coming in, and are doubly welcome after the long stoppage of orders from that quarter. The demand from the antipodes is very limited, except from Western Australia. In marine work the various branches are fairly well employed, although the amount of work is not equal to that for railway purposes. The great advance in freights in October was due to an accidental combination of circumstances, and not to the sudden inflation of the world's trade. It only happened that a large number of vessels were in the wrong place, and as soon as the situation was adjusted the exaggerated rates of freight fell, and with them the demand for new ships. The orders booked in the meantime will, however, keep the builders busy for some time to come. There are no new items of special interest to record in connection with armour. Bessemer billets are firm at 6*l.* to 6*l.* 10s., and in other directions the market maintains a strong tone.

South Yorkshire Coal.—The majority of the collieries in this district are being worked six days per week. Trade has once more opened strongly, and the demand for all kinds of fuel is now exceptionally good. The house-coal market is firm, and the large output of steam coal is readily disposed of. The Humber ports are taking a fairly good tonnage, and as the iron, steel, and textile industries are fairly active, values are well maintained. Best Silkstones realise at the pits from 8s. 6d. to 9s. 6d., Barnsley house coal 8s. to 9s., hards 7s. to 7s. 6d., manufacturers' coal 4s. to 5s. 6d. for best qualities, smudge 2s. upwards, coke from 8s. 6d. to 10s., best washed varieties up to 13s.

WATER SUPPLY OF LEICESTER.—The new Leicester Corporation Water Works reservoir at Swithland is now rapidly filling. The storage capacity of the reservoir is 383,000,000 gallons, and the water is now a little more than a foot below the weir. At Bradgate the stock is 482,000,000 gallons. At Thornton also there is a full supply. Altogether, Leicester has now a stock of 1,200,000,000 gallons of water, and no apprehensions are entertained of any further scarcity. Summer has, however, still to come.

THE ROLLING OF ARMOUR PLATES.—Mr. C. J. Stoddart, managing director of the Parkgate Iron Works Company, Rotherham, writes an interesting letter to a Yorkshire newspaper, in the course of which he states that the first armour plates were rolled at the Parkgate Iron Works, and that long before 1856, the year of the starting of the Atlas Works, the late firm of Samuel Beale and Co. were the only makers of rolled plates in the district. For some years previous to 1856 this firm, Mr. Stoddart says, rolled large plates for the Great Eastern steamship, and for the Irish mail boats Ulster, Munster, Leinster, and Connaught. In consequence of the flutter caused at the Admiralty by the appearance of the French armoured vessel La Gloire, a communication was made to Palmer Brothers, of Newcastle, who consulted with Mr. Samuel Beale on the matter. This gentleman, together with Mr. G. G. Saunderson, who was then manager of the works, decided to make an experiment in armour-plate rolling. As a result, the first battery plate from the Parkgate Iron Works was sent to Palmer Brothers and Co. on February 9, 1856, and between that date and the following April nearly 200 tons were supplied, ranging from 3 in. to 4½ in. in thickness. These formed the armour of H.M.S. Terror, which was launched in 1856.

PERSONAL AND TRADE NOTES.—Mr Charles Weiss, Assoc. M. Inst. C.E., who, since October, 1895, has been resident engineer and manager at the works of the British Aluminium Company, at Foyers, N.B., has resigned his position for personal reasons, after having superintended the erection of the plant and successfully started the manufacture of aluminium. We understand he will shortly sever his connection with the company.—Mr. Joseph M. Wilson, M. Inst. C.E., after 28 years' service as a member of the Board of Managers of the Franklin Institute of the State of Pennsylvania, Philadelphia, U.S., during 10 years of which he was President of the Institute, has declined renomination. He still retains an official connection with the Institute, however, as President of the Board of Trustees.—We learn that the plant of the Wigston Electrical and Engineering Company, Limited (in liquidation), has been purchased by Messrs. Girdlestone and Co., 16, Davies-street, W., who will carry on the business under the title of the Westminster Engineering Company, Limited. Mr. F. V. Andersen will act as consulting engineer to the firm.—Mr. H. B. Spencer, of 91, Haworth's Buildings, Cross-street, Manchester, will in future represent the Otis Elevator Company, Limited, in that city.—Mr. G. S. Goodwin, consulting engineer and naval architect, of Alexandra Buildings, James-street, Liverpool, has admitted into partnership Mr. A. Hamilton and Mr. W. F. Lambert. The firm will in future be known as Messrs. G. S. Goodwin and Co.—Mr. W. H. Severn, of Palace-chambers, 9, Bridge-street, Westminster, having dissolved partnership with Mr. H. F. Gooch, is continuing the business of consulting and inspecting engineer with Mr. J. C. I'Anson, formerly of Fry, I'Anson, and Co., Darlington, and of Saltburn-by-the-Sea, Yorks. The same address will be kept under the style of Severn and I'Anson.—Mr. H. C. Eyres, whose recent resignation of the management of the Coalbrookdale Company's London business, and appointment to that of the architectural department of the Falkirk Iron Company, we recently noted, was on Saturday last entertained by the Coalbrookdale London staff, and presented with an illuminated address, together with a handsome piece of plate.—We are officially informed of the following changes in the management of the Brush Electrical Engineering Company: Mr. J. S. Raworth, whose time is now almost entirely devoted to the development of the "Universal" steam engine, has resigned his position as joint manager and chief engineer, and has been appointed consulting engineer and elected a director of the company. Mr. W. M. Mordey, who for many years has been chief electrician, will in future act as consulting electrician to the company, and will be free to undertake other work, the company, however, retaining his advice and assistance with regard to the articles of his design and invention which it manufactures. Mr. Percy Sellon, lately joint manager with Mr. J. S. Raworth, has been appointed general manager of the company, and Mr. C. E. Hodgkin works manager at the Loughborough Works.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—Yesterday there was a very numerous attendance on 'Change, and a cheerful tone prevailed. Perhaps the most satisfactory feature of the market was the desire exhibited on the part of buyers of pig iron to enter into contracts for forward delivery. Sellers were in no hurry to do business ahead. Models and photographs of considerable interest to Cleveland and Durham were exhibited by Mr. E. F. Jarvis, illustrating a system of water cooling whereby, it is claimed, ample supplies of cold water for condensing purposes, &c., can be obtained at a nominal cost. We learn that the plants in operation in Cleveland are giving satisfaction. Although the system is a German invention, and very largely adopted there, the whole of the plant is manufactured in England. For prompt f.o.b. delivery of No. 3 g.m.b. Cleveland pig iron 41s. 6d. was freely offered, but it was very difficult to find sellers prepared to do business at such a figure. Parcels changed hands at 41s. 7½d., whilst some firms held out for 41s. 9d., and reported that they were able to get it. For delivery to the end of March 42s. was paid. Middlesbrough warrants were steady throughout the day, opening at 41s. 6½d., and closing 41s. 6d. cash buyers. No. 1 Cleveland pig was reported scarce, and 43s. 6d. was generally quoted for it. No. 4 foundry was 41s., and grey forge 40s. East coast hematite pig iron had a decided upward tendency in price, and this was to be expected considering the present cost of production. For early delivery of mixed numbers 52s. was paid, and as much as 53s. was asked by some makers. Foreign ore was very firm in price, the demand being large. Rubio was 15s. 6d. to 15s. 9d. ex-ship Tees. To-day affairs were rather quiet owing to warrants easing a little, but prices for makers' iron were not quotably changed. Middlesbrough warrants closed 41s. 3d. cash buyers.

Manufactured Iron and Steel.—Little new can be reported of the manufactured iron and steel trades. In all departments there is considerable activity, and prospects for the future are regarded as bright. There is really no change in quotations, but the tendency is certainly in the right direction. Common iron bars are put at 5*l.* 7s. 6d.; iron ship-plates, 5*l.* 5s.; steel ship-plates, 5*l.* 10s.; iron ship-angles, 5*l.* 2s. 6d.; and steel ship-angles, 5*l.* 7s. 6d.—all less the usual 2½ per cent. discount for cash. Heavy sections of steel rails are 4*l.* 12s. 6d. net at works.

The Coal and Coke Trades.—Coal on the whole is steady, but some kinds show a slight easing. Gas coal commands fancy prices for odd cargoes, but the period of largest consumption is now passing away. Bunker coal is not so firm as it was. Coke does not change in price, but the fact is there are not many sales just now, most consumers having made rather long contracts. About 13s. 6d. may be given as the general quotation for good blast-furnace qualities delivered at Cleveland works.

THE ARGENTINE NAVY.—The Argentine ironclad Almirante Brown has left Buenos Ayres for France, where she will receive new guns.

ENGINEERING AT THE WEAR.—The North-Eastern Marine Engineering Company, Limited, at their Sunderland works, last year constructed engines for 37 vessels, the total power being 17,290 indicated horse-power. This, added to the 37,150 indicated horse-power of machinery made at the Wallsend works, gives a total of 54,440 indicated horse-power—the highest of any north-east coast firm.

CAPETOWN.—Mr. W. T. Olive has addressed a letter to the Capetown Town Council requesting to be relieved of his duties as city engineer and surveyor. In the event of the council consenting to cancel an agreement entered into by Mr. Olive in March, 1895, he will be willing to act as engineer for the city drainage scheme, either until the completion of the works, or for such a period as the council may desire.

EMBANKING THE WATERS OF THE NILE AT ASSOUAN IN UPPER EGYPT.—At a meeting of the Victoria Institute, held at Adelphi-terrace on Monday last, the proceedings were commenced by reading a letter received by the Institute from Her Majesty, and the election of new members, after which Professor E. Hull, LL.D., F.R.S., described the last proposed scheme for embanking the waters of the Nile at Assouan in Upper Egypt. After referring to the long lapse of time during which the cultivation of the ground in Egypt had been carried on by irrigation, and having described the origin of the rise and fall of the Nile and the source of the fertilising sediment, the author proceeded to deal with the question of the proposed embankment of the Nile waters at the First Cataract, by which during the period of low Nile the waters would accumulate to the extent of allowing a second flood by means of distributing canals carried down the valley on each side of the river. He also gave an historical sketch of the various projects proposed by Linant de Bellefonds, Count de la Motte, and Mr. Prompt, and the final adoption of the Assouan site on the report of Mr. W. Willcocks, Director-General of Reservoirs, together with the arrangement by which the Island of Philæ, with its monuments, would be preserved from injury. As regards the advantages of the scheme in increasing the productions of Egypt, it had been estimated by Mr. Garstin that the gain to the State would amount to 850,000*l.* per annum, and the increased value of the crops from Upper, Middle, and Lower Egypt to 16,000,000*l.* per annum.

NOTES FROM THE SOUTH-WEST.

Cardiff.—The best descriptions of steam coal continue in strong demand, and colliery proprietors have, in some cases, disposed of nearly the whole of their production for five or six weeks in advance. Prices have been tending upwards, the best descriptions having made 11s. to 11s. 3d. per ton, while secondary qualities have been firm at 10s. 6d. to 10s. 9d. per ton. The demand for steam coal has also been in excess of the supply. Household coal has shown considerable firmness: No. 3 Rhondda large has made 11s. to 11s. 3d. per ton. Patent fuel has been in good request at previous prices. The demand for coke has been active: foundry qualities have made 17s. to 17s. 9d. per ton, and furnace ditto 16s. to 16s. 6d. per ton. There has been a steady inquiry for iron ore, but prices have been scarcely maintained; the best rubio has made 14s. 6d. per ton. The manufactured iron and steel trades continue brisk, there having been numerous inquiries for steel rails, steel sleepers, and Bessemer and Siemens steel bar.

Barry Railway.—A project has been brought forward for constructing a deep-water pier at Weston. The promoters ask for powers to construct a pier from a point adjoining the Marine Hotel for a distance of about 2000 ft., where a depth of 12 ft. of water would be obtained at low tide. The project will have the assistance of the Barry Railway Company. It is stated that the Barry Company also intends to construct four steamers for passenger traffic, two of which will be ordered and will be available for service next season.

Pembroke Dock.—The monthly meeting of the Pembroke Town Council was held at Pembroke on Tuesday. Mr. Beesley, C.E., attended, and submitted plans and estimates both for sewerage and for supplying Pembroke Dock with water. The council decided to apply to the Local Government Board for authority to borrow 27,000*l.* for water purposes and 15,000*l.* for sewerage, being the engineer's estimates. Mr. Beesley was further instructed by the council to prepare a scheme for the sewerage of Pembroke Ward, and this he promised to do within a month.

BRAZIL AND THE ELECTRIC LIGHT.—An order is stated to have been placed with a New York engineering company for the machinery required to work an electric light plant of 15,000 lights in southern Brazil.

THE STEAM YACHT "IVY" AND THE BENIN PUNITIVE EXPEDITION.—The part to be played in the Benin expedition by this steam yacht suggests a brief description. She was built by the Earle Company at Hull, and handed over to the Protectorate in less than a year from the time of commencement. Her ordinary speed of 10 knots can be increased to 13 knots; she is very roomy, an excellent sea boat, with plenty of accommodation for her officers and crew, besides 10 spare cabins and a large troop deck for the transport of military; she can carry about 500 native soldiers. Her dimensions are: Length over all, 237 ft., and 204 ft. between perpendiculars; breadth, 34 ft., and depth 16 ft. 6 in. She is constructed on the composite principle. The deck-house is 130 ft. in length and 20 ft. in breadth, built of teak, as are also all the cabin fittings and furniture. The yacht is specially ventilated. She carries a 7-pounder forward and two machine guns aft. The machinery consists of two sets of triple-compound engines of 1150 indicated horse-power, which drive a pair of bronze propellers, and steam is supplied from two large steel multitubular boilers working at 150 lb. pressure. Her draught of 10 ft. 3 in. enables her to get further up the Niger than any of H.M. ships on the station.

H.M.S. "TERRIBLE."—It was intended during the past week to have the gun trials of H.M.S. Terrible, but the weather proved too hazy, and the vessel returned to Portsmouth Dockyard on Monday, the 18th inst. Some trials, however, were made with her steering engine, and the helm was put from the middle line to hard over in 11 seconds, and from hard over to hard over in 25 seconds, the time specified in the contract being 30 seconds. In connection with the progressive speed trials two runs have been made on the measured mile at Stokes Bay, but the others have been postponed. There was a 1-knot tide running, but other conditions were favourable. Going with the tide the speed was 11.25 knots, the starboard engine making 49.12 revolutions and developing 1115 indicated horse-power, and the port engine 47.62 revolutions and 893 indicated horse-power. This gives a mean of 48.8 revolutions, and a total of 2008 indicated horse-power. Against the tide the speed was equal to 9.326 knots, and on this run the starboard engine made 50.51 revolutions, and developed 1180 indicated horse-power, while the port engine made 48.03 revolutions, indicating 907 horse-power. The mean was 49.27 revolutions, and the total 2087 indicated horse-power. Thus for the two runs the means were: Speed, 10.288 knots; engine revolutions, 49; indicated horse-power, 2047. We shall continue our article on the trials when these progressive speed trials are completed. Messrs. Allen, of Bedford, call attention to the fact that in the list of auxiliary machinery working during the 29 hours' coal consumption trial of H.M.S. Terrible, given on page 84 *ante*, there are omitted two of the three sets of electric light machinery which were working at nearly the full load. Each set is capable of developing 90 indicated horse-power, so that with this addition of 180 horse-power the coal consumption of the propelling machinery is slightly better were deduction made for auxiliary machinery, but, as already explained, the Admiralty do not make any allowance. Messrs. Allen installed the engines.

ROLLING STOCK FOR THE BARSI LIGHT RAILWAY.

CONSTRUCTED BY THE LEEDS FORGE COMPANY, LIMITED, LEEDS.

(*For Description, see Page* 106.)

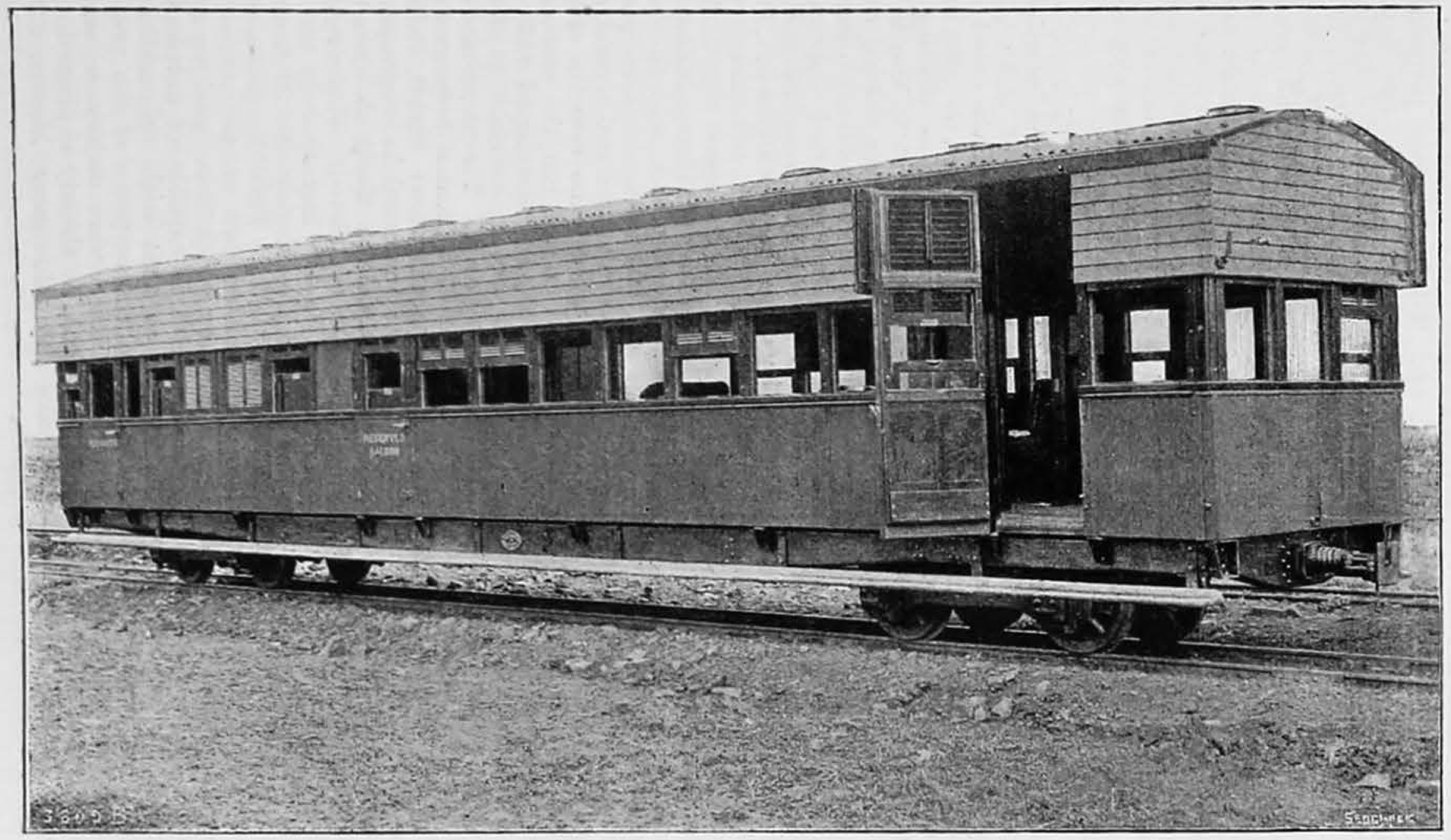


FIG. 2. SALOON CAR.

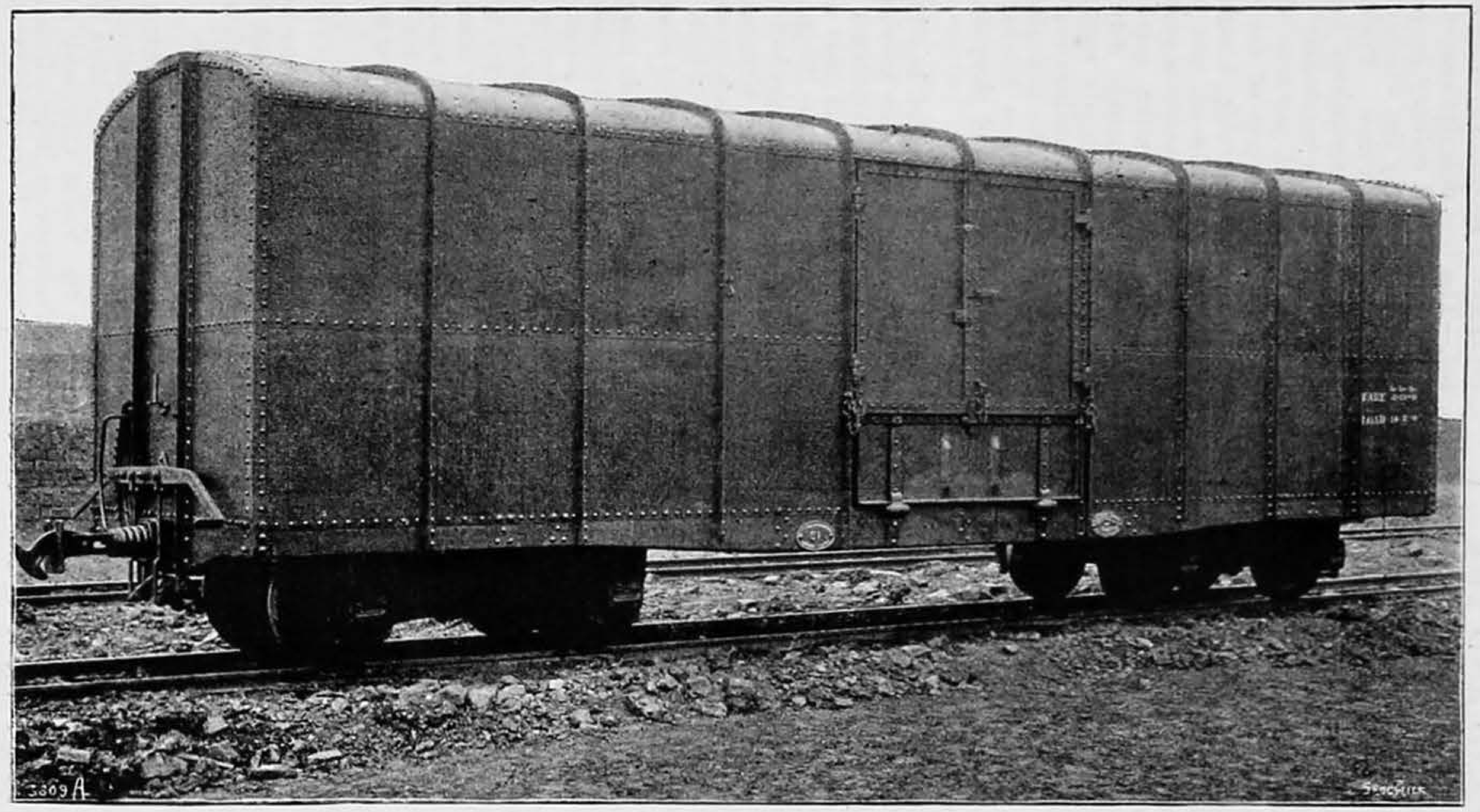


FIG. 3. STANDARD COVERED GOODS WAGON.

FIG. 4. LOW-SIDED TRUCK.

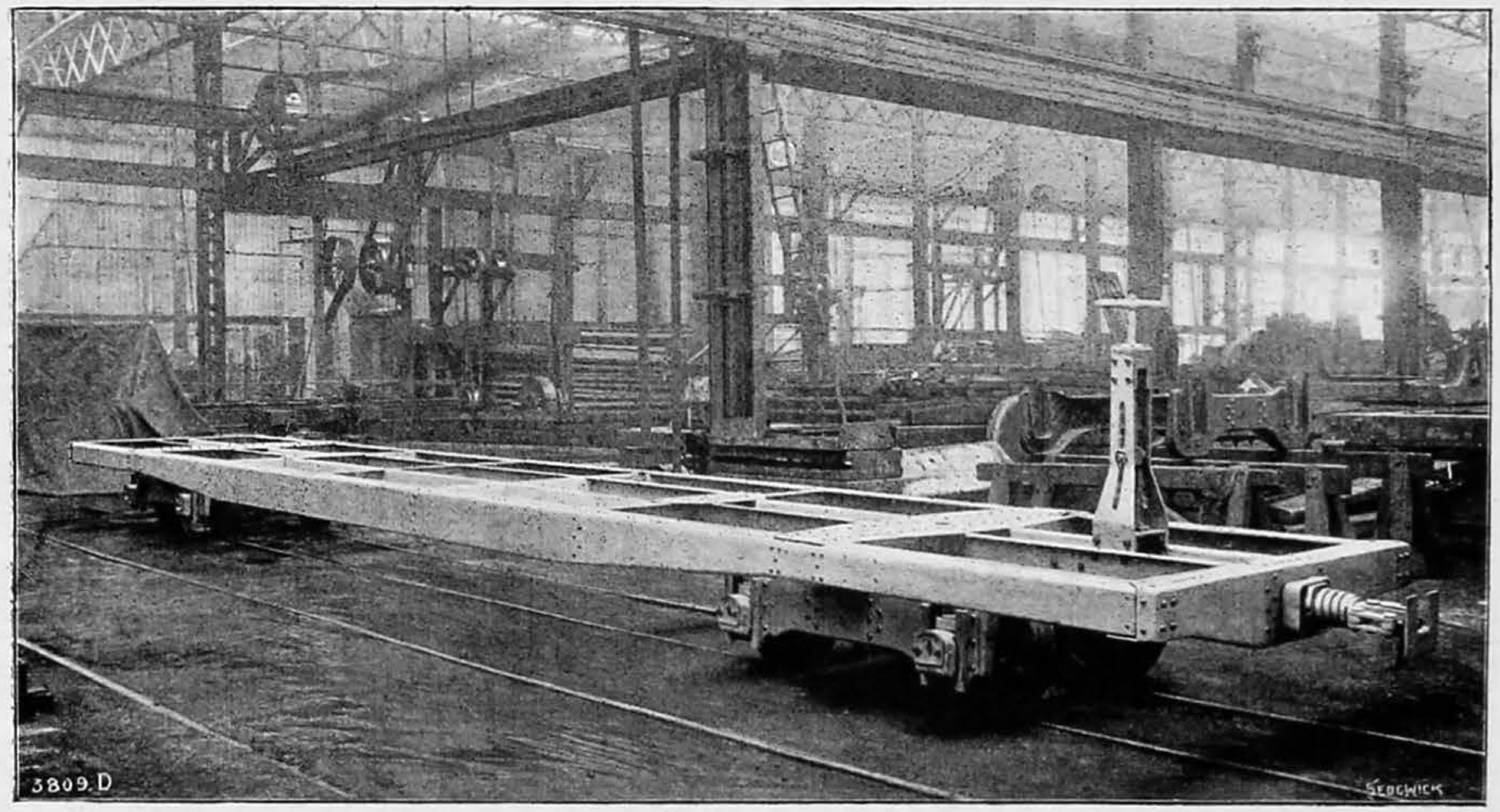
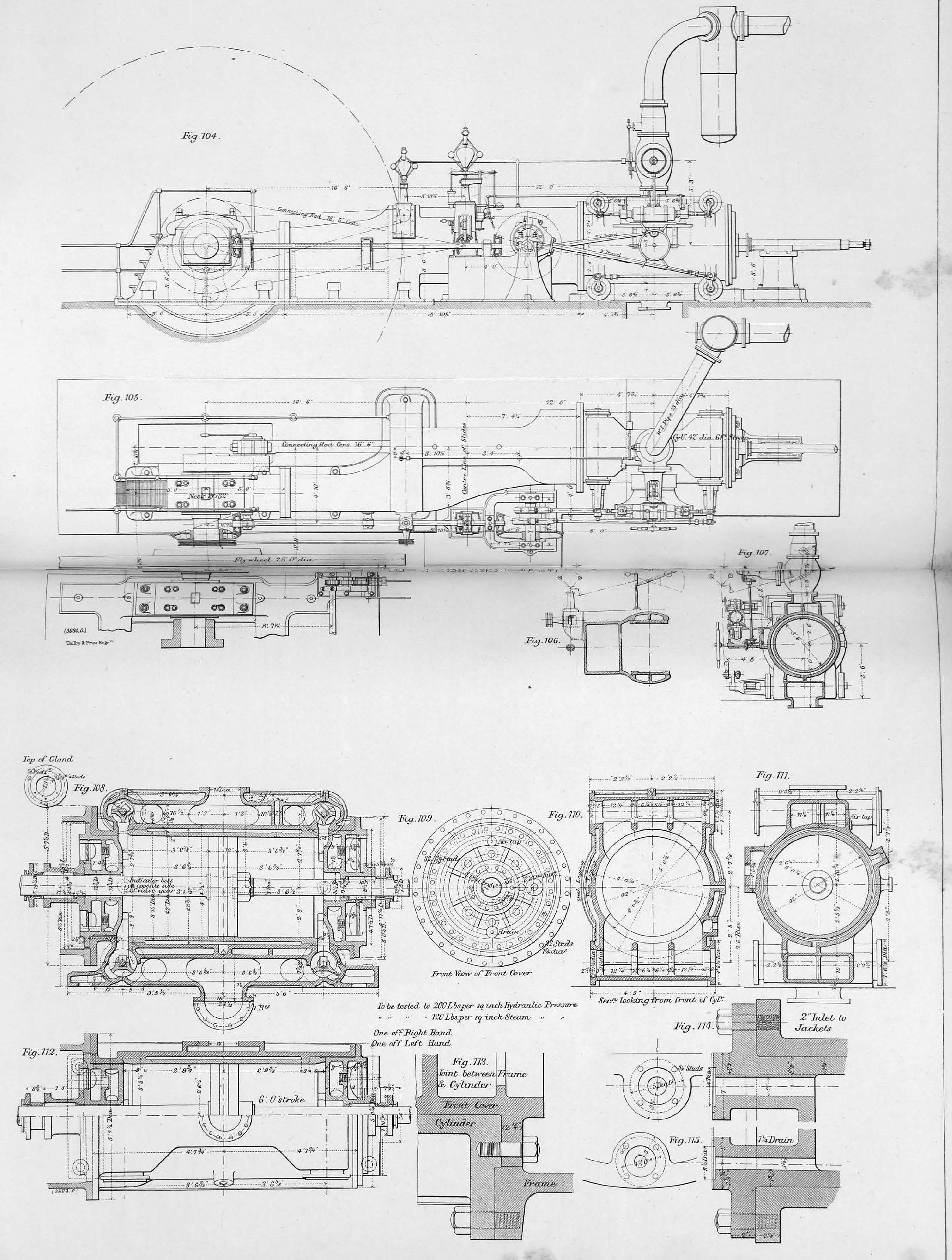


FIG. 5. STANDARD CARRIAGE UNDERFRAME.

GLASGOW DISTRICT SUBWAY: CABLE HAULAGE ENGINE.

MESSRS. SIMPSON AND WILSON AND MR. D. H. MORTON, GLASGOW, ENGINEERS; CONSTRUCTED BY MESSRS. YATES AND THOM, ENGINEERS, BLACKBURN.

(*For Description, see Page* 95.)



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With a Two-Page Engraving of the GLASGOW DISTRICT SUBWAY: CABLE HAULAGE ENGINE.

NOTICES OF MEETINGS.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, January 26, at 8 p.m. Paper to be read with a view to discussion: "The Diversion of the Periyar," by Colonel J. Pennycuick, C.S.I., R.E. Students' meeting, Friday, January 29, at 8 p.m Paper to be read: "An Experimental Investigation of the Efficiency of a Pelton Waterwheel," by Mr. S. Henry Barraclough, B.E., Stud. Inst. C.E. Dr. Alexander B. W. Kennedy, F.R.S. (Member of Council), will take the chair.

THE SURVEYORS' INSTITUTION.—Monday, January 25, when the adjourned discussion on the paper read by Mr. Howard Martin (Fellow) at the last meeting, entitled, "The Future Development of the Surveyors' Institution," will be resumed. The chair to be taken at eight o'clock.

INSTITUTE OF MARINE ENGINEERS.—Monday, the 25th inst., at 58, Romford-road, Stratford, E., at 8 p.m. A paper will be read by Mr. B. H. Joy, on "Joy's Valve Gear and Assistant Cylinder."

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, January 28, ordinary general meeting at 8 p.m., at the Institution of Civil Engineers, 25, Great George-street, Westminster, S.W. "Electrical Interlocking the Block and Mechanical Signals on Railways," by Mr. F. T. Hollins, Member.

ROYAL INSTITUTION OF GREAT BRITAIN.—Friday evening, January 29, at nine o'clock. Professor Jagadis Chunder Bose, M.A., D.Sc. (Professor of Presidency College, Calcutta), on "The Polarisation of the Electric Ray."

THE INSTITUTION OF JUNIOR ENGINEERS.—Saturday, January 30, at 3 p.m. Visit the Lion Brewery, Belvedere-road, Lambeth.

SOCIETY OF ARTS.—Monday, January 25, at 8 p.m. Cantor Lectures. "Material and Design in Pottery," by Mr. William Burton, F.C.S. Four Lectures. Lecture II.—Tuesday, January 26, at 8 p.m. Applied Art Section. "The Artistic Treatment of Heraldry," by Mr. W. H. St. John Hope, M.A.—Wednesday, January 27, at 8 p.m. Seventh ordinary meeting. "Voice Production," by Mr. William Nicholl. Dr. C. Hubert Parry, Director of the Royal College of Music, will preside.—Thursday, January 28, at 4.30 p.m. Indian Section. This meeting will be held at the Imperial Institute. "The Moral Advance of the Peoples of India during the Reign of Queen Victoria," by Mr. William Lee-Warner, M.A., C.S.I., formerly British Resident in Mysore, and Chief Commissioner of Coorg. The Right Hon. the Lord Herschell, G.C.B., D.C.L., will preside. —Thursday, January 28, at 8 p.m. Howard Lectures. "The Mechanical Production of Cold," by Professor James A. Ewing, M.A., F.R.S. Six Lectures. Lecture I.

THE SOUTH STAFFORDSHIRE INSTITUTE OF IRON AND STEEL WORKS' MANAGERS.—Saturday, the 30th inst., at the Institute, Dudley, when Mr. Alex. E. Tucker, F.I.C. (Past-President), will read a paper on "Lubricants and Lubrication." The paper will be illustrated by several lantern views. Chair to be taken at 7 p.m.

ENGINEERING.

FRIDAY, JANUARY 22, 1897.

HIGHER TRAINING IN TECHNOLOGY.

ALL those interested in the question of technical education will rejoice in the triumphant vindication of the work of the Central Technical College, which appears in the report of the committee appointed, at the request of the Mercers' Company, to consider the "expenditure of the Central College of the City and Guilds of London Institute for the Advancement of Technical Education, especially as compared with results." The wording of this request shows pretty clearly where certain sections in the City felt the pinching of the shoe. For a given expenditure the various polytechnics were passing through their classes many more students than the Central Technical College, so that the expenses per student in the latter seemed high, no regard being paid to the quality of the work accomplished in the two classes of institution. This latter can only be judged by experts, whilst every man in the street is quite capable of appreciating mere matters of quantity. Moreover, and quite legitimately, many of the guilds felt that in the case of the Central Technical College they were not getting due credit from the public for the heavy pecuniary sacrifices which were necessary to establish and maintain it, whilst an equal sum expended on a second-grade polytechnic of little or no advantage to the industries of the country would receive frequent and eulogistic mention in the press. Further, a certain amount of ill-feeling was created in the City by the bestowal of what was in truth a well-deserved knighthood on Sir Philip Magnus for his work in directing the technological undertakings of the guilds. But the men who had found the sinews of war were at the same time passed over, and their friends felt aggrieved, and perhaps not unjustly, as there is nowadays a disposition to depreciate the qualities by which the wealth of the nation is maintained or increased. As much talent, and far more mental worry, is expended in building up a big business as in attaining the position of Senior Wrangler in the Mathematical Tripos.

With such feelings prevalent as those mentioned above, the Governors of the City and Guilds of London Institute were well advised in promptly meeting the views of the malcontents, and appointing a very strong committee to go into the whole matter, this committee including representatives of both the professional and the commercial members of the guilds. A President and a Past-President of the Institution of Civil Engineers, and three Past-Presidents of the Chemical Society, insured that the committee should be competent to deal with the question of the efficiency of the training provided at the college, whilst the other members were equally well equipped on the financial side of the matter. This special committee in turn appointed two sub-committees; one, under the presidency of Mr. E. L. Beckwith, dealt with the finance and administration of the college, and the other, of which Sir Douglas Galton was chairman, with the educational work. Both committees completely vindicate the college in all respects. The former, in its report, gives a short history of the Central Technical College, which, as stated at its inception, was formed to accommodate three classes of student, to number about 200 in all, and to consist (1) of those intending to become teachers, (2) of persons over 16 who, having passed an entrance examination, took a complete course in technology, and (3) special students, such as men already engaged professionally, who wish to attend special courses. The building and equipment of the college cost 101,800l., and the net annual cost to the guilds is rather less than 7000l. per annum, whilst the original estimate was 3000l. more. It is difficult on this showing to see any possible ground of complaint. Indeed, in place of censure for their extravagance and waste, the college authorities deserve the thanks of the guilds for the remarkable economy with which they carry out their work.

Comparison with other institutions of somewhat similar standing will be of interest, and are supplied in the report of the sub-committee. They show the capital expenditure of the Central Institution has been but 101,800l., whilst abroad the Engineering and Physics Department of the McGill University has cost 202,000l., the Massachusetts Institute of Technology (very similar to the Central Technical College in its scope) 210,000l., the Technical High School at Berlin no less than 450,000l., and that at Munich 193,000l., whilst in France the Ecole Centrale des Arts et Manufactures has cost 250,000l. for its buildings alone. The cost per student is also much less than elsewhere, as shown by the following Table:

—	Number of Students.	Gross Cost per Student	Net Cost per Student
		£	£
Central Technical College	210	54	31
England:			
Cooper's Hill	100	120	
Royal College of Science	300	67	57
America:			
Massachusetts Institute	1200	60	22
Cornell University	1503	63	43
Johns Hopkins University	600	61	25
McGill University (Applied Science only)	175	60	29
Germany:			
(Report of Royal Commission, 1884)	2000	..	100
Switzerland:			
Polytechnic, Zurich	720	59	50

The net cost per student is also, it will be seen, well below the average of the other colleges mentioned, and where lower than at the Central, the difference is due to higher fees.

Many of the complaints which have been made against the Central Technical College have been founded on an anonymous pamphlet published some time back, the writer of which displayed considerable ingenuity in inventing his facts and garbling his quotations to meet his already settled conclusions. This pamphlet has been dealt with by the committee seriatim, and its statements traversed one by one. The most ridiculous was, perhaps, a charge of professorial extravagance, implied rather than definitely stated. It appears that three of the professors are allowed to control an expenditure of 400l. a year each for laboratory apparatus, &c. This sum cannot be considered an extravagant one from any point of view, and, as a matter of fact, we understand that the professors have often to employ in the laboratories instruments belonging to them personally, the equipment being incomplete in these respects. One important feature of the arrangements at the Central is that the professors have no share in the fees, but are paid a fixed salary of 1000*l*. per annum each. This is an excellent arrangement from the student's point of view, as there is thus no inducement to lower the standard of the entrance examination, and a whole class is not kept back for the sake of two or three "weaker brethren." From the professor's standpoint, however, it may be doubted if the plan meets with equal approval, as their present stipends are lower than those actually received by the occupants of chairs at institutions of much lower standing, where the professor is awarded a share of the fees. As matters stand, it appears that the entrance examination at the Central is more difficult than at any other technical college in the kingdom. Indeed, considering the deplorable state of secondary education here, it is, perhaps, too difficult. The masters of the great public schools, in addition to their notorious laziness, are steeped in the old classical traditions, and their pupils, though occasionally able to write fairly grammatical Greek and Latin, are too often grossly ignorant of the facts of nature around them. No substantial reform in this regard is to be expected. The modern side of such schools is looked down on by both boys and masters, and the cleverer youths are kept as much as possible on the classical side, whilst, judging from impassioned appeals to the authorities to lower the standards for the entrance examinations for the Army, it would seem that the teaching, such as it is, is far from competent. Nevertheless the heads of these establishments have enormous influence on the educational progress of the country, their example being followed by the smaller middle-class schools. It will not be at all surprising if the various polytechnics, now so popular and so useless, so far as any direct benefit to the industries of the country is concerned, do not find their true field of development in providing a good secondary education on scientific lines.

Many people seem to imagine that a technical college should turn out fully equipped engineers, who should step into highly-paid berths immediately on finishing their course, and are aggrieved to find that a further stage of training is necessary before the ex-student's services are of much commercial value. Many of the complaints against ex-students of technical colleges arise from an absence of tact and an abundance of self-conceit on the part of the latter. As the purely shop-trained youth is often imbued with a sublime contempt for theoretical knowledge of any kind, so the "techniker," to use a German term, despises a chief draughtsman ignorant of the calculus, and who refers to a book of tables when he desires to ascertain the strength of an I-beam. That enthusiastic youth, on the other hand, will calculate out the same beam by a long and tedious process, too often making a slip of a decimal point or other equally essential matter. Such mistakes are of little importance in a college drawing-office, but in actual practice might, if undetected, endanger both life and limb. An experienced man can usually give a fair guess as to what his calculation should result in, but a student new to the work has, at first, no such methods of checking his results. Often he will feel hurt at the fuss made over what he considers a mere slip of the pen, whilst his superior too often considers the incident as a striking example of the uselessness of a college training.

THE SECOND-CLASS PASSENGER.

DURING the next few weeks the railway companies will hold their half-yearly meetings, and we shall hear the oft-repeated tale of great increases in the receipts from third-class passengers, of the stationary condition of first-class traffic, and of diminished revenue from the second class. Year after year there is the complaint that the second-class passenger is disappearing, and hints are thrown out that he must be entirely abolished. Ended or mended he must soon be, for a source of revenue which steadily diminishes, in the face of great progress in business, certainly requires radical treatment of some kind. The simplest method is to take off the second-class coaches altogether, and reduce the divisions to first and third. This has been done on the Midland and in Scotland for many years, and the public is fairly content. More recently the trains running from London to Edinburgh and Glasgow have been restricted to two classes of coaches. The change was due mainly to the introduction of the third-class dining car; it was out of the question to run three classes of restaurants in one train, and, therefore, one description of passenger had to be sacrificed. Apart from these instances, however, the great English lines are unwilling to follow the Scotch example. The second-class passenger is to them in the nature of a windfall, a gift from the gods, which they have done nothing to earn. He pays them 30 to 100 per cent. above third-class fare, and gets practically nothing in return for it in the way of comfort. No wonder they are loth to part from him.

The second-class passenger is a survival from what are, to many among us, the prehistoric times of the "Government train." In those days he got full value for the extra money he paid over third-class fare. He travelled at a good speed in a carriage that was wind and weather tight, and had sometimes a padded seat. The man who went with a "Government ticket" stopped at every station, and not unfrequently he found the train had gone into a siding for an indefinite period. He sat on a bench which grew harder and harder as the hours dragged wearily on, and he only leaned against the back as a variation to his discomfort. In the early days his carriage had not even a roof, and even when this defect was remedied, it had no windows except in the sliding panel in the door. When these conditions obtained, the second-class passenger bore an unmistakable stamp of superiority; in the language of the day, he was "genteel," and was a relation in blood—although not the equal in wealth—to the first-class passenger. But when third-class carriages were attached to all trains, in the early seventies, a new state of affairs arose. Every one travelled at the same speed, and thus the chief advantage of the well-to-do was thrown open to all. Gradually, as the companies recognised what a mine they had tapped in the third-class passenger, the style and fitting of his carriage improved, until now, on main line trains, it leaves very little to be desired. The second-class carriage, meanwhile, was neglected, and if it did not remain as it had been, it only received sufficient modification to render it distinguishable from the third-class. In the essentials of comfort—roominess and softness of seat—the two are practically alike.

Those lines which were subject to the influence of the Midland reduced the second-class fare when they added third-class to all trains, and probably on all lines there has been a decrease of second-class fares during the last 20 years. But in no case was the reduction sufficient to put the second and third class passenger on an equality, in view of the relative facilities which they enjoyed. For the privilege of a distinctive pattern of lining, and an additional inch of stuffing in the cushions, the second-class passenger paid 30 to 35 per cent. extra on the northern lines, and 50 to 150 per cent. extra on the southern lines. In an article in our issue of December 2, 1892, advocating the reduction of second-class fares (vol. liv., page 699), we gave a list of representative fares bearing out these figures. In other words, instead of paying about 3s. 6d. an hour for riding, he paid 4s. 8d. and more. At that rate a coach running five single journeys per week between London and Glasgow, and being on the average half full, would earn an additional 4000*l*. a year if it were labelled second instead of third, a very handsome return on the extra hundred pounds or so spent on its fittings.

A considerable number of people still travel second class, and pay second-class fare for third-class accommodation. At the first glance it appears curious that they should part with their money for no return; but a little consideration shows that what they pay the company for is the privilege of travelling among their social equals. The figure II. painted on their carriage door is a barricade against the intrusion of the drunken, the dirty, and the ill-behaved, and for this some people are willing to pay 1s. or more per hour. It is not that third-class passengers are not generally perfectly pleasant companions, but that there is the chance of occasional annoyance of a very serious kind, and to avoid that, timid and fastidious people are ready to pay. As education spreads, we may expect outbursts of ill-breeding to become less and less frequent, and with the improvement in manners will come a further decline in the receipts from second-class carriages. There is so little companionship among railway travellers that there is no gain from sitting with persons of a high social position; all that one desires are negative traits. A man who attracts no attention whatever is as satisfactory a fellow-voyager as an Admirable Crichton.

The railway companies have two alternatives before them in respect of second-class traffic: they can end it or mend it. The Scotch companies have done the former. There are signs that the English companies will do the latter. The matter lies in a nutshell: the second-class passenger must get value for his money, either by the reduction of the fares, or by increase of comfort, or by both. For 25 years he has been neglected, while the first-class passenger has been pampered, and the third-class petted. Our view is that an increase of comfort would draw large numbers out of the third class, and that the change should take the form of increased room. "Five on a side" is an admirable injunction from a company's point of view, but as an experience extending over five or six hours it induces comparisons with the middle passage and with the Inferno. Before the journey's end you begin to loathe humanity, especially in the form which presses so heavily against you on either side. Four on a side is quite a bearable condition, especially if there be a middle division, which affords each the opportunity of supporting himself without interference with his neighbour. Without any alteration of fittings, other than an arm in the centre of each seat, it would be possible to make a sudden and noticeable increase in the second-class returns of any of our trunk lines. Occasionally—very occasionally—as at Christmas or Bank Holidays—there would be a fractional diminution in the seating capacity of a train, but none in the receipts. Those of our readers who are accustomed to travel third-class on such occasions know how readily many people would pay a little extra to avoid the crushing which takes place.

The increase which occurs in the receipts from the second class when the fares are reduced has lately been demonstrated on the London and South-Western Railway. That line is free from the competition of the Midland, and therefore its second-class fares have been on the level of the first-class fares on many of the northern lines, viz., at 1½d. per mile. On May 1, 1896, the directors, acting on the advice of their able manager, Sir Charles Scotter, decided to make a general reduction. In the following seven months there was an increase in the number of ordinary second-class passengers of nearly 98,000, and an increase in the corresponding receipts of between 16,000*l*. and 17,000*l*. This increase was not obtained at the expense of the first-class receipts, for they grew also, and it is evident that it was due to the institution of a more liberal policy. To show the extra cost of travelling by the second-class we have taken at random a few fares from London to places on the South-Western system:

Fares from London to Places on the South-Western Railway.

Place.	Second-Class. Single.		Second-Class. Return.		Third-Class. Single.		Third-Class. Return.	
	s.	d.	s.	d.	s.	d.	s.	d.
Andover ...	7	0	12	2	5	7	11	0
Bagshot ...	3	4	5	10	2	8	5	0
Barnstaple	21	6	37	10	17	3	34	6
Bodmin ...	26	0	45	8	20	10	41	8
Corfe Castle	13	3	23	3	10	7	21	2
Fareham ...	7	9	13	6	6	2	11	6
Micheldever	6	0	10	8	4	10	9	8

A glance at the list explains the cause of the increase. The second-class fare is now only about 20 per cent. greater than the third for single tickets, and 10 to 14 per cent. greater for return tickets. As most of these latter are available for a month, there is very little reason for any person in comfortable circumstances travelling third class. As the Great Western Company run in competition with the South-Western to many points, they naturally have to adopt the same scale of fares. It thus comes that the two west lines actually carry second-class passengers more cheaply than do the north lines, which we are apt to regard as being in the first rank. This advantage is not compensated by any want of speed or comfort. Both the South-Western and the Great Western lines can compare with any in the country in this respect.

We trust it will not be long before this valuable example is followed, for, to use an unconventional expression, there is money in it for the companies, and comfort for the public. Under the present conditions of rolling stock, 1½d. per mile for second-class passengers would yield a good return to the companies, while if our suggestion of a middle division in the carriages were adopted, there would be no difficulty in filling them at 1¼d. a mile. Sir Richard Moon used to point to the hundreds of pounds taken at Euston every week when it was suggested that second-class carriages should be abolished, and ask why the company should throw away such a source of income. Why, indeed? The difference paid between third and second class fare is almost entirely profit. The right course is not to abandon a certain source of income, but to encourage it, and the best way to do this is to give a fair return for the price demanded. There are more than two strata of society in this country, and it is good business to recognise the fact. At present the railway companies divide mankind into the rich, the poor, and those who are willing to pay more for their accommodation than it is worth. We are glad to learn that the last type of persons is steadily diminishing. The people whom the companies should place in the third category are those who want protection from the two disadvantages of third class—unpleasant company and overcrowding. Here is a remunerative and large source of traffic entirely neglected, and the sooner the present policy of many of our lines is abandoned the better for the shareholders.

AMERICAN OPINIONS OF JAPANESE INDUSTRY.

As is the case with almost every other debateable question, there is a great diversity of opinion regarding the extent and intensity of Japanese competition and the possibilities of the development of the industrial resources of Japan in the near future. On these subjects we shall always keep our readers informed, as far as possible from first sources, and present to them the different aspects of the subjects in which there is room for difference of opinion, so that they may form their own conclusions or judge of the correctness of those at which we have arrived. Our only purpose, we need scarcely say, is to help British manufacturers and engineers to adapt their productions to the requirements of the Far East, and to guard them against loss through ignorance of the conditions which actually exist.

In the United States of America the discussion of the probable results of Japanese competition is being carried on by those immediately affected with considerable vigour, and no doubt it will interest our readers to know what is said on the subject by those who have taken the trouble to make themselves acquainted with actual conditions, and therefore we shall from time to time note the most important points which are raised. The system of protection which has existed in America has created so many artificial interests that an impression has been given in that country that Japanese competition is merely a bogey which has been raised to terrify the American artisan and cause him to vote on certain party lines. Others seem to have the idea that it has been raised chiefly by the Lancashire bimetallists who believe that the cotton mills of the Far East are going to absorb a great part of their trade, and they wish to see silver monetised in order that what they consider to be the special advantages of silver-using countries may be taken away. We must, as far as possible, content ourselves with facts, and with conclusions which follow directly from these facts, and disentangle the discussions from all party or personal interests.

A short time ago a very interesting report was published in the "Bulletin of the Department of Labour" of the United States, and partially republished in the Journal of the British Board of Trade, which in many respects is worthy of careful study. It was written by Mr. W. E. Curtis from personal observations in Japan, and although we may differ from some of the conclusions at which he arrives, we have no reason to doubt his statements of facts. He gives a sketch of the industrial revolution in Japan, and shows most distinctly that that country is becoming less and less dependent upon foreign nations for the necessaries and comforts of life, and is making her own goods with the greatest skill and ingenuity. Since their release from the exclusive policy of the feudal lords, the people have studied the methods of all civilised nations, and have adopted from each those which seem to them the most suitable for their own purposes and convenience. They have found one thing in Switzerland, another in Sweden, another in England, others in Germany, France, and the United States, and have rejected what is of no value to them as readily as they have adopted those things which are to their advantage. Mr. Curtis is of opinion that the Japanese workman can make anything he has ever seen. His ingenuity is astonishing. Give him a piece of complicated mechanism—a watch or an electrical apparatus—and he will reproduce it exactly, and set it running without instructions. He can imitate any process and copy any pattern or design more accurately and skilfully than any other race in the world. It is that faculty which has enabled Japan to make such rapid progress, and which, in the opinion of Mr. Curtis, promises at an early date to place her among the great manufacturing nations. He believes that the industrial revolution which is now going on in Japan is quite as remarkable as the political revolution that occurred there 30 years ago, and equally important to the rest of the world. He points out that until recently all the manufacturing done in Japan has been in the households, and 95 per cent. of the skilled labour is still carried on in the homes of the people, and in a measure independent of the conditions that govern wage-workers in other lands. This, of course, does not apply to the factory industries which have made so much progress in recent years, in which we may note, in passing, there has been a great increase in the rates of wages, although these are still far below those of the corresponding rates in this country. The ancient system of household labour is being rapidly overturned by the introduction of modern methods and machinery. The older artisans are offering a vain resistance, and cannot be drawn from their antique looms and forges by any inducement that has yet been offered; but the younger generations are rapidly acquiring a knowledge of the use and value of labour-saving machinery, and factories are being built in all parts of the empire. As we have from time to time indicated, the greatest progress thus far has been made in cotton spinning and weaving, but considerable developments have also been made in the mechanical industries. Moreover, as Mr. Curtis points out, in four years the new treaties go into effect, when foreigners will be allowed to engage openly in manufacturing enterprises. Then their capital and experience will give a decided stimulus to mechanical industry, and the increase in the productive power of Japan will be even more rapid than now.

We cannot follow Mr. Curtis in his interesting account of the development of the cotton industry in Japan, and of the profits which have been made from it, especially as we have already given some idea of the subject in former articles. Suffice it to say that he fully confirms the figures and opinions which we have stated. He also gives a sketch of the extent of some of the other industries. His most important conclusions are summed up in the following paragraph, in which he says that "While the Japanese will soon be able to furnish themselves with all they use and wear and eat without assistance from foreign nations, they will be compelled to buy machinery and raw material, particularly cotton and iron. Therefore foreign sales will be practically limited to those articles, and, in addition, the market for machinery will be limited as to time. The Japanese will," he says, "buy a great deal within the next few years—almost everything in the way of labour-saving apparatus—but they are already beginning to make their own machinery, and in a short time will be independent of foreign nations in that respect also. Another important fact—a very important fact—is that they will buy only one outfit of certain machinery; this they will copy, and supply all future demands themselves. They will go on until the new treaties take effect, when foreign patents will be protected."

The facts, and to a large extent the opinions, of Mr. Curtis have been confirmed by the observations of the Hon. Robert P. Porter, who has in various ways been enlightening the people of the United States on the subject. In an article in one of the magazines he goes so far as to say that "in the United States little attention has been given to the question except by representatives of branches of business that have suddenly been confronted with a competition from Japan that has thrown all calculations to the winds and for the moment paralysed prosperous industry." Probably this may be considered an exaggeration, but his opinions have been arrived at after a careful inspection of all the chief industries of Japan, and he bears witness to the great activity which everywhere prevails, an activity which, indeed, is distinctly shown by the official reports showing the amounts of the exports. He has compiled a Table of the most important of these for the years 1885 and 1895, and the results are striking enough. The Table is as follows, the values being in silver dollars:

	1885. dols.	1895. dols.
Textiles of all kinds ...	511,990	22,177,626
Raw silk	14,473,396	50,928,440
Grains and provisions	4,514,843	12,723,771
Metal goods	2,112,997	6,538,220
Drugs, including sulphur and camphor ...	1,089,513	3,078,357
Books and paper ...	150,032	488,358
Tea	6,854,120	8,879,242
Matches...	60,565	4,672,861
Straw braids	(no record)	1,387,643
Matting...	935	3,461,369
Umbrellas (European)	1,765	735,207
Porcelain curios and sundries	2,786,876	11,624,701

After giving an account of the extent of the cotton industry in Japan, Mr. Porter expresses very emphatic opinions with regard to the future of that industry, and we cannot do better than quote his words verbatim. He says: "The future *situs* of the cotton industry, at least to supply the Asiatic trade, is bound to be China and Japan. England is doomed so far as this trade is concerned, and nothing can save her—not even bimetallism, as some imagine. Cotton mills are going up rapidly, both in Osaka and Shanghai, and only actual experience for a period of years will demonstrate which of these locations is the better. My own judgment, after a close examination of every item in the cost of production, is Japan. In this contest for the cotton trade of Asia, the United States must supply more and more of the raw cotton. The improvement in the number of the yarn spun and in the quality of the cotton cloth woven simply means a larger proportion of American cotton. Two new lines of Japanese steamships have been projected this year, and these ships are to run between the United States and Japan. The export of 50,000,000 dols. worth of cotton cloth to China and Korea will be no great achievement for Japan before the close of the century." Mr. Porter is further of opinion that should Japan take up the manufacture of woollen and worsted goods, as she has done cotton, her weavers could give Europe and America some surprises and dumbfound those who claim that there is nothing in Japanese competition. A constant supply of cheap wool from Australia makes it possible, while he believes that the samples of Japanese woollen and worsted cloth and dress goods which he saw in Japan indicate that in this branch of textiles the Japanese are as much at home as in silk and cotton. He quotes the opinion of the Japanese Vice-Minister of Agriculture and Commerce to the effect that "the Japanese are unrivalled in the world for cleverness, and their future is truly awe-inspiring to contemplate." If there were no facts to support this opinion, we might put it down as due in great part to national vanity, but while it must be admitted that that element is not wanting in the Japanese character, even their most severe critics are willing to allow that they have some ground for it. The facts and figures quoted by Mr. Porter are in themselves a very good reason for a considerable amount of pride on the subject, and he does not hesitate to say that when Japan is fully equipped with the latest machinery, in his opinion she will be the most potent industrial force in the markets of the world. This conclusion is probably an exaggeration, but the facts and figures which he has given prove most conclusively that Japanese competition is not the myth which some people seem to think that it is.

SUBMARINE TELEGRAPHY.

SIR HENRY MANCE publicly commenced his year of office, as President of the Institution of Electrical Engineers, on Thursday, the 14th inst. The members attended in large numbers to signalise the event, and their loyalty met with a better reward than it often does on such occasions, for they had the pleasure of listening to an address which was full of charm. Sir Henry, indeed, confessed, half apologetically, that his aim was to interest rather than to instruct. He certainly succeeded in interesting, and instruction was by no means absent from his remarks. Most presidents of scientific societies fail in both particulars, for the catalogues of statistics which they read to their members are like the sands of Sahara for dryness, bearing neither flowers nor fruit. Possibly a schoolmaster might consider them instructive on account of the facts they contain, but the President bears no rod, and cannot command the attention of his audience, except by interesting them. From a long experience of inaugural addresses, we have found that few are really successful which are not in some way autobiographical. We do not mean that they must necessarily deal with the speaker's personal affairs, but they must be the outcome of his life in one aspect or another. The best address of all—alas, how infrequent it is!—represents the resultant, to use a geometrical expression, of the actions and experiences of a career which has been attended by so much success that years and honours march hand in hand in public view. Surely a professional life of three or four decades should provide material for one hour's discourse without assistance from the Encyclopædia Britannica, or from back volumes of Proceedings. But, whether it be from excess of modesty, or from some other cause, it is seldom that a President draws on his own knowledge for his address, and this is the cause why there are so many failures. Inspiration is often sought from books and periodicals, and the result is a second-hand article which no one values.

Sir Henry Mance did not attempt to formulate the results of the many years he has devoted to submarine telegraphy, as he might well have done with great benefit to his audience; but he essayed the lighter task of giving an account of its rise and progress, interspersing his history with many personal observations and incidents which lent point to his remarks, and gave a verisimilitude to his narration. In many of the matters about which he spoke he had borne an important part; and although some of them are now historical, his words had the freshness which always attends the testimony of an eye-witness. Beginning with the experiments of Baron Schilling in the Neva in 1812, he traced the use of subaqueous conductors by Colonel Pasley in 1838, by Dr. O'Shaughnessy in 1839, by Professor Wheatstone in 1840, by Professor Morse in 1842, and by Ezra Cornell in 1845. In 1846 Jacob Brett and Alexander Prince obtained a renewal of their provisional certificate of registration for the General Submarine and Oceanic Telegraph Company. In 1849 an English company obtained a charter from the French Government granting them the exclusive right of sending telegraphic intelligence between England and the French coasts. To save the concession from lapsing, a single gutta-percha coated wire was sunk by lead weights, and messages transmitted until the wire was grappled and broken by French fishermen. The next year (1850) an iron wire-sheathed cable was laid by Crampton,* and completed on the last day of the concession. The next three cables laid were failures, and so much disaster was connected with this form of engineering enterprise that of the 20,000 miles laid during the first 16 years 9000 miles were abandoned before 1865. When he came to the Persian Gulf telegraphs, Sir Henry Mance was on his own ground, as he was engaged in laying a cable there in 1864, and was associated with it for many years. He was able to give many interesting details about the locality, and the phenomena that are to be met with there. In speaking of the tradition that Alexander, when marching his army towards Beloochistan, communicated with Nearchus by means of polished steel mirrors and reflected sunlight, Sir Henry recalled that the experiments which led to the introduction of sun signalling in modern armies were made on the same spot 2000 years later. He did not mention, however, that it was he who invented the heliograph, which has been of so much use in military operations in the East.

There are to-day more than 1300 submarine cables in existence, aggregating 162,000 miles; they represent an expenditure of about 40 millions sterling, of which 75 per cent. is English capital. Up till recently they have all been manufactured in England, but now there are cable factories at Calais, at St. Tropez, at La Seyne, and at Spezzia. When cables are laid they are by no means safe from accident. Faults have occurred from lightning, earthquake, landslips, submarine volcanoes, and even the attacks of fishes. To repair them a fleet of 41 telegraph ships is maintained, stationed all over the world. To prevent corrosion of the sheathing wires there is now applied to each a covering of preservative tape and compound. The specific gravity of the cable is thus reduced, and the strain upon it, during sinking, is lessened. Sir Henry gives the amount of new cable required for repairs of a line laid in shallow water as follows:

	Per Cent. per Annum.
For the first five years	$\frac{1}{2}$
,, 6th to the 10th year...	$\frac{3}{4}$
,, 11th ,, 16th ,, ...	1
,, 17th year	$1\frac{1}{4}$
,, 18th ,, ...	$1\frac{1}{2}$
,, 19th ,, ...	$2\frac{1}{2}$
,, 20th ,, ...	$2\frac{1}{2}$
,, 21st ,, ...	3

In the seventies the speed of working submarine cables by the mirror system was 15 to 16 words a minute. It is now possible, with the latest Atlantic cables, to send nearly 50 words, of five letters each, per minute, by means of an automatic transmitter. By means of the automatic curb transmitter, with an adjustable curb commutator, the speed of working on the Eastern Telegraph Company's cables has been increased by 30 to 35 per cent. Sir Henry is sanguine as to submarine telephonic communication. He referred to the plans of Mr. Preece and of Dr. Silvanus Thompson, and also to one by Messrs. Phillips and Barr, which we do not remember to have seen before. They propose to employ what is practically a double conductor, but the return circuit for each wire, or group of wires, would be the earth. It is intended that the insulation between the two conductors, or groups of conductors, shall be comparatively low, so that an appreciable amount of leakage would occur from one circuit to the other. By means of a suitable key, one conductor would be simultaneously charged with a similar current as the other is discharged; and it is claimed that the fall of potential on the one circuit, as it is disconnected from the battery and put to earth, would be balanced by the rise of potential on the other, so that the retarding effects of static induction would be reduced to a minimum. Of course all such plans involve increased cost, and it may be better economy to put down two or three cables of the existing type than one of the improved kinds.

We have done less than justice to Sir Henry's pleasant address by picking out a fact here and there and stringing them together. The charm of his personal recollections cannot be transferred in this fashion; to convey that we should have to reprint the whole of what he said, and considerations of space prevent that. We could wish that he had enlarged more on his personal share in rendering submarine telegraphy more easy and commercially profitable, and we are sure that his hearers would have acquitted him of egotism in the matter, since it was impossible for him to give a full account of what has been done, especially in the East, without referring to the great share he had in it. However, it is somewhat ungracious to complain of a good address because it might have been still better. Generally the fault of such productions is that they could not be worse.

* See ENGINEERING, vol. xl., page 170.

THE WEATHER OF 1896.

WHEN the sun has "wheeled in triumph through the signs of heaven," and New Year's Day is announced, we are reminded that "the twelve celestial signs have brought about the annual reckoning," and occasion is afforded for a retrospection of the characteristics and notable events of the weather during the past year. The British Islands had in this year a splendid crop of wheat, a poor crop of hay; and, as in all other years, other crops were influenced favourably or adversely by the weather. In the present condensed summary these subjects cannot be investigated, but by bringing into prominence the chief features of the year's weather, some indications may be given of the directions in which inquirers may seek to correlate the effects to their causes, so far as they may depend on atmospheric influences. All plants are influenced more or less by weather conditions. Bright sunshine, clear or gloomy, dry or damp, hot or cold weather, especially if prolonged, leave marked results on plants. Mr. Mawley's report on phenological observations for 1896 should have much interest for agriculturists as well as meteorologists.

The year opened with a week of gloom. The official Daily Weather Chart for 6 P.M., 8th, was the first in the British Islands that showed atmospheric pressure above 31 in. The station was Stornoway, and by next morning all over the northern portions of Great Britain and Ireland the barometers were above 31 in. At 9 A.M. at Glasgow 31.119 in. was recorded. The barometer has not been nearly so high since 1882, when the weather of January was similar. The winter was remarkable for high temperature and scanty rainfall, conditions which are seldom coincident at this season. The drought, with which the year commenced, was apparently terminated by abundant rain on nearly every day in March. It recommenced, however, in April, only to end in the latter part of August, which was the first month in the year in which the mean temperature fell just below the normal. The spring was so dry that it left a general requirement for more water. Fortunately in June sufficient rain fell to mitigate the severity of the drought. From April to August the northern half of Scotland had favourable weather from the farmer's point of view, but all other parts of the islands were for the third time in four consecutive years smitten with drought. The weather undoubtedly favoured the wheat crop; a well-prepared seed-bed, a dry warm winter that imposed no check upon growth, a hot dry summer, timely rains in March and in June, all conspired to produce one of the earliest harvests on record. The quality of the grain was exceedingly good, and the quantity much above the average yield; altogether so fine a crop has not been harvested since 1868, a year very similar in its seasonal characteristics to 1896. The early sown barley gave a good yield of excellent quality; but a droughty season is always detrimental to the oat crop. The autumn on the whole was very wet; in Scotland the rains did much damage to the crops and delayed the ingathering. As indicative of the healthiness of the year, it may be stated that the death rate in the metropolitan district, the most populous in the kingdom, varied only between 22 per thousand per annum in July, and 15 in September.

The mean pressure and temperature of the atmosphere for the entire year, at extreme positions of the British Islands, to which the Isle of Man is central, were as follows:

Positions.	Mean Pressure.	Difference from Normal.	Mean Temperature.	Difference from Normal.
	in.	in.	deg.	deg.
North ..	29.85	above 0.08	46.8	above 1.0
South ..	30.06	,, 0.09	52.6	,, 0.8
West ..	29.99	,, 0.12	51.7	,, 2.0
East ..	29.98	,, 0.09	48.8	,, 0.3
Central ..	29.98	,, 0.10	50.2	,, 1.1

The distribution of rain in frequency and quantity may be inferred from the following results:

Places.	Rainy Days.	Amount.	Difference from Normal.
		in.	in.
Sumburgh	273	43.96	above 6.71
Scilly	197	25.72	below 8.29
Valentia	242	48.59	,, 7.21
Yarmouth	186	20.92	,, 6.21

The duration of bright sunshine throughout the year, estimated in percentage of its possible amount, was for the United Kingdom 32, Channel Isles 43, south-west England 39, south England 36, east England 34, south Ireland 33, central England 31, north-west England and west Scotland 30, north Ireland, north-east England, and east Scotland 28, north Scotland 22. A fair amount of sunshine, and probably a sufficiency of rain, it was not so much a lack of these essential elements as their irregular and unequal distribution, which was irksome first in England, Wales, and Ireland, as drought, and afterwards as excessive wet in Scotland. The resultant for the year of the monthly resultants of the winds over these islands generally is W. by N., equivalent to a wind from that direction during 110 days. Taking the estimated force of the winds into the computation, the resultant is W. by S., 3.6 miles per hour. The mean distribution of atmospherical pressure shows that the average current of air is the mean of these two results.

The months may be concisely characterised as follows: January was gloomy, mild, and very dry. February was dull, warm, and very dry. March was mild, rainy, and stormy. April was mild, dry, and windy. May was dry, hot, and had the most sunshine. June was fine, rather dry, and had much sunshine. July was dry, harvest very early and rapid in England. August was rather dry and had little sunshine. September had little sunshine and excessive wet; the rains commenced about August 24, and were prolific throughout September. October was dull, cold, stormy, and excessively wet. November was fair, mild, and dry. December was very wet, mild, and had moderate sunshine. The dry air, sunny days, morning frosts, and some days of strong winds rendered November very favourable for agricultural work.

Some of the notable events connected with the year's weather are the following. A wind pressure of 27.5 lb. on the square foot was recorded at Greenwich on March 6; and the lowest atmospherical pressure, 28.3 in., occurred on the 3rd in north Scotland. On June 9, notwithstanding the prevalent drought, 1.37 in. of rain fell at the North Foreland, and next day 1.30 in. at Dungeness. On July 7 the Ashmolean Museum was struck by lightning. As indicative of the great heat in south-east England during this month, the observations made at Greenwich Observatory may be cited. On the 14th the thermometer in shade rose to 91 deg., in sunshine to 154 deg.; as a contrast, on the 16th, 58 deg. and 62 deg.; 21st, again 90 deg. and 153 deg. respectively; and 80 deg. in the shade was exceeded on 12 days. On the 24th 1.79 in. of rain fell at Parsonstown. On August 28, 2 in. of rain fell at Stornoway. On September 25 a wind pressure of 24 lb. on the square foot was recorded at Greenwich during a powerful tempest, which was very destructive, at Dover especially. About this time floods occurred in the rivers of Essex. On October 8 a severe storm visited the west and north coasts, causing the lightship at Daunt's Rock to founder at her moorings and the loss of her crew, and also the lightship in the Solway to go adrift. On the 10th snow fell in Scotland. As July exhibited strongly the effect of solar radiation, so did November terrestial radiation, for on the 6th, while Stornoway had temperature 49 deg., Loughborough had only 24 deg.; again, on the 10th Aberdeen 50 deg., Dungeness 30 deg.; and on the 30th, Valentia 47 deg., Oxford and Cambridge 23 deg. On December 4 a gale of great force destroyed the Chain Pier at Brighton, and wrought much damage on the south coast. About 5.30 A.M., the 17th, shocks of earthquake were experienced all over central England. On the 20th, while Valentia had temperature 49 deg., Parsonstown had only 17 deg. On the 23rd the lowest temperature of the year—9 deg.—was recorded at Braemar.

TRANSATLANTIC PASSENGERS.

THE stringency of the regulations as to immigration into the United States is once more reflected in the return of passengers debarked from Atlantic liners at the port of New York during the past year, for while a few years ago, say in 1892, 500,000 were landed, last year the total was 351,573, the decrease being most marked in steerage passengers. Fortunately many of the old emigrant steamers have been withdrawn—thus 71 "tramps" crossed in 1893, and only 30 in 1896—so that, instead of about 1000 voyages being made by all ships, only 852 are included in last year's return; thus the average number of passengers per steamer is 412. This is 36 less than in the previous year, but even then it might be regarded satisfactory if a reasonable fare could be got. In the beginning of last year rates were very low, 50s. to 60s. being taken for steerage; but an agreement as to Continental steerage rates was first arranged, and one effect was a material decrease in the number of Scandinavians travelling by way of Hull and the Mersey to the States. Thus the White Star Line have taken 30 per cent. less steerage passengers, although the total only shows a decrease of 3 per cent. Following upon this agreement, all the companies managed to combine and arranged not only that summer rates should be charged from May to October, but that the minimum cabin rate should be 20*l*. for fast steamers and 15*l*. for steamers of the Britannic and Germanic type, and 12*l*. for the City of Rome, while the Allan Line, Dominion Line, &c., are to charge 10 guineas. Formerly the summer was of varying shortness—August to October in several cases—and rates were down to 12*l*. and 15*l*. The winter rates are 15*l*. for the fast steamers and 12*l*. for the Britannic and Germanic type. There is to be no reduction for return fares, and tickets are only to include the voyage from port to port, not the railway fare from London to Southampton or Liverpool. All European companies are included, even although they do not call at a British port, the French charging 17*l*. 10s. from Paris to New York with La Touraine and 16*l*. for the other steamers, and the Netherlands-America from Rotterdam 11*l*. 10s. With those fares, which came into operation at the end of November, and 6*l*. to 7*l*. for steerage passengers, which have ruled for some months, the Atlantic steamship companies have been doing better lately, and will probably be satisfied should last year's volume of traffic be maintained throughout this year.

The number of cabin passengers last year was 99,223, whereas in the previous year it was 96,558, and in 1894, 92,561. There seems, therefore, an improvement of about 8 per cent. from the lowest point, but, as we have hinted, four and five years ago the normal total was over 120,000 cabin passengers. However, the reduction per steamer has not been so very marked. The average in 1893 was 125; in 1894 it had dropped to 105; by reason of the fewer steamers engaged it increased in 1895 to 122, decreasing again to 116 last year. These figures, however, are somewhat illusory, for many of the ships do not carry saloon passengers. One ought rather to take the total. Thus in the four years named the average totals have been 503, 319, 448, 412. This decrease is due to the number of steerage passengers. During the past year 252,350 voyagers so crossed, probably to seek a new sphere of industry and a new home, for we understand the higher rate obtaining has slightly checked the practice of Italians and Jews returning for a brief season to work in Europe at the busiest time of the year, going back afterwards to the States. This partly accounts for the heavy decrease on the figures of five years ago, but much of it is due to the very proper sifting at New York of the useful from the unfit, indolent, or improvident immigrants. In 1893 there were 364,700 steerage passengers: cholera and restriction brought the number down to 188,164 in 1894; in the following year there was a recovery to 258,560; the total for the past year, 252,350, being thus 6210 less than in 1895. The total is therefore 33 per cent. less than in 1892, while the decrease in cabin passengers is only 18 per cent., and it seems probable that many who formerly went in the steerage prefer the second cabin now.

The fast and new steamers seem to be favoured more, alike by the cabin and steerage voyager, for one can trace the influence in the figures. Thus White Star and Inman gained the advantage from their ships in the early 90's, but had to give place to the new Cunarders. The American Line, however, have improved steadily year by year, this year's addition being almost exceptional. As in many previous years, our pioneer company, the Cunard Line, head the list. Their number of saloon passengers, however, shows a slight decrease of 845, about $4\frac{1}{2}$ per cent., the total being 17,999, while at the same time they carried 20,681 in the steerage, which is not much below the average of recent years. They have also the highest total as an average per ship, which is not surprising, in view of the success of the Lucania and Campania, and of the great regularity of the Etruria and Umbria, which have been making from $19\frac{1}{2}$ to 20 knots on their best voyages last year, notwithstanding that they have been steaming since 1884. The American company take second place again, and their total shows an increase of 713 cabin passengers, or nearly $4\frac{1}{2}$ per cent., while, when compared with the total for the last year they sailed out of Liverpool (1892), there is an increase of 2790 cabin passengers. The total is 16,859 cabin and 12,830 steerage passengers. The latter is 6750 less than in the previous year. The Hamburg-American step from fifth to third place, with a total of 12,173 cabin and 32,280 steerage passengers; but they ran 100 instead of 57 steamers, as in the case of the Cunard Company. The difference, however, was largely due to steerage ships. The number of cabin passengers is 1630 more than in the previous year, due partly to the practice adopted last year of calling at a French port. Even when compared with 1893, the total is fairly satisfactory, the decrease being only $6\frac{3}{4}$ per cent., equal to 880 cabin passengers. The decrease on the number of steerage passengers is small. The White Star, on the other hand, have a slight decrease—1.7 per cent.—on the cabin passengers when comparison is made with 1895; but the number is 1700 less than in 1893, while the steerage total is 7656 less than in 1893. The North German Lloyd seem to have experienced the worst decline on the figures of 1893, but this will doubtless be rectified when they get their two new 22-knot steamers from the Vulcan and Schichau establishments. The Anchor Line, whose vessels sail out of Glasgow, have improved on last year's total of cabin passengers, but, like most companies, experience a decline as compared with 1893; while the Allan-State Line have a decreased total, both when compared with last year and with 1893. The French and Red Star Company have not improved on the previous year's total; but the Netherlands Company has done rather better. The totals are given in the annexed Table:

Passengers Landed at New York.

Line.	1893.		1895.		1896.	
	Cabin	Steerage.	Cabin	Steerage.	Cabin	Steerage.
Cunard	18,462	25,103	18,844	21,724	17,999	20,681
American	14,374	12,100	16,146	19,580	16,859	12,830
Hamburg-American ..	13,052	33,091	10,543	30,141	12,173	32,280
White Star	13,327	28,876	11,805	30,725	11,607	21,220
North German Lloyd ..	15,930	68,465	10,805	44,326	10,921	38,034
Anchor (Glasgow) ..	8,510	11,546	6,604	10,011	6,949	6,448
French (Havre)	10,205	16,559	7,587	16,469	6,847	17,371
Red Star (Antwerp) ..	7,015	24,483	4,890	12,554	4,750	13,517
Netherlands	6,235	30,514	3,146	13,702	4,350	13,609
North German Lloyd (Med.)	2,372	17,693	2,065	11,691	2,634	16,146
Allan State (Glasgow) ..	3,459	10,298	2,509	3,512	2,260	1,464

It is interesting to note further that the Cunard ships, on an average, carried 315 cabin and 363 steerage passengers each trip. In the previous two years their cabin averages were 353 and 336. The American Line took 296 cabin and 225 steerage passengers, as against 323 and 392 respectively in 1895, and 283 and 331 in 1894. The White Star Line carried 632 in each ship, of which 408 were in the steerage; but in the previous year the average was 804. The French company took 131 saloon and 315 steerage. In these cases it may be taken that there was a regular weekly sailing; while the Cunard and American companies sent five supplementary ships. The North German Lloyd, on the other hand, sent 121 vessels, and the Hamburg-American 100, and as half of these were only emigrant carriers—the two companies stand highest in respect of steerage passengers—it is difficult to approximate the average number of passengers in cabin and steerage in each ship. The North German Lloyd carried 404 per ship and the latter 443, which is far behind the 600 of the two great Liverpool lines.

The only other point of general interest is as to the relative proportion of passengers carried by British ships. Out of 852 voyages, British-owned ships made exactly one-fourth—214. They carried 38,845 cabin passengers, or 39 per cent., as compared with 40 per cent. of the total in 1895, and 40.5 per cent. in 1893, when the total was satisfactorily high. Our proportion, therefore, has not decreased to any great extent, and at the same time Germany's has remained steady—26.4 per cent. in 1896, 25.4 per cent. in 1895, and 26 per cent. in 1893. They carry a number of cabin passengers, but have a greater steerage traffic. This is not surprising. In 1893 British ships carried 26.5 per cent. of the steerage traffic from all Europe, although very few of our ships sailed from Continental ports; in 1895 we had 30 per cent., and in 1896 27 per cent. German ships took 37.7 per cent. in 1893, 40 per cent. in 1895, and 38.7 per cent. in 1896.

SOUTH AMERICAN RAILWAYS.

THERE is a certain feeling against everything connected with South America; and it is to be feared that, upon the whole, this feeling is justified by actual facts. At the same time, South America is certainly a region possessing great natural resources, and what is required to turn these resources to account is a larger measure of stability, peace, and good government. The population of the principal American countries is relatively small; but as immigration is now steadily proceeding, this is a drawback which will exist no longer. In Brazil, indeed, it may be already regarded as overcome, although there is no doubt still room in the great Brazilian Republic for a much larger number of inhabitants. The largest South American railway undertaking is the Buenos Ayres Great Southern; and this, at any rate, appears to be a well-managed and prosperous concern. The gross revenue collected by this company for the year ending June 30, 1896, was 1,296,121*l*., as compared with a corresponding collection of 1,123,797*l*. in 1894-5. The working expenses in 1895-6 were 469,445*l.*; and in 1894-5, 394,754*l.* The net profits realised for 1995-6 were accordingly, 826,676*l.*, as compared with 724,043*l.* in 1894-5. The net profits of 1895-6 were further increased to 852,392*l.* by interest on reserve funds, profit on remittances, &c., and, after providing for all fixed charges, adding 45,000*l.* to the reserve fund—a novel feature in railway finance—and paying a dividend upon the ordinary stock at the rate of 5½ per cent. per annum, the company is enabled to carry 4486*l.* forward to the credit of 1896-7. The average length of line open to traffic upon this prosperous system in 1895-6 was 1403 miles, as compared with 1401 miles in 1894-5. The ratio of the working expenses to the traffic receipts stood in 1895-6 at 36.22 per cent., as compared with 35.57 per cent. in 1894-5. The working expenses were increased last year by a heavier outlay incurred in maintaining permanent way, in consequence of continuous rains. Both the main lines are now ballasted with stone from Plaza Constitucion to Temperley, and the laying of 85-lb. rails will be commenced shortly. The laying of 70-lb. rails and fastenings between Las Flores and Azul and Altamirano and Maipu will be completed in about two months. Certain gradients have been improved upon the Los Leones branch. The company has also important extensions on hand. The first of these extensions is from Lobos to the neighbourhood of Mayo; the earthworks have been completed, permanent way is being laid, and bridges, station buildings, and other works are being pushed forward. A commencement of the Lobos and Navarro extension has not yet been made, possession of the land required not having been obtained. As regards the Saladillo and Alvear extension, surveys have been made, and plans have been submitted for governmental approval. Plans for an extension from Mayo to San Carlos have been approved by the Government, and plans for an extension from Alfalfa to Guamini have been submitted for official sanction. The plans of the first section of an extension from Bahia Blanca to Neuquen have been approved, and preparations are being made for a commencement of the works. Allusion has already been made to the introduction of heavier rails upon portions of the system; this has been necessitated by an increase in the speed and weight of the trains run by the company, and the directors have authorised the opening of a permanent way renewal fund, to which revenue will contribute 2000*l.* per month. The length of line relaid on the Las Flores and Azul and the Altamirano and Maipu sections during the past year was 115 miles; the cost of these works to the close of June, 1896, was 54,613*l.*, of which 33,000*l.* had been charged off against revenue at the close of the financial year. At the close of June, 1896, the company owned 185 locomotives of all kinds, as compared with a corresponding stock of 183 engines at the close of June, 1895. The number of vehicles used by the company in its coaching department at the close of June, 1896, was 310, as compared with a similar number at the close of June, 1895. The number of vehicles used for the conveyance of minerals, goods, live stock, &c., at the close of June, 1896, was 7272, as compared with 6908 at the close of June, 1895, showing an increase of 364. The company's locomotive stock at the close of June, 1896, was made up as follows: Local tank engines, 12; mixed traffic four-wheeled coupled engines, 55; mixed traffic compound engines 24; express passenger engines, 5; goods six-wheeled coupled engines, 28; goods compound engines, 47; shunting engines, 14.

The Recife and Sao Francisco (Pernambuco) Railway is a Brazilian undertaking—one of the early Brazilian ventures enjoying a Brazilian Government guarantee of interest. The Brazilian Government has become rather shy of late years of granting additional interest guarantees, and probably experience has justified it in arriving at this conclusion. The drawbacks attending a Government guarantee of interest are: First, the difficulty which the guaranteeing Government experiences in securing a vigorous and efficient development of traffic and a prudent and judicious maintenance of way and works; and, secondly, the loss of independence on the part of the company receiving official aid. Disputes are tolerably certain to arise from these two causes, and such disputes appear to have become more numerous since the adoption by Brazil of a republican system of government. The Brazilian Re ublic recognises somewhat ostentatiously the obligations contracted by the empire which preceded it; but although these obligations have been nominally recognised, there has been much more haggling over details during the last seven or eight years. Further, the extraordinary depreciation of the milreis, which has been such an unhappy feature in the current history of Brazil, has disorganised Brazilian social life, and has rendered it necessary for Brazilian railway companies to introduce a higher scale of fares and rates. The Recife and Sao Francisco has had no difficulty in obtaining the approval of the Brazilian Government to its policy, as the Brazilian Treasury has a direct interest, of course, in easing off the guarantee of interest which it has given to the company. But, at the same time, it is doubtful policy for railway companies to advance their charges, as any such advances are calculated to reduce traffic. The objection to higher tariffs is, however, less in the case of the Brazilian railway companies than it would be elsewhere, as the depreciation of the milreis has had the effect of rendering it necessary to advance prices all round, wages included. In the course of last year, the Recife and Sao Francisco brought two additional locomotives and tenders, two additional first-class carriages, two additional passenger brake vans, and 10 additional low-sided trucks into service; and two additional first-class carriages, on bogies, and two 10-ton locomotive steam cranes are now in course of construction. With the help of the additional rolling stock provided, and with the assistance of the large increase authorised in rates and fares, the company was enabled to raise a revenue of 140,380*l.* in the first half of 1896 as compared with a corresponding revenue of 124,162*l.* in the corresponding period of 1895. The revenue of the undertaking appears, however, to have a tendency to increase, irrespective of any special or temporary influences, the collection for the first half of 1886 having been only 56,082*l.*, and for the first half of 1876 only 38,063*l.* In the course of the first half of this year 14,356 sleepers, 3942 steel rails, 4350 chairs, 35,724 keys, 10,108 spikes, 318 fishplates, 9006 fish-bolts, and one crossing were renewed; and 4156 cubic metres of stone were used to fill in breaches occasioned by floods. About 7¼ miles of steel rails were laid, making a total of 62 miles of steel rails out of the whole 77½ miles worked by the company. The company has no extensions in course of construction, the Brazilian Government, as we have already hinted, being now exceedingly chary in granting further guarantees. The Recife and Sao Francisco contrives, with the help of the existing guarantee, to work out a dividend of 5 per cent. per annum upon its stock; but it has been unable to follow the wise example of the Buenos Ayres Great Southern in the matter of a reserve fund.

NOTES.

THE EXHIBITIONS OF 1896.

THE number of exhibitions held during 1896 was very considerable, in fact, probably a record number, but their financial results have been, on the whole, unsatisfactory. The Berlin Exhibition has, in more senses than one, been a disappointment, and it will no doubt be a long time before the capital of Germany again attempts—albeit on a much smaller scale—to rival Paris. A number of concerns within the exhibition, but independent of it financially, have brought very poor results, and the exhibition itself has a heavy balance on the wrong side. It was thought at first that a million of marks, or 50,000*l.*, would cover the loss, but this will more likely be at least 50 per cent. more, the restoring of the Treptow Park having entailed a much heavier expenditure than calculated. In addition to this comes the pulling down of the various buildings, of which it was expected that several would be allowed to remain. The first notice to the guarantors was for 40 per cent., and further calls will no doubt be necessary. The All-Russia Exhibition at Nishni-Novgorod, which, at least in several respects, gave much satisfaction, and in a most positive manner demonstrated the immense resources and rapid growth of many Russian industries, has made a very heavy loss. It is difficult to state how many millions of roubles this exhibition has cost; but this was anticipated and considered quite justifiable. The same, to some extent, applies to the Millennium Exhibition at Buda-Pesth, where national and patriotic sentiment was the principal *raison d'être*. The national exhibition at Geneva was on a much smaller scale, and the loss is proportionate. It is estimated at about half a million francs (20,000*l.*), and the guarantee fund has been completely absorbed. As in Berlin, the unfavourable summer has been blamed for this unsatisfactory result, which applies to the exhibition and the exhibitors alike; but the management at Geneva is understood to have left much to be desired, and the expenditure has in some cases been out of proportion to the whole undertaking. A contrast to the exhibitions referred to was the one at Dresden, which comprised industry and art; the arrangements were suitable, and the number of visitors was considerable. The exhibition also showed a satisfactory financial result. The exhibition at Malmö, Sweden, which was rather a plucky venture, has done pretty well, the loss being estimated at only about 1000*l.*, which the Industrial Union of the town covers.

TELEPHONES IN GERMANY.

The telephone system in Germany has, during the last few years, been extended in all directions, both between the different points of Germany, within the various towns, and with other countries, so that the aggregate mileage of the lines, and the number of telephone conversations, are now four times larger than was the case five years ago. In the year 1891 the longest line in operation was Berlin-Breslau (about 220 miles), but at present conversation is carried on to perfection on lines two or three times that length, *i.e.*, Berlin-Memel (about 630 miles), Berlin-Mühlhousen (about 580 miles), Berlin-Copenhagen (about 500 miles), Berlin-Vienna (about 420 miles). A number of still longer and more important lines are being constructed or contemplated, comprising a line Bremen-Amsterdam, a new line Berlin-Vienna, with stations in Dresden and Prague, Berlin-Brussels, Berlin-Buda-Pesth, and Berlin-St. Petersburg. It goes without saying that this almost universal telephone system is of immense value to the commerce and industry of the German capital, the more so as the charges are moderate, the longest distance charge generally being 3s. for a three minutes' conversation. The long-distance lines are all double, the wire varying between 2, 3, 4, and 5 millimetres, according to the distance. Nearly all the drawbacks from the practical value of long-distance telephones, such as induction, &c., have been successfully overcome during the last year or two.

THE RECORD OF WRECKS.

It takes some time to gather in the records of shipwrecks, and the return now issued by Lloyd's Registry of Shipping is for the quarter ending with September, the months when land experience suggests that nature is kindest, and yet 211 vessels of 162,724 tons were "removed," a record which exceeds those of the corresponding periods during this decade, excepting 1895. The normal tonnage is 130,000 tons, but in the autumn months of 1895 195,480 tons were removed, and, as indicated, 162,724 tons is returned as the waste shipping of last autumn. There is one satisfactory feature, however: the amount of tonnage broken up voluntarily is higher than it used to be. Foreigners would not have our old ships—they prefer the modern economically engined steamers—and the old metal has now to be sold. Thus 180,000 tons of shipping have been broken up in the past year; and one cannot help feeling that if still more were similarly treated we should not have that same long record of ships missing—the saddest of all fates. Some 60 or 70 ships a year are so "posted" at Lloyd's; in the quarter under review, nine of 8550 tons sailed from port and were never again heard of. This is much below the average; it is quite high enough. Wrecks accounted for 96 vessels being deleted from the lists, the tonnage being 62,763 tons. This compares with 79 vessels, of 69,559 tons, and 79 vessels, of 51,873 tons, in the two previous quarters. Collisions usually involve the loss of from 12,000 to 16,000 tons; for the quarter under review the tonnage is 14,386, the measurement of 21 vessels. It is some satisfaction to find that the rate of loss of British ships is lowest among all the nations, being 46 for each 10,000 vessels owned, while for Austro-Hungary it is equal to 228, Norway 120, Spain 111, Holland 111, Colonies 110, Sweden 95, Italy 85, Russia 83, United States of America 72, France 70, Germany 54, Denmark 49. When we come to the return of the sailing ships, which provides two-thirds of the losses, partly because of their impotence under adverse conditions and also their age, we find a greater tendency to abandon the ships at sea, and in this respect the Norwegians present a bad return. Thus in a year 18 Norwegian sailing ships had been abandoned—seven in the quarter under review. Their loss rate for sailing ships is 137 per 10,000; that for Holland is 172; Spain, 156; the Colonies, 144; France, 122; Sweden, 119; Russia, 116; Germany, 90; Italy, 84; United States, 79; Denmark, 76; and the United Kingdom, 61. The Austro-Hungary ratio appears high again, but it is in both instances due to the large proportion of vessels broken up. It is interesting to note that although Britain possesses nine times the steam tonnage of any power, Norway as well as the United States have sail tonnage equal to half that owned in this country.

THE NIPPON YUSEN KAISHA.

From the report presented to the shareholders at the annual meeting held in Tokio on the 25th November, it is evident that the most important steamship company in Japan is not only rapidly increasing in size, but also continues to flourish financially. The shareholders have received a dividend of 12 per cent. on their capital as the result of the work of the company during the preceding year, which is very satisfactory when the keen competition which everywhere prevails is taken into account. The chairman stated that in 1893 the ships in the possession of the company, fit for navigation, were 45, representing a tonnage of 64,157. At the end of September last there were 54 steamers, and nine more were subsequently purchased from the Government on 15 yearly instalments, without interest, thus making a total of 63 vessels, representing a tonnage of 126,579, so that in three years the number of steamers was increased by 18 and the tonnage by 61,421, or nearly double what it was three years previously. In 1893 the total mileage of navigation traversed in home and foreign waters was 14,600 nautical miles, which has now increased to 49,200 nautical miles, or an increase of 3½ times. The assets of the company at the end of September last amounted to 20,254,765 yen, as against 12,507,713 yen in 1892 (a yen is worth 2s. 2½d.). The three years under review formed a period during which affairs of the greatest importance occurred in the history of the navigation of the empire. At the time of the war with China, nearly all the vessels of the company were placed at the service of the Government, but still they were able to carry on the ordinary shipping business of the country. In June last, owing to the determination to extend their operations to foreign countries, the capital of the company was increased from 8,800,000 yen to 22,000,000 yen. At present three new lines to Europe, America, and Australia are opened, thus forming a base for future operations in different parts of the world. New ships are being built in order that these lines may be effectively worked, but meantime a beginning has been made. Since the European line was opened in March last, pretty large cargoes have been obtained both ways. But while the imports of iron and machinery into the East from Europe have largely increased, the exports from the East have not yet correspondingly grown. Moreover, the rate of export freight has been unusually low, being only 5s. per ton from Singapore to Marseilles, and 6s. 3d. to London. On the Bombay line a good trade was carried on in exporting cotton, and in addition to the regular steamers, other vessels had to be occasionally chartered to meet the demand. For some time the competition from a combination of the P. and O. Company, the Austrian Lloyd, and an Italian firm was very severe, but in July last an arrangement was come to, and the competition ceased. The Australian line will be opened during the next half-year, as all the arrangements for it have been practically completed. Of the three lines to America decided upon by the company, the one to Seattle, Washington, U.S.A., was opened in August last. This line connects with the Great Northern Railway, which crosses the American continent and terminates in Seattle. Two steamers have started on the line during this period. As the steamers which are being built are delivered, it is intended to connect with Hong Kong and Shanghai. The great progress which has been made by this company shows that the Japanese are determined to become a great maritime nation, while the developments of their navy prove that they mean to be in a position to defend their seaborne trade.

LAUNCHES AND TRIAL TRIPS.

THE screw steamer Avondale Castle, built by the Fairfield Shipbuilding and Engineering Company, Limited, for the Castle Mail Packets Company, Limited, and launched on November 5, was put through her official trials in the Firth on the 13th inst. The Avondale Castle is an intermediate steamer for the Cape service, and is a single-screw steamer classed 100 A1 at Lloyd's, 440 ft. in length, 50 ft. in breadth, and 33 ft. in depth, with a gross tonnage of about 5600. The cargo holds are five in number, and have capacity for about 6000 tons of cargo, and each hold has a separate hatch and double steam winches for quick despatch in loading and discharging. The main hatch is specially constructed to take in boilers and mining machinery of the largest dimensions, for lifting which a steel spar is provided, along with adequate gins and steel wire gear. There are about 170 first and second class berths placed amidships, with dining saloons and drawing and smoking rooms for each class. All these are in polished hardwood, artistically designed, and handsomely upholstered. The third-class passengers have the poop and after 'tween-decks entirely to themselves. These are suitably divided into cabins of various sizes. The engines are of the triple-expansion type, with three cylinders and three cranks. The shafting is of forged ingot steel and the propeller of bronze. On the trial, the vessel being in a light condition, a speed of about 15 knots was easily maintained.

Messrs. Harland and Wolff, Belfast, launched on the 5th inst. a large twin-screw steamer named the Delphic, the latest addition to the fleet of White Star steamers. The dimensions of the new vessel are 475 ft. long by 55 ft. beam, the gross tonnage being about 9000, and she will be employed in the New Zealand trade, with other vessels of the White Star and the Shaw, Savill, and Albion line. The distance traversed on each voyage exceeds 26,000 miles. The new vessel, like the Gothic, will be fitted with two sets of triple-expansion engines and twin screws, thus affording an additional element of safety. The Delphic will be fitted with two large refrigerating machines on the dry-air system, and there will be a total refrigerated space in three holds of about 285,000 cubic feet, or equal to about 100,000 carcases of sheep.

The new screw steamer Garmoyle, which has been built by the Caledon Shipbuilding and Engineering Company, Limited, Dundee, to the order of the Clyde Shipping Company, Limited, Glasgow, performed her official trial trip on Friday last, the 8th inst. The weather was extremely boisterous, but, in spite of the unfavourable circumstances, a satisfactory run was made, a speed of 15 knots having been attained by the new steamer. The Garmoyle has been constructed for the Clyde Shipping Company's cargo and passenger trade between Glasgow, Ireland, and London. Her principal dimensions are: Length, 250 ft.; breadth, 33 ft. 6 in.; depth, 16 ft. 4 in.; and gross tonnage, 1250. It may be mentioned that the Garmoyle is the fourteenth vessel built by the Caledon Shipbuilding Company for the Clyde Shipping Company.

Messrs. Laird Brothers, of Birkenhead, took out on the 13th inst. H.M.S. Thrasher and completed a very satisfactory official full-speed trial in presence of the Admiralty representatives. The speeds obtained on six runs on the measured mile at Skelmorlie, on the Clyde, were as follow:

	Steam. lb.	Time. min. sec.	Speed. knots.
1st mile	207	1 58	30.51
2nd ,, ...	208	2 1½	29.64
3rd ,, ...	210	1 55½	31.16
4th ,, ...	208	2 0	30.00
5th ,, ...	205	1 58	30.51
6th ,, ...	207	2 1	29.75

The mean speed worked out at 30.34 knots. The trial was continued for the usual three hours, the vessel being taken as far down as Pladda, and the average speed for the continual steaming was 30.04 knots. The Admiralty was represented by Messrs. Welch and Emdin, of the construction and engineering branches respectively; Devonport Dockyard and Reserve by Messrs. Gregory and Deacon; and the contractors by Mr. William Laird, of Birkenhead, Mr. R. Ratsey Bevis conducting the trial on their behalf. This concludes the exhaustive series of trials set the first four of the 30-knot destroyers constructed by Messrs. Laird for the Admiralty.

The new steam yacht Christine, of 245 tons, Thames measurement, built and engined by Messrs. David J. Dunlop and Co., Port Glasgow, to the order of Sir William Scott, Bart., of Ancrum Castle, Roxburghshire, ran her official trial on the Firth of Clyde on the 13th inst., when the weather conditions were most favourable. The dimensions are as follow: Length between perpendiculars, 130 ft., and from taffrail to billethead, 152 ft. 6 in.; breadth, 20 ft.; depth moulded, 12 ft. 6 in.; net tonnage, 107.44; and gross tons, 195.59. The machinery consists of a set of triple-expansion engines, with cylinders 11 in., 18 in., and 28 in. in diameter respectively, with a piston stroke of 24 in. Steam is supplied at a working pressure of 160 lb. by a single-ended multitubular boiler. The trial throughout was satisfactory. A speed of 11.4 knots was obtained, being the mean of two runs on the mile at Skelmorlie.

The second of six first-class torpedo-boats of the Viper type, lately ordered by the Chilian Government, was successfully launched on Saturday, the 16th inst. from Messrs. Yarrow's yard at Poplar. The remaining four boats are to be shipped in pieces and finally put together and riveted up in Chili. The first of these four was also tested under steam in the presence of the Chilian authorities, having been completely erected and bolted together in the contractors' yard.

Messrs. Ramage and Ferguson, Limited, Leith, launched on the 18th inst. a screw steamer named Vestra of about 1000 tons, built to the order of Messrs. J. T. Salvesen and Co., Grangemouth. The dimensions are 216 ft. by 32 ft. by 16 ft. 3 in. moulded, with triple-expansion engines having cylinders 15 in., 24 in., and 39 in. in diameter by 30 in. stroke, and one large boiler working at 160 lb. pressure. This vessel, which will carry 1300 tons deadweight, and is expected to steam 10 knots, is a sister ship to the steamers Vala and Vina, built by Messrs. Ramage and Ferguson, Limited, for the same owners in the beginning of 1894.

Messrs. Wigham Richardson and Co., Newcastle, launched on January 18 the second of two sister vessels which they have been building to the order of the Osaka Shosen Kabushiki Kaisha of Osaka, Japan. The vessel is 261 ft. in length, 35 ft. beam, and 23 ft. deep. She will be rigged as a two-masted fore-and-aft schooner, and will have accommodation for first and second class passengers in a bridge amidships and in a poop, and there are also fittings for a large number of steerage passengers. The steamer will be propelled by triple-expansion engines, which, with their boilers, are being constructed by Messrs. Wigham Richardson and Co. As the vessel left the ways she was named the Takao.

The paddle steamer Paris, which has been built by Messrs. A. and J. Inglis, Pointhouse, for the Mensagerias Fluviales del Plata, has left the Clyde for Monte Viedo. The vessel is intended for passenger service on the River Plate, and internally is as finely fitted and furnished as any boat which ever left the river. She is 300 ft. long, 66 ft. broad over all, 30 ft. deep from the upper deck, and about 2000 tons gross. Of the type Messrs. Inglis have already built several steamers for the same company; but even in the unsettled regions which Europeans lump as South America, the trend is towards more luxurious surroundings afloat, and it is safe to assume that nothing like the Paris has as yet been seen on the Plate. Accommodation is provided chiefly for first-class passengers and for a few second class. There are four decks—promenade, saloon, main, and lower—and on the saloon and main decks one can accurately measure the advance on her predecessors which the new boat represents. The saloon deck shows the first-class Clyde shipbuilder at his best. The dining saloon and a large number of the state-rooms are on this level. Amidships the engine space breaks the continuity, but forward of the obstruction there is a handsomely-fitted dining saloon, and aft there is an apartment of almost similar size, which may be used as an auxiliary dining-room, but will probably be utilised as what is termed on liners a "social hall." Wide corridors, in which are sofas and chairs, connect the two. The panelling throughout the ship is all in light wood, with hand-painted panels and a finely carved gilt cornice. The fanlights are also hand-painted, and the glass panels of the state-room doors are similarly treated. The sofas, chairs, &c., are upholstered in Utrecht velvet. There is a complete installation of electric light. Among the novelties on board is a set of aluminium boats. On trial her speed was 16½ knots. The engines are of the triple-expansion three-crank type for paddle-boats, of which the firm has built several sets, of which we hope to give illustrations shortly.

STEEL RAILS FOR THE PENNSYLVANIA.—The Pennylvania Railroad Company has contracted for 40,000 tons of steel rails. The contracts are divided as follows: Cambria Iron Company, 10,000 tons; Pennsylvania Steel Company, 10,000 tons; Carnegie Steel Company, 10,000 tons; Lackawanna Steel Company, 4000 tons; and Illinois Steel Company, 6000 tons. Further contracts are expected to be let before the close of the year.

RAILWAY TICKETS.—The Russian railway authorities have recently introduced a new arrangement in connection with the booking, a series of 10 tickets being sold at the single ticket price, less 40 per cent. discount. This innovation does not seem to work very well, a number of men having started a new trade, consisting in buying up the tickets for certain trains and again retailing them—at a profit, of course—to the passengers, who, however, pay less th n for single tickets. It is obvious that the railways are losers by this arrangement.

METAL PRICES.—Messrs. Vivian, Younger, and Bond, 117 and 118, Leadenhall-street, London, have just published their annual diagram showing the prices of copper, tin, Spanish lead, and Scotch iron for the past 16 years. As was indicated in our own diagram, the fluctuations during the past year have not been great, copper moving between 50*l.* and 40*l.*, tin between 61*l.* 15s. and 56*l.*, lead between 11*l.* 16s. 3d. and 10*l.* 15s., silver between 31⅜d. and 29⅜d., and Scotch iron between 49s. 3d. and 44s. 9½d. These are exceptionally low prices. In 1890, for instance, tin reached 170*l.* and copper 105*l.*, while lead was at 15*l.* 10s. The highest price for silver was in 1890, when 54⅝d. was reached, while in that year also iron was dealt in at 66s. 3d. Since that time prices have all dropped, although in the past year there has been a slight recovery in silver and copper. The diagram is on a large scale, and shows the trend of prices at a glance.

BOILER TUBES.

To the Editor of Engineering.

Sir,—Your numbers of December 11 and 18 last contained letters relating to the employment of welded and weldless tubes in water-tube boilers, and, in view of this discussion, the following notes may be of interest to your readers.

The boilers of the Jauréguiberry referred to in one of the above-named letters bearing the signature "Neutral," were fitted with welded tubes, and in the course of the trials the failure of one tube at the weld produced a violent return of flame in the stokehole which caused the death of six stokers. The tube which failed opened for a length of about 30 centimetres (12 in.), and the margins of the opening showed no signs of attachment, they being perfectly clean and still bearing the marks of the tool by which they had been formed. It might thus be said that the edges were merely stuck together and the adhesion had disappeared.

Similar failures, presenting identically the same features, had already occurred in other water-tube boilers of a type different to that fitted to the Jauréguibery, and these accidents are quite independent of the design of the boiler.

If there be introduced into a tube, apparently perfectly welded, a mandril which is slightly conical, and which has a diameter slightly greater than the internal diameter of the tube, there results very quickly an opening of the weld, the edges of which separate from each other without, in the majority of cases, showing any real union of the material.

Moreover, if, without inserting a mandril, as just described, a welded tube be hammered along the weld at the same time as it is submitted to an internal hydraulic pressure of 20 to 30 kilogrammes per square centimetre (say 285 lb. to 430 lb. per square inch), it will often be found that the weld will open suddenly and sometimes even—as a result of the percussion—at a point distant from that at which it is struck by the hammer.

All these facts, which are, it is true, more noticeable in the steel tubes now generally used than in iron tubes, lead us to the conclusion that with these welded tubes not only are we always liable to discover a bad weld, but that even when the weld appears sound it may offer but slight resistance.

These facts being established, it is easy to understand the danger which attends the use of welded tubes in water-tube boilers, or, in other words, in boilers in which the pressure is exerted in the interior of tubes and thus exerts a tensile force tending constantly to open the weld. If such a rupture is accidentally produced for even a small length, it tends to extend suddenly under the action of the jets of water and steam to which it gives passage. Moreover, if we add to the above the effects due to the perpetual expansion and contraction to which such tubes are subjected, it is not to be doubted that there should be employed, for water-tube boilers, weldless tubes manufactured with every care.

For boilers having tubes traversed by the products of combustion, and in which the pressure on the tubes is external, the welded tubes are sufficient because the weld is submitted to compression, which tends to close it even if it is bad.

I remain, &c.,
J. d'Allest.

40, Chemin de la Madrague, Marseilles, Jan. 7, 1897.

TECHNICAL EDUCATION.

To the Editor of Engineering.

Sir,—I have read with interest the renewed discussion on technical education in your paper. But I note that all the letters are from "managers" (more or less), and I think perhaps a letter from one of those much-discussed individuals, viz., a premium pupil, will not be amiss.

I am thankful that there are such men as "General Manager" who will occupy some of their valuable time in publicly giving us a warning. In my own case, I am not ashamed to own, I was born conceited, and I expect if I could have spoken when I was born I should have said, "Don't you think me a nice-looking boy?" But I am digressing.

To prove how conceited I was, I commenced to take in your valuable paper while at school, when only 15 years of age, and well do I remember the pride with which I used to carry it about, though I understood very little of it. Of course I said I understood it, when asked by my father, who, it may be added, had the pleasure of paying for it. But I used to read it; and a very good job, too; *one* thing that impressed itself on my mind was the fact that technical students were too conceited to get on in this world.

After leaving school I went to a technical college, where I had a lot of knowledge, more or less useful, crammed into my head. And I wish to take this opportunity of protesting against the uselessness of stuffing youths preparatory to their launching out into the world as practical engineers with such things as differential and integral calculus and the like. I have never differentiated anything since I left college, and do not wish to. These branches of higher education do not tend to help you as a student in your studies, but they do tend to muddle you. And I do maintain that had the time spent in such subjects been spent on such things as working out indicator diagrams, &c., my pupilage would not have needed such a long extension.

When I left college I decided to think at any rate that I knew nothing (acting on the advice I derived from Engineering).

Well, the result is that though I have not quite finished my time yet, I am an outside foreman for a large firm of engineers in the north, and I am superintending the putting down of large plant daily. I own that the first few months in the fitting shop polishing connecting-rods and the like went very much against the grain, but I decided to do it without protest, and for my present post I have indirectly to thank you, Sir; and I do hope that should any other pupil see my letter, he will be warned in time and will not make a fool of himself as I have seen several already do. *Nobody* will respect him for his stuck-on airs and loud talk.

Apologising for taking up so much of your valuable space,

Yours faithfully,
January 17, 1897. One of Them.

To the Editor of Engineering.

Sir,—Being one of those much-abused men evolved by the present system of education, perhaps you will allow me to say a few words which you may assume to be a defence of it or otherwise. First of all, let me say that, although a college man, I have never shirked dirt or work where practical experience was to be gained thereby, and that I have worked to some purpose is testified by the fact that I now hold a position of trust in an important works.

Generally, your correspondents assume that all students of engineering are fools, because they have met a few. Let me ask them how many fools have they met in practice?

From my own experience it cannot have been less in number. Assuming that a technical education does make a man a bit bumptious, his bumptiousness may equal, but cannot possibly excel, the priggishness and ignorance that I have found amongst some practical men; and the sole chance one has is to assume an ignorance and meekness proportioned to the case in question.

To be called "a practical man" is, I fear, in many cases, a sort of fetish to conjure with, and a cloak to hide gross stupidity.

There are many technically trained men now holding positions of trust, who never say a word in defence of the system by which most of their present knowledge was acquired, and who are constrained to keep quiet by the opinion of their superiors, who are generally practical men.

One thing must be rather puzzling to a student, and that is, the diversity of opinion held by practical men upon points which have long been determined, and of which they seem quite ignorant, as if they had lived in a tub all their lives. This ignorance leads to a distrust of technically trained men in the knowledge of practical men generally, which should not be.

Again, I have noted that influence "at court" holds great sway in the engineering profession, and that merit is recognised only by accident or the force of circumstances. All I can say upon this point is, given a friend with a controlling influence in an engineering firm, and I do not care: my ignorance might be quite bovine, and I would never starve so long as I remained honest in the general way of honesty.

I am surprised that some of the engineering professors have not yet answered the letters which have appeared in your paper, and I can only account for it by supposing that they think that technically trained men will fight their way to the front in spite of the animus shown by some few "practical" men.

Very few men ever supposed that a college or technical education was to supplant the time put in works, but was meant to be supplementary in order to give greater intelligence to a workman or engineer.

Believe me, Sir, yours truly,
Sub Rosa.

EXPANDED METAL IN FIREPROOF FLOORS.

To the Editor of Engineering.

Sir,—From the account of the tests on long span concrete floors carried out at Mr. Lockwood's yard, Sackville-street, Manchester, on the 11th inst., appearing in your last issue, it would seem that the Monier floor proved less satisfactory than the Golding type. Before admitting this, it would be well to consider the following points: (1) The Monier floor depended on the strength of the concrete, which was only 38 days old, whereas steel channels formed the chief support of the Golding floor. Thus, the former would grow stronger with age, while the strength of the latter would remain stationary. (2) The Golding floor was 4 ft. 2 in. wide, as against 4 ft. in the case of its rival, and had thus an area of 50 square feet, and not 48 square feet, as the account in question states; thus the load actually carried was only 16.2 cwt. per square foot, while the exact figures for the Monier floor are 12.2 cwt. per square foot. (3) The Golding floor was, indeed, standing when the experimenters left, but it fell half an hour after their departure, without additional load having been placed on it. The immediate cause was the breaking of the central tie-rod (due, it was afterwards discovered, to a bad flaw in the material), which caused the abutment joists to take an increased horizontal deflection under the thrust of the channel arches. (4) In this case the channels of the Golding floor were spaced only 3 ft. 6 in. centres; were this to be increased, the strength of the floor would be proportionately reduced, and it would become necessary to inquire into the strength of the flat floor between.

It is also by no means proved that the substitution of "expanded metal" for round or Monier rods, as they are sometimes called, effects a gain in strength. In certain tests, carried out under our direction early in 1896, which otherwise would have enabled us to set this point at rest, the abutments yielded to such an extent as to render an elementary comparison with the present experiments of little value.

The lateral deflection alluded to in the account above mentioned was inappreciable in the case of the Monier floor, and in the case of the Golding floor was chiefly due to the already mentioned flaw in the central tie-rod. These experiments were carried out at our suggestion, and under the direction, at the request of the representatives of the Expanded Metal Company, of Mr. Walter Beer, who acted for us.

In conclusion, as the New Brighton Tower has been mentioned, we may state that while Sir Benjamin Baker is consulting engineer to that structure, we are engineers and architects, and supervise the work.

We are, dear Sir, yours faithfully,
Maxwell and Tuke.

41, Corporation-street, Manchester.
January 19, 1897.

ORIGIN OF THE WORD "TRAM."

To the Editor of Engineering.

Sir,—In a recent issue of Engineering a correspondent makes the statement that the word "tram" originated from the word "Outram," a man of that name having had something to do with the construction of pioneer railroads. This idea originated with Smiles, and is in keeping with the romances he makes out in connection with his engineering heroes, but it does not appear to have any other foundation than the ingenious imagination of that author.

The word "traam," meaning the handle of a wheelbarrow or sled, is Scandinavian, and has been known ever since the articles to which the name is applied were used. It has also been used in Scotland for centuries as applied to the shafts of carts, wheelbarrows, ploughs, &c. Burns, in his "Inventory," says:

"An auld wheelbarrow, mair for token;
Ae leg an' baith the trams are broken."

In 1555 the following note was written in connection with an English institution: "To the amendinge of the highwaye or tram from the weste ende to Bridgegait, in Barnard Castle, 20s."

From this testimony it would appear that the word "tram" has probably been used since implements with parallel handles were employed, and it has no doubt originated from the word "trammel." The French use the word "tramme" in the sense that we use "tram," and it is to be found in old books written in that language. Instead of the name "Outram" giving us the expression "tram," it probably originated from the word, as many other surnames have come from the occupation people followed. In old times in Scotland, when two men were required to manage a plough, one man was within the trams, the other was out-tram man. Nothing is more natural than that some man doing that work should get the name "Outram" until it became his recognised surname, just the same as Smith, Carpenter, Wright, and many other names originated from the occupation men followed.

Angus Sinclair,
Editor *Locomotive Engineering*.

New York, January 7, 1897.

MACHINERY ON HIRE-PURCHASE.

To the Editor of Engineering.

Sir,—Though a constant reader of your invaluable paper, it was only to-day that I came across the letter of Messrs. M. Powis Bale and Co. in your issue of the 1st inst. Their complaint as to the injustice of our present law in regard to the hire-purchase of machinery, understates rather than overstates the hardships to which a lessor of such valuable chattels may be put. It is not enough for him to obtain the landlord's undertaking in writing that he will not seize. That he had in the present case, for here the hirer was himself the freeholder of the land. Yet he was able—thanks to the feudal respect which our law pays to contracts regarding land and its corresponding contempt for "mere chattels"—to make a good title to some one else's machinery in his mortgagor. The only way in which the lessor of machinery can really protect himself is by taking a mortgage of the actual realty covered by the machinery. This is, of course, in most cases impossible, and so he cannot really protect his property. He must, therefore, forego this branch of his trade altogether, or else base the rent he charges for letting out his machines on such an estimate as will recoup him for an occasional experience such as befell the plaintiff in this case. Such necessary caution must, of course, check trade and penalise the honest hirer for the faults of the law.

Yours truly,
Benedict W. Ginsburg, LL.D.

12, King's Bench Walk, Temple, E.C.,
January 14, 1897.

Coal-Mining in the Midlands.—The noble familie of Bentinck and Pelham-Clinton are endeavouring to turn the coal wealth of their estates to increased account, and this means a good deal. For several months past the Wigan Coal and Iron Company, Limited, has been considering the advisability of sinking one or more pits on the east side of Worksop, on land within three miles of Clumber House, and one mile from Worksop. Boring has been proceeded with over various portions of the coal area leased to the company, viz., Manton, Bevercotes, Rockley (Gamston), and Little Malton. The results have been satisfactory, it having been shown that the "dip" is practically the same at Manton as at Shireoaks, the boring indicating the course of the coal to be from west to east and south-east. It is hoped and expected that the first sod of a new shaft at Manton will be turned by the Duchess of Newcastle early in May. This week another bore has been commenced on the Morton Grange estate, near Checker House.

SAFETY BOILER GAUGES.

GAUGE glasses are becoming more and more a source of anxiety to engineers and stokers. The high-pressure steam now used seems to dissolve the interiors, particularly at the upper extremity, rendering them liable to give way at the slightest touch, and when they do give way the result, in a confined stokehold, is not a thing to be lightly faced. Indeed, in numerous instances men have lost their lives, and in very many others serious scalds have been experienced, before the escaping steam and water could be shut off. To remedy the evil, self-closing gauge cocks have been devised, and many have been applied, but it cannot be said that they have met with universal acceptance. Others have tried to limit the range of the steam and water by placing guards round the gauge glass, but often these have obstructed the view and the men have removed them. The best arrangement of this kind which we have seen is illustrated on Fig. 1. This view has been prepared

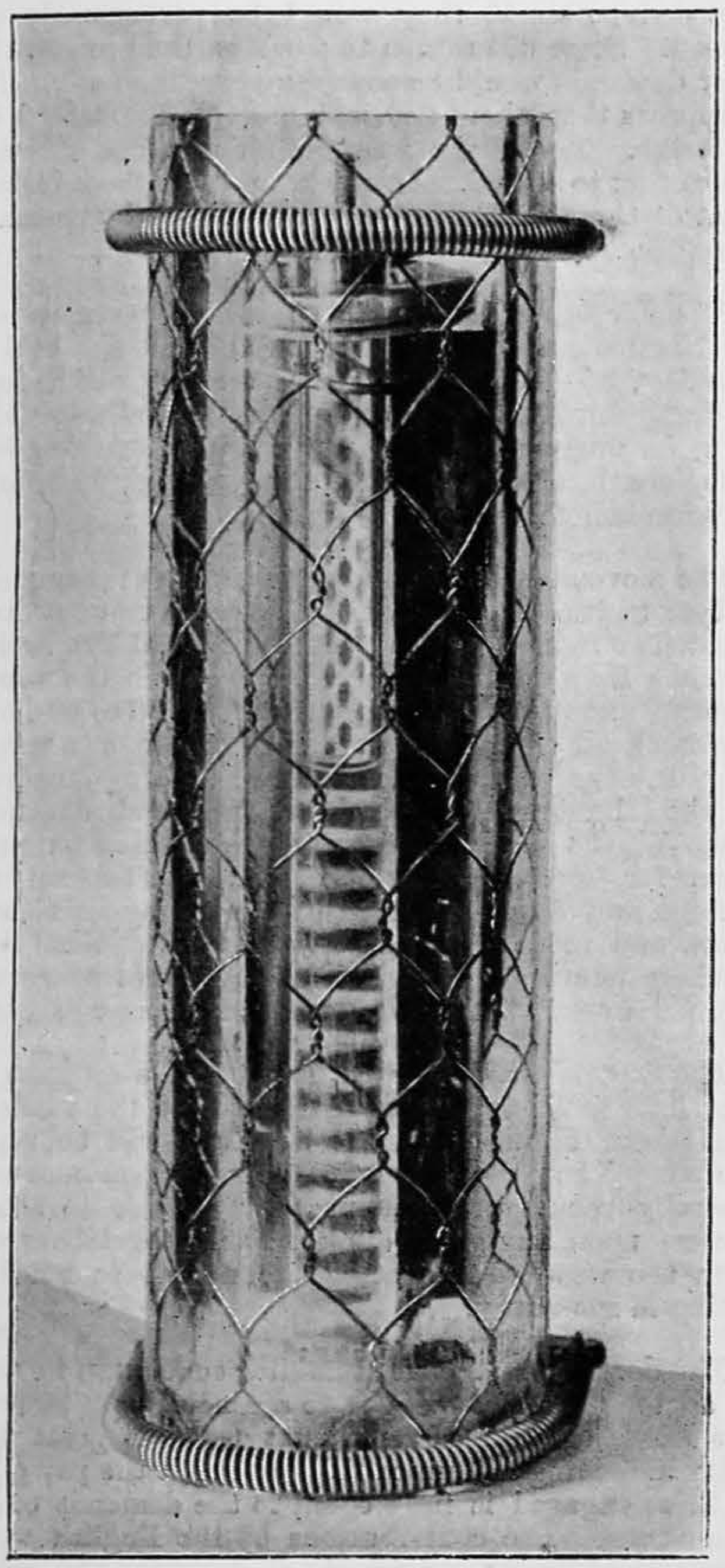


FIG. 1.

directly from a photograph in order that our readers may be able to form an opinion for themselves as to whether the guard renders it difficult to see the gauge glass. If the illustration had been drawn on wood, there would always have been the chance of the engraver emphasising certain features at the expense of others, but in a photograph this personal element does not come in. As a matter of fact, a photograph does less than justice to this appliance. Those who are acquainted with the practical details of photography will know how difficult it is to get a picture of a piece of curved glass, such as that shown, without its transparency being impaired by reflected light. The observer, looking at the actual object, takes no note of the brilliant parts of the glass, and looks through them, but the sensitive plate cannot exercise this selective action. Hence, although great care was exercised in producing the original of our illustration, it falls very far short of conveying the full idea of the transparency of the guard around the gauge glass.

This guard is of polished plate-glass, bent into horse-shoe or D form. The glass is of considerable thickness, and embedded within it is a piece of wire netting, which holds it together in case of fracture. From the view one might imagine that the wire was on the surface, but by looking carefully at the right-hand edge, it will be seen that it is in the body of the glass. There is thus interposed between the stoker and the escaping steam a very substantial barrier, which is not likely to become cracked, and even if it does, still holds together and fulfils its function.

These glass guards can be affixed to any gauge fittings at once, without drilling holes or making other alterations. Two brass yokes, connected by an adjustable rod, clip on to the union nuts of the gauge cocks, and from them two spiral springs pass round and embrace the glass guard, the whole being capable of detachment and of displacement in a few moments.

The gauge glass can be seen through the guard in the illustration, and the water level is most clearly depicted. The part of the glass containing water is crossed by alternate dark and light bands of most distinctive character, while that part containing steam is backed by dots. This effect is more clearly demonstrated in Fig. 2, which has been photographed without the interposition of the glass guard. In these days of water-tube boilers, when the gauge glasses must of necessity be placed far above the heads of the stokers, it is most desirable that every assistance should be given them to prevent their

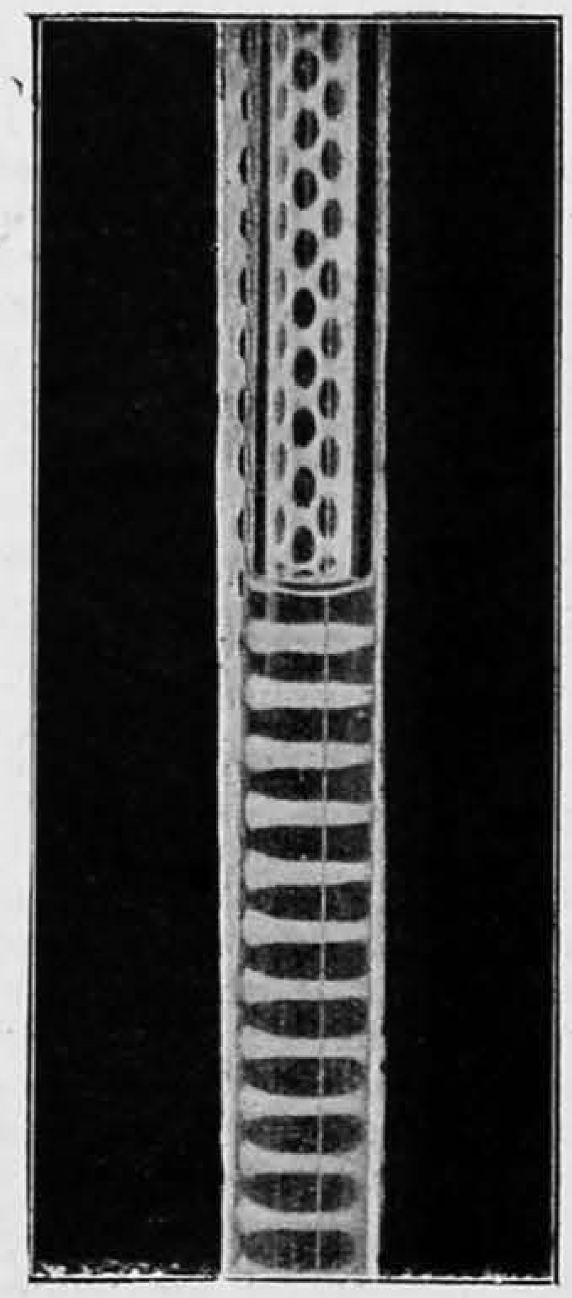


FIG. 2.

making mistakes as to the water level, and the appliance we illustrate seems most effectual for this purpose. It consists merely of a half-tube, pierced with three rows of holes, and coated with white enamel. This tube is placed behind the gauge glass, and is seen through it. Where the glass is filled with water it (the glass) becomes a cylindrical lens, spreading out sideways all the rays of light that pass through it, making a dot appear like a line, and a disc appear like a band. The empty part of the tube exercises no sensible influence in altering the shapes of the objects seen through it, and hence there is a most unmistakable line of division corresponding to the water level in the gauge glass. It is impossible to imagine a man failing to recognise the true water level in the gauge, provided there is a reasonable amount of light in the boiler-room. In some cases the reflector is covered with luminous paint, the intention being that it shall be exposed to light during the day, and put in position at dusk, the reflector previously used being removed. Both these appliances are manufactured by Messrs. Wallach Brothers, of 57, Gracechurch-street, London, and are sold by mill furnishers and ironmongers.

INDUSTRIAL NOTES.

IN the general summary of the state of employment, the Labour Department of the Board of Trade point out that a comparison of the returns relating to employment might be misleading if confined to the previous month, because of the holidays at Christmas and at the new year. Therefore, the comparison is made with those of a year ago, and it is shown that there was a decided improvement over last year's report at the same date. The improvement has been more particularly marked in coal and ironstone mining, in the iron and steel trades, crude and finished, and in the engineering and shipbuilding trades, and kindred industries. It is perhaps sufficient to say that the building trades maintained their position throughout the whole of 1896. On the other hand, there was a slight falling off in the textile and clothing trades towards the close of the year. The percentage of unemployed was slightly higher than in the previous month's report, but lower than in any year since 1890 at the same date. A total of 111 trade unions made returns, having an aggregate of 439,881 members, of whom 14,186, or 3.2 per cent., were reported to be unemployed. At the same date a year ago there were 4.8 per cent. of unemployed in the 88 unions reporting, with a total of 398,258 members. The chart line for the year was almost wholly towards a lower level, with very small fluctuations. The proportions of unemployed are thus classified. In 72 unions with 298,936 members the unemployed were under 3 per cent. In 20 unions with 67,216 members the ratio was between 3 and 5 per cent. In 19 unions with 73,729 members the proportion was 5 per cent. and over, up to 10 per cent. in eight unions with 8319 members. These figures cover the very worst portion of the year in so far as employment is concerned. But there is another encouraging feature in connection with the figures: not only was the percentage of unemployed lower than at any time during the last six years, but the prospects for the new year were better, not only for the workers by the volume of trade, but for the employers by the gradual but slow rise in prices.

The work at the coal mines during the month was somewhat less than in the previous month, but the average was good on the whole. At pits employing 402,848 persons, the average time worked was 5.16 days per week, as compared with 5.31 in the month previous, and 4.88 a year ago. The unemployed in Durham and Northumberland were only 1.2 per cent. of the total numbers, as compared with 1.4 in the previous month, and of 1.7 a year ago. Employment at the ironstone mines and open works continued good; at the 125 works reported upon, 16,435 persons were employed, the average time worked being 5.65 days per week, as compared with 5.81 in the previous month, and 5.57 in the same month a year ago. As regards the latter it was found that 4½ per cent. more were employed than a year ago. The signs, therefore, are healthy all round.

In the pig-iron industry trade was a good deal better than it was a year ago. The ironmasters making returns had 346 furnaces in blast, compared with 331 a year ago. The total number employed was 22,263, compared with 21,276 a year ago. Not only was there an increase in the total number of furnaces in blast, and of men employed, but the time worked and the output were far greater. At 130 steel works 36,572 persons were employed, as compared with 31,036 a year ago, an increase of nearly 18 per cent. in the year. At 91 puddling furnaces and rolling mills the number employed was 17,733, as compared with 16,994 a year ago, an increase of over 4 per cent. There was an improvement in the tinplate trade, 328 works being at work, compared with 261 in the month previous. It thus appears that in the productive industries connected with raw material for manufacturing purposes, as regards the iron, steel, and metal trades matters look very encouraging.

In the engineering and kindred trades employment continues to be good. The percentage of men out of work was only 2.5 per cent., as compared with 5 per cent. a year ago. In the shipbuilding trades there has been a further improvement, the list of unemployed being lower by far than a year ago. At the date covered only 7.7 per cent. were unemployed, as compared with 10.5 per cent. a year ago. The proportion is still high, but it is one-fourth less than at the same date a year since. Here again we find encouragement in the fact that the prospects are good, both for the engineering and cognate trades and for the shipbuilding industries. The outlook is regarded as good for the whole year, if nothing happens to mar the prospects.

The building trades have continued busy all through the autumn and winter so far, except that the painters have fallen off, as is usual at this time of year. The proportion of unemployed in the unions making returns was only 2.1 per cent.. The wood-working and furnishing trades have been fairly well employed for the season of the year. The proportion out of work was 4.3 per cent., as compared with 4.6 a year ago. The printing and bookbinding trades continue to be well employed on the whole, the proportion of unemployed members of the unions being 3 per cent., as compared with 4.1 per cent. a year ago. In the paper trades there is but little change, but the proportion was 3.3 per cent., as compared with 3.1 per cent. a year ago. Employment in the glass trade is slack; the number out of work is equal to 12.5 per cent., as compared with 8.8 per cent. a year ago.

In the textile trades it seems that the cotton-spinning branch is fairly good, but the weaving branches have been slack. In the woollen trades employment is slack in the principal centres, and in some others there has been a decline. In the worsted branches the improvement apparent a month ago has not been maintained in all cases; and in the hosiery branches there is some slackness in several departments. In the 475 mills reporting, employing about 80,000 females, only about 75 per cent. were on full time—less than in the previous month.

Dock and riverside labourers have been busy. At the London docks and wharves the average number employed had risen to 16,705, as compared with 15,180 a year ago. In most of the seaport towns there has been tolerable activity at the docks and wharves, and the indications are that the activity is destined to continue. In most of the agricultural districts there has also been considerable activity, with slight irregularity only in a few, and that chiefly as regards odd men, taken on temporarily. It therefore appears that both in what are called the skilled, as well as the unskilled, trades, employment on the whole is tolerably good.

Only some 36 fresh labour disputes occurred in the month, affecting about 6316 persons, as compared with 65 disputes, involving about 15,000 persons, in the previous month. The total number in December, 1895, was 37 disputes, affecting 4000 workpeople. Ten of the disputes were in the engineering, shipbuilding, and metal trades, six in the building trades, five in coal-mining industries, four in the textile trades, three in the clothing trades, three in connection with ships and docks, and five in other miscellaneous industries. Thirty-eight old and new disputes were settled, affecting 8244 persons ; in these, 18 disputes, involving 3026 persons, were favourable to the workpeople ; 12, affecting 3320 persons, were unsuccessful ; and four, affecting 878 persons, were compromised. In four disputes, affecting 1020 persons, the conclusion was indefinite. The aggregate time lost through strikes in the month was 199,000 days.

The changes in the rates of wages and hours of labour were more numerous than the disputes seem to indicate. The changes affecting wages involved 58,500 persons, of whom 57,000 obtained increases, and only 1500 sustaining decreases. The estimated effect of all the changes was an average increase of 1s. 4d. per week in the wages of all affected. In the total, about 14,400 coal miners, 7200 blastfurnacemen, and 25,000 engaged in engineering, shipbuilding, and kindred industries enjoyed an increase in the rates of wages. As regards the others, about 4000 tinplate workers and 4000 glass bottle makers also got an increase. The only decrease reported was among the fustian cutters, some 1500 being adversely affected. In the case of about 3300 workpeople, the changes were preceded by strikes ; as regards about 9800 the changes took place under sliding scales, wages boards, &c. The remainder, affecting 45,400, were settled by negotiation, by mutual arrangement, or were by advances voluntarily conceded by employers.

With the dawn of the new year 1897, the Amalgamated Society of Engineers commenced a new departure, and one of some consequence, by the publication of the *Amalgamated Engineers' Monthly Journal*, devoted to "Trade Unionism, Co-operation, and Brotherhood." For 46 years they have had their monthly, quarterly, and yearly reports, but these were more or less of a private character, being entirely taken up with the administrative details of the organisation. Now they offer what is to all intents and purposes a public journal. With a starting list of 87,455 members, the new journal ought to become a powerful influence in the industrial world. Of the total 87,455 members, 7602 were in receipt of benefit, as follows : On donation, 2617 ; on the sick list, 2043 ; on superannuation allowance, 2942. The total cost of these benefits was 3360*l*. 19s., or 10¾d. per member, per week. These figures are exclusive of purely trade members, probationary members, &c. The report anticipates a good year for trade, and for the society. The report cautions the members against shirkers, against men for whom jobs are found, and yet who do not turn up ; it adds, "Much as we wish to have a large membership, we have yet no intention of harbouring shirkers within our ranks." Reporting on wages and other movements, it is stated that 53 hours per week have been conceded at Liverpool by the employers without the loss of a single hour. Wages have been raised at Belfast, Glasgow, Greenock, Paisley, Barrow, Chorley, Rochdale, Haslingden, Heywood, and Northwich, by friendly negotiation for the most part. At Newton-le-Willows and at Cleckheaton 2s. per week advance have been obtained after a short and sharp contest. At Shipley, Keighley, Colne, and Kilmarnock the men are still out for the advances sought. The overtime question is being pressed in several places, and at Oldham Messrs. Platt have agreed to a set of regulations which are regarded as a model for other places and firms. At Merthyr the men were beaten after a strike lasting 13 weeks. At Armstrong's the outworkers are striving for extra pay, or weekly expenses away from home. The journal invites discussion on the eight hours' day, and how to obtain it.

The monthly report of the Associated Ironmoulders states that the past year was encouraging by the increase of members, and the increase of those at work. The decrease in the number of unemployed was 100, and that, too, at a time when there is usually a slackness of trade. The total expenditure was less than the income by 1417*l*. 17s. 7d., so that the balance is increasing rapidly. The trade reports from the various districts indicate industrial activity, and the expectation is that there will be a busy year in Scotland. An effort is being made to open up the closed shops in Glasgow, mainly shut on the overtime question, and at a conference held on the subject a resolution was carried which it is hoped may attain that object. Another important point considered by the conference was the establishment of a conciliation board, and the secretary was empowered to confer with the employers upon the question. The Federation of Engineering and Shipbuilding Trades is moving for weekly pays on the Clyde and the Forth, and also on the question of working hours. The idea is to reduce the normal working time to 51 hours per week, irrespective of overtime. A number of firms give the 51 hours now, it is reported, and the men seek to make the hours uniform for all. Commenting upon the extra pay, time and a half, for overtime, the report adds, "which nobody wants, but it is still wrought, strange to relate." Overtime is not wanted when trade is slack and many are out of employment, but when trade is brisk all want it, or nearly all, strange as it may seem to some officials.

The Cotton Spinners report 3 per cent. of their members unemployed, but this was from all causes. The total number of members is given as 14,124, showing a loss in the past year of 1135 members. There were 27 dispute cases in the month, of which 19 or 20 were attended to and settled. This is done by the joint committee, or by personal negotiation with the employers. The report states that the prospects for the year are brighter than they were a year ago, the margin being nearly ½d. per pound higher that it was. It is hinted that shares will go up, and that dividends will be paid where for some time there have been only losses, with certain exceptions. Some questions are still unsettled.

The trade reports from the Lancashire districts show that the engineering and kindred trades not only maintain that briskness and activity which has for some time been manifest in all its chief centres, but that the outlook continues to improve. Most of the establishments started the year well supplied with orders for some time ahead, and new work is coming forward in sufficient quantities to practically insure a continuance of activity over the remainder of the year. It has been a long time since such a report could be supplied at the commencement of a new year. An examination of the detailed reports of the Amalgamated Engineers indicates that employment is good in most districts. Instead of very bad, bad, slack, dull, declining, and other words expressive of depression, we have very good, good, or moderate, indicative of activity and prosperity. A rather peculiar instance of the view taken by some secretaries of the state of trade is given by one secretary of a branch in Lancashire. He marks his sheet as "bad," that is, with a B. But in looking along the tables it is found that with 30 full members, and one trade protection member, total 31 members, not a single man is on donation in either of the columns. There are other instances of the same kind. If trade is bad while all the members are at work, what must it be when the sheet is marked good ? The wages movement seems to have practically settled down in the Lancashire districts, for it appears that only in one large centre is there really a dispute, and that one is being quietly conducted. In the iron trade there is little noticeable activity, but a considerable weight of buying is going on in all departments, and full rates are being obtained without difficulty. In the finished iron branches no quotable advance in prices was made at the quarterly meetings, but there has been a hardening of prices in the case of sheets, which previously had been low in price. The steel trade has advanced to a decidedly stronger position, large sales of hematite having taken place.

In the Wolverhampton district the iron trade maintains the very strong position it has held during the last two months. Manufacturers in every branch have been, and are, fully employed in executing the orders accepted during the closing months of last year, and a large accession of new business is anticipated from the numerous inquiries already at hand. Consumers of finished iron are pressing for deliveries, and some good offers have been received both from home and abroad. The recent advance in unmarked bars of 5s. per ton is well maintained, and all prices are firm in the district. The demand generally, for all classes of iron, is good. As regards the steel trade some heavy orders have been placed, and preparations are being made to largely increase the output. In the engineering branches of trade there is not a single member of the unions out of work, and the secretaries of the branches mark their labour sheets as "good." The ironfounders and the boilermakers are in a similar position.

In the Birmingham district the quarterly meeting was largely attended by buyers and sellers from all parts of the kingdom, and was considered to be in every respect an encouraging gathering in so far as trade was concerned. The black sheet manufacturers advanced the price of sheets 5s. per ton on the previous minimum. Orders were fairly plentiful for Australia, South Africa, and South America, but there was a falling off in demand as regards India. There is a large demand for steel, and the production has largely increased. At the same time prices continue to harden, for the requirements are quite equal to the output. The engineering trades are very busy ; only seven members of the union, out of 1355, were returned as unemployed during the Christmas and New Year's holidays.

A dispute occurred at the Dunlop Tyre Company's works at Coventry a fortnight ago on a small scale, but in the early part of last week the number on strike was increased from about 80 males by the addition of from 250 to 300 females. The statement on the one side is that the women and girls came out in sympathy with the men ; on the other side it is alleged that they came out at the solicitation of the pickets. Notices were issued to the effect that unless those on strike returned to work, they would be permanently dismissed. Some did return to work on the promise that their demands would be considered individually. But it appears that about 250 men and girls remained out on strike. The strike was for an advance of wages amounting to 4s. 6d. per week, and for the reinstatement of three men who were discharged by reason of being the leaders.

A conference of federated engineering employers of the North-East Coast, Clyde, and Belfast was held on Tuesday, at Carlisle, under the presidency of Colonel Dyer, to consider the application of trial-trip allowances for engineers. The subject was considered at some length, after which it was adjourned, no definite decision being come to.

The movement of the railway employés is beginning to bear fruit. The Midland Railway Company have decided to reduce the hours of shunters at the busiest stations from 60 to 48 hours per week in the winter months, and of the goods guards from 66 to 60 hours per week all the year round. Of course, as a matter of risk, the winter months are more dangerous to the shunters by reason of fog and darkness. Some of the other companies are making preparations for some concessions. The porters on the London and North-Western are agitating for shorter hours and increased wages ; it is alleged that their working hours are 99 per week, the wages being only 17s. per week. The Midland pays 19s. per week.

The Scottish trade unions have called a congress for March 25 to 27, at which it is said that the whole of the labour organisations of Scotland will be represented. The proposal is to decide upon measures whereby the several unions will be able to act in concert upon any great question affecting labour, not with the view of federating the unions so much as acting in sympathy.

The dockers' strike at Hamburg continues, in spite of all the efforts to bring it to a conclusion. Some of the English captains assert that there is great difficulty in loading and unloading, and that the pay given to those engaged is fully equal to the demands of the union men. The contributions by the English workmen are increasing in amount.

The dispute at the Penrhyn quarries is evoking a good deal of comment, and subscriptions are pouring in towards supporting the men. Lord Penrhyn has issued a vindication, in which his lordship states that he is not opposed to combinations properly conducted. The quarries have been thrown open once more, but all applications for work are to be "considered on their merits." The matter is to be raised in Parliament.

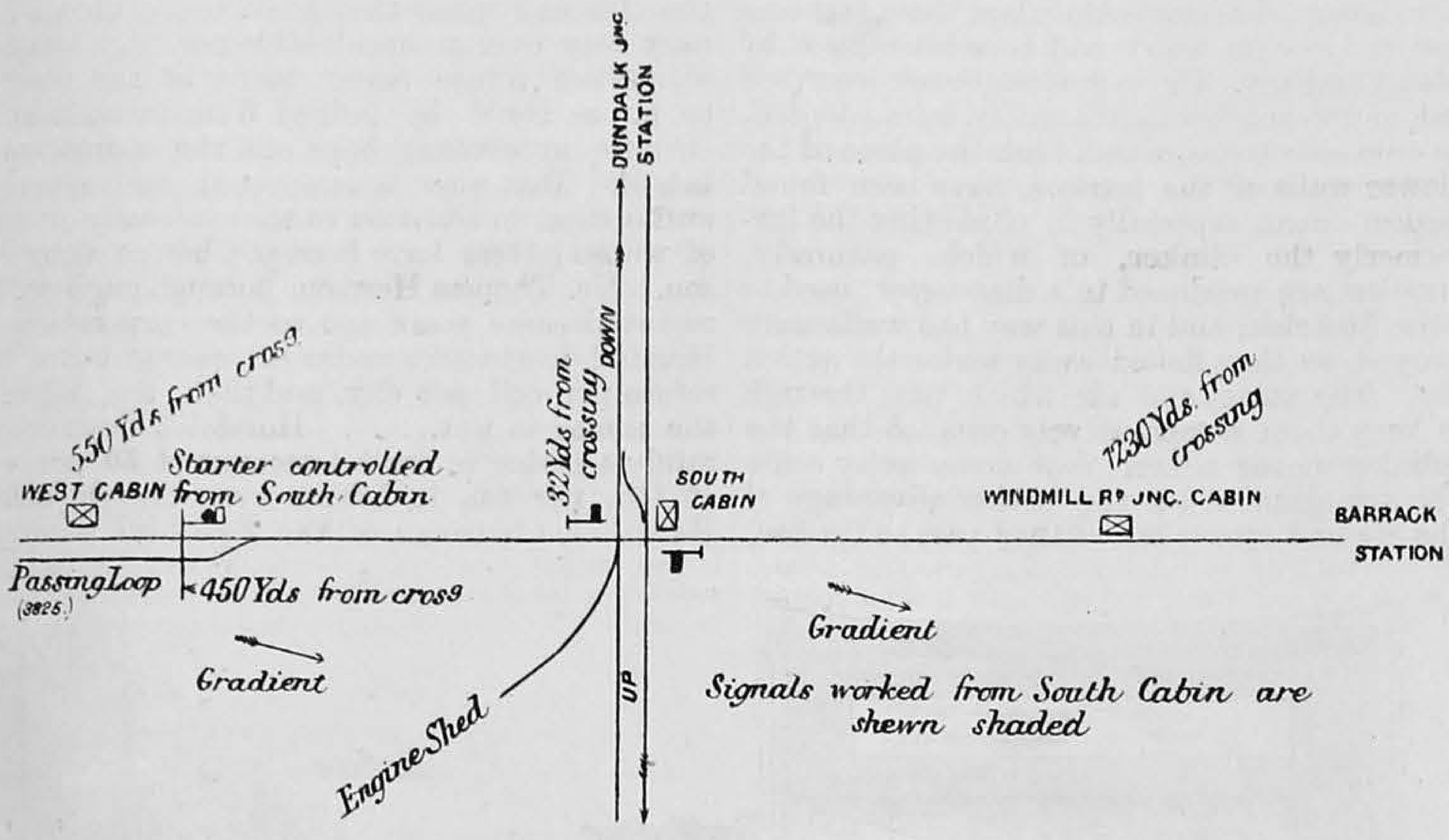
The Cleveland miners have asked for an advance of 7½ per cent. in their wages. The employers have offered 6¼ advance in two instalments, which offer will be placed before the men. A dispute took place last week at the Pinxton Colliery, near Alfreton, by which about 1200 hands were thrown idle. The dispute at the Bwllfa Colliery, Rhondda Valley, which has lasted so long, has at last been referred to arbitration. Some 1500 men were involved. No further development has taken place in the Scottish coal districts.

The trial of the glass bevellers' case for picketing, &c., has resulted in a verdict for the employers for 674*l*. 13s., with costs. It was expected to raise important issues, but the collapse seems to have been due to certain facts made known to the counsel for the defendants, and Mr. Asquith suggested a settlement by consent. Possibly these verdicts will induce pickets and officials of the unions to be more careful, and abstain from practices which are declared to be illegal. There is a wide scope allowed by law, but terrorism will not be tolerated by the judges.

DOUBLE COLLISION NEAR DUNDALK.

A DOUBLE collision occurred in the early hours of the 3rd of October near Dundalk Junction station on the Great Northern Railway of Ireland under the following circumstances. About a quarter of a mile south of Dundalk station the double main line from Dublin to Belfast is crossed on the level by the single line from Enniskillen to Greenore, as may be seen in the accompanying figure, on which the lay of the roads and position of the signals mentioned in Colonel Addison's report are diagrammatically shown. The single line is worked on the electric staff system, and West Cabin and Windmill-road Junction Cabin are staff cabins. There is bell communication between the West and South Cabins, but not between the latter and Windmill-road Junction. A goods train for Barrack-street station, having exchanged staves at West Cabin, was given on by the signalman there to South Cabin in due course. As South Cabin had a light engine and tender on the up line at the time, and was about to cross them over to the down line and then let them into the engine shed road, he did not reply, but proceeded with the shunting operations. It had become the custom at this crossing to allow trains to pass the West Cabin starter at danger, and to wait for permission to cross at the crossing stop signal, and so the west signalman instructed the driver to draw forward up to the home, but instead of doing this the driver went on and fouled the crossing. The South Cabin signalman heard the goods coming and shouted to the driver of the light engine to hurry up, he being then on the down line running towards the siding, and this he immediately did, but not in time to prevent the goods engine striking his tender and tearing it away from the engine, and overturning it so as to block both roads. The fireman was thrown to the ground by the parting of the tender, but neither he nor any one else sustained any injuries. The tender of the goods train (the engine was running tender first) was slightly damaged, but after a delay of about half an hour, and with the authority of the Dundalk locomotive foreman, the goods train proceeded towards Barrack-street station, but it had not gone far when the train parted from the engine, and this was not discovered by the driver until he gave up his staff at Windmill-road Junction. The staff was returned to him, and he went back to fetch his train. In the meantime the guard had discovered that it was parted, and he went forward to see where, but owing to a bridge over a river not being provided with a footway, he was unable to get to the head of the train before the engine returned, and, coming up too quickly, ran into the wagons, breaking one up and damaging another. The driver and the fireman of the goods train, who had left the company's service at the time of the inquiry, made a written statement to the effect that the home signal was off at the crossing, and was thrown up in their faces. Though it would have been possible for this signal to have been lowered after the light engine had used the cross-over road and before it was allowed to set back to the siding, yet, as Colonel Addison remarks, this is very improbable, and as other statements of these men appear not to be true, he comes to the conclusion that in this instance also they are open to doubt, and that "the carelessness of the enginemen is largely due to a cause which, to the very great credit of railway servants, is so uncommon as to be almost unknown. Although the evidence is to the effect that the driver was not actually drunk, his fireman apparently was, and both men are proved to have twice absented themselves from their engine . . . . under circumstances which point to their having gone to a public-house."

But the Government Inspector is not satisfied that the arrangements for controlling the traffic at this level crossing are satisfactory or sufficient. Owing to buildings, there is no view possible between the main line and the single line from the crossing to the West Cabin, and the gradients on the single line are somewhat steep, varying from 1 in 120 to 1 in 860, with 110 yards of level between the West and Windmill-road Junction Cabins, and therefore he would like to see the level crossing replaced by a bridge, but in the meantime he considers it imperative that (1) no trains should be allowed to leave West Cabin with the starting signal at danger; (2) communication should be established between the South and Windmill-road Junction Cabins; (3) the home signal east of the crossing should be moved further back, or an outer home provided. To these requirements the company should offer no objection, we take it. It also came out in the inquiry that block working is not in force in Dundalk station, although no exemption has been obtained from the Board of Trade, and as Colonel Addison was unable to ascertain under what regulations the traffic is carried on, he concludes his report with the statement that "some further information on this point seems to be required from the company." Why, of course it does! The Board of Trade can hardly find fault with railway companies allowing some of their rules to be regularly broken by their servants as long as it allows its own regulations, made with the authority of Parliament, to be, as in this instance and many others which we have had from time to time to chronicle, quietly ignored and contravened until some accident ensues, and then the Board merely contents itself with inquiring as to the method in which this contravention is carried out. Truly, we are a patient people!



SUPERHEATED STEAM ENGINE TRIALS.

AT the ordinary meeting of the Institution of Civil Engineers held on Tuesday, January 12, Mr. John Wolfe Barry, C.B., the President, in the chair, the paper read was on "Superheated Steam Engine Trials," by Professor William Ripper, M. Inst. C.E.

The author pointed out that the use of superheated steam had been in abeyance for the past 30 years, during which time a continually increasing gain in steam engine efficiency had followed the development of the multiple-expansion engine, and the increase of steam pressures. The limit having been now nearly reached in this direction, engineers were again reverting to superheating, from which a further considerable increase of efficiency might be looked for. Trials had been carried out on a 17 indicated horse-power "Schmidt motor," a single-acting, simple, non-condensing engine, supplied with superheated steam from a Schmidt superheater, to determine the steam consumption of the engine working with various degrees of superheat, and at temperatures considerably beyond those usually employed; and also to find to what extent the dryness fraction of the steam, and the heat exchange between it and the cylinder walls, were affected by the superheat.

The heat expended in superheating reduced the amount of heat employed in evaporation of water, but the heat so diverted for the purpose of superheating was shown to be productive of a considerable gain in thermal efficiency. Thus an expenditure of 5, 10, and 15 per cent. of the furnace heat to superheat gave a net gain of 12, 38, and 70 per cent. respectively of the work done for heat supplied.

When the load on the engine was fairly constant very little regulation of the superheat was necessary, and the temperature of the superheated steam in the coils remained remarkably steady. If the load on the engine was reduced, the temperature of the steam in the superheater immediately began to fall, though there was no appreciable change in the condition of the fire; on the other hand, if the load was increased, the temperature of superheat increased also. If superheated steam was desired at the engine, then the superheat being once taken up by the steam should have its high temperature preserved by all possible means till it reached the admission valve of the engine.

It was stated that no important gain could be theoretically expected from superheating, the actual gain in practice being due to the more or less complete removal of the loss by cylinder condensation. When steam was superheated it was in a more stable condition than without superheat, and if the steam contained sufficient excess heat, the steam in the cylinder could be rendered dry at cut-off and at release. This had been accomplished in certain of the trials described in the paper. Superheating thus removed the principal source of loss of heat in the cylinder, namely, water at release, and it reduced also the amount of the heat exchange between the steam and the cylinder walls to a minimum.

The effect of varying degrees of superheat upon the steam consumption per unit of power was illustrated by a large number of trials under varying conditions. Taking one example, it was shown that steam at 120 lb. per square inch pressure superheated to 674 deg. Fahr. on entering the engine, reduced the steam consumption from 38.5 lb. without superheat, to 17.05 lb. per indicated horse-power per hour, the rate of decrease of steam consumption with increase of superheat being approximately uniform within certain limits.

It was pointed out from the indicator diagrams how rapidly the superheat disappeared on admission of the steam to the cylinder, and how few were the cases in which the steam in the cylinder was found to be superheated at cut-off, though admitted in a highly superheated condition. It appeared from these experiments that unless the degree of superheat of the steam entering the engine reached at least 200 deg. Fahr. above its normal temperature with a late cut-off, or a still higher degree of superheat for an earlier cut-off, the condition of the steam in the cylinder at cut-off was that of wet steam at the temperature of saturation.

In order that the steam in the cylinder might be superheated during expansion and dry at release, it was necessary that its temperature on entering the engine should be about 300 deg. Fahr. above the temperature normal to its pressure. When the steam was dry at release it was superheated at cut-off from 50 deg. to 100 deg. Fahr., finally falling at end of about three expansions to the temperature of saturated steam. For a small increase in the number of expansions the temperature at cut-off rapidly fell to that of saturated steam.

The author considered superheating not as a means of obtaining a thermal efficiency in any way proportional to the temperatures used, but as a device for realising as far as possible the full thermal efficiency of saturated steam, by rendering the cylinder practically non-conducting. The practical difficulties supposed to be associated with the production and use of superheated steam had been satisfactorily overcome. Experience had shown that with ordinary care as to purity of feed water, superheater tubes after long periods of severe work showed no signs of burning, scaling, or injury of any kind. With the greatly improved quality of lubricating oils no trouble need arise with the lubrication of superheated steam engines.

The best results could be obtained when the steam was supplied at about 650 deg. Fahr. at the engine. It was important to use good non-conducting material to maintain the high temperature of the steam in its passage to the engine. The best results in these trials had been obtained in association with a high range of pressure in one cylinder with a late cut-off. Any cause which tended to increase initial condensation in the cylinder with saturated steam tended also with superheated steam to absorb the superheat and to neutralise its useful effect in the cylinder. Superheated steam at high temperatures might be safely and advantageously used in double-acting engines. Many such engines were now at work or in course of construction.

The point requiring chief consideration in the design of engines to work with superheated steam was the steam admission arrangements. The steam admission valve, being subjected to the maximum temperature, should be practically frictionless, so as to remove the necessity for its lubrication.

The paper was accompanied by an Appendix of Tables giving the results of a large number of trials, and accompanied by diagrams illustrating the effects of superheating on steam consumption, dryness fraction of steam during expansion, heat interchange between the steam and the cylinder walls, work done per pound of steam, and thermal efficiency.

TABLE OF FORCE OF WIND.—The following Table, prepared by Mr. J. T. Corner, the Engineer-in-Chief of Portsmouth Dockyard, to whom we are indebted for a copy, gives the numbers adopted by the Navy for winds of various velocities and force:

Table of Force of Wind.

Nautical Numbers.	Name of Wind.	Velocity in Knots.	Force per Square Foot in Pounds.
1	Light air	1	.0067
		2	.027
		3	.060
2	Light wind	4	,107
		5	.167
3	Light breeze	6	.240
		7	.327
4	Moderate breeze ..	8	.427
		9	.540
5	Fresh breeze	10	.667
		11	.807
		12	.960
		13	1.13
		14	1.31
6	Strong breeze ..	15	1.50
		16	1.71
		17	1.93
		18	2.16
		19	2.41
		20	2.67
7	Moderate gale ..	22	3.23
		24	3.84
8	Fresh gale	26	4.51
		28	5.23
		30	6.00
9	Strong gale	32	6.83
		34	7.71
		36	8.64
10	Heavy gale	38	9.63
		40	10.7
11	Storm	45	13.5
		50	16.7
12	Hurricane	60	24.0
		70	32.7
		80	42.7
		90	54.0
		100	66.7

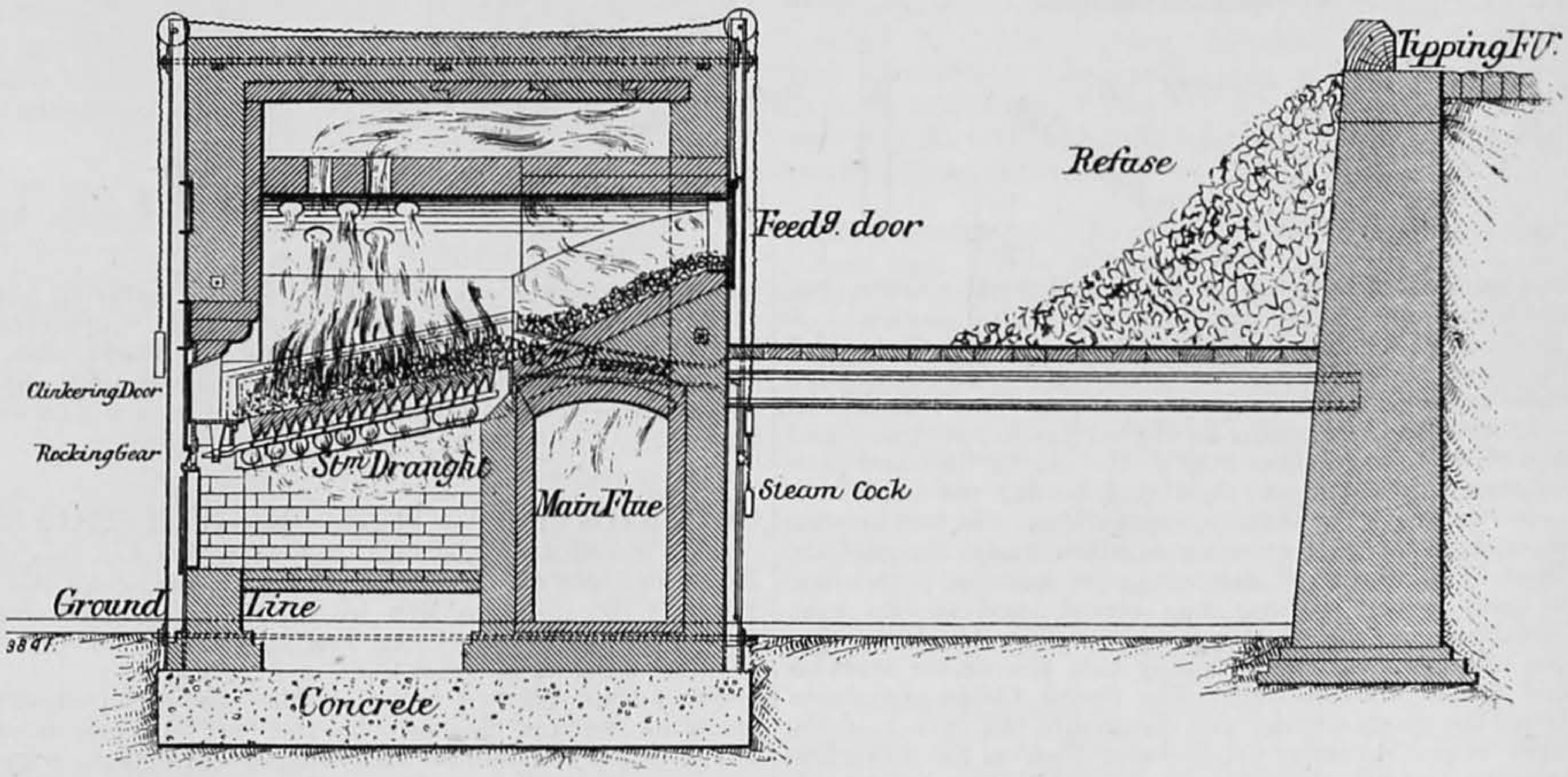
THE HORSFALL REFUSE FURNACE.

On the present page we illustrate the Horsfall refuse furnace, a type of destructor which we recently had an opportunity of seeing in operation at Oldham, in Lancashire, a town in which a good deal of attention has been given to the disposal of refuse. The most important feature in connection with this furnace is that by the arrangement of forced draught, and owing to the method by which the refuse is fed into the furnace, no unpleasant or noxious gases escape from the chimney. An explanation of the method of working will serve to explain this claim.

The annexed illustration shows a sectional elevation through one cell of the Oldham furnaces. As will be seen, the refuse is brought in by the town carts to an elevated roadway, and from thence is tipped on to a collecting platform adjacent to the furnace. The feeding door is on this side, and opens directly on to an inclined "dead-plate," which, however, in this case is of masonry. The door at the other side of the furnace is for clinkering. As a continuation of the dead-plate the furnace bars are placed, they also being inclined from end to end so as to assist the action of feeding the fires and clinkering. The dead-plate and furnace bars form the floor of a masonry cell which is arched at the top and has above it a masonry chamber. The whole is, of course, constructed of firebrick or some refractory material, whilst the whole structure is held firmly together by iron buckstaves.

The chief virtue of a destructor is to complete destruction, that is to say, it must reduce all organic matter or refuse to its component gases, and burn these gases before they pass away, so that the products of combustion will be odourless and colourless, consisting only of carbonic acid, mixed, of course, with steam, nitrogen, and a residue of oxygen. The problem is one with which steam engineers are well acquainted, but which they can hardly ever solve, owing to the conditions to be observed in generating steam. The destructor engineer has also had his difficulties, as many residents in the neighbourhood of destructors know to their cost. The Horsfall destructor is one of those which solve these difficulties. When the green or undried refuse is shovelled on to the dead-plate, it at once begins to give off fumes, but these fumes have to pass over the fire, and between it and the glowing vault of firebrick above, until they finally escape through the holes in the latter, which are shown in the engraving, and from thence into the chamber above. In this way the fumes or gases from the semi-putrescent matter, which constitutes so great a part of town's refuse, are thoroughly burnt. The Horsfall Company attach—very properly—great importance to the presence of a hearth or dead-plate, that is, a part of the structure as an extension of the grate, where the matter to be consumed can be well dried before an attempt is made to burn it. By these means the refuse is brought to the most perfect state which can be reached by it before being brought on to the grate bars. The noxious fumes from the drying refuse are given off equably, and are, therefore, more sure of being consumed, a result which is fortified by the fact that the dry fuel keeps the fire in proper shape. It is looked on as a mistake to try to burn green refuse. From the top chamber the products of combustion pass to the main flue, which is common to all cells in the battery, and which leads into a large firebrick chamber known as the mattress chamber. This is provided for the purpose of burning infected bedding, condemned meat, &c., and it will give an idea of the heat at which the gases escape from the furnace proper, when it is remembered that the brickwork of this chamber is at a glowing red heat, sufficient to consume large quantities of condemned meat. On the occasion of our visit the door at the top of the mattress chamber was opened, and a glance was sufficient to satisfy one that no unconsumed gases could pass through the chamber and the flues leading to it.

The Horsfall destructor is a forced-draught furnace, steam jets being used for the purpose. It is unnecessary here to point out the assistance which forced draught gives in securing complete combustion of fuel, for the fact is well known to engineers, and has been amply proved, more especially in marine practice. The result has not altogether been accounted for, but no doubt it is largely due to the more effectual mixing up of the gases over the fire. In the destructor the air for combustion is carried into the furnace by means of steam jets which are directed into what is described as a steam trumpet, as shown by dotted lines, and placed at the firing end of the furnace. The sides of the furnace are composed of cast-iron boxes which have openings leading to the ashpit. The steam, and the air carried forward by it in the shape of an induced current, thus pass beneath the grate bars, and the ashpit being closed, the only outlet is up through the fire. There is a controlling device by which the steam jets are shut off whenever the charging or clinkering doors are opened, thus automatically providing against flame or gases passing out.



So far we have described the destructor part of the installation, but, as will be gathered from what has been said about the state of the mattress chamber, there is a great volume of heat in the products of combustion as they pass along the flues. At Oldham this is utilised for the generation of steam, which is used for the steam jets and for driving two mortar mills, by which the clinker is worked up, and for other purposes on the works, in addition to which there is a quantity left for the electric light station adjoining, and to supply power for the horse-provender department of the corporation.

The destructor at Oldham commenced working in 1891, and then consisted of six cells, but in July, 1895, the corporation, acting on the advice of their superintendent, Mr. Walter Jessop, determined to adapt these furnaces to the improved system which had been introduced by the Horsfall Company. The side blast boxes described were added, and some other modifications were adopted. These cast-iron side boxes, which took the place of the firebrick lower walls of the furnace, have been found a great improvement, especially in clinkering the furnace. Formerly the clinker, of which, naturally, large quantities are produced in a destructor, used to adhere to the firebrick, and in this way the walls were soon destroyed, as they flaked away under the action of the rake. The steam and air which pass through the boxes keep them comparatively cool, so that the slag and clinker never adhere, but come away quite clean. The arrangement has the further advantage of heating the air and steam before they pass to the fire, and the combustion is, therefore, greatly facilitated. No trouble has been experienced with the firebars.

At the same time that the six original cells were altered, four others were added, and these have a new form of blast nozzle which has the advantage of being practically noiseless. We propose, however, dealing with this question of silent blast on another occasion.

From data obtained during the work done at Oldham, it appears that over 8 tons of ordinary town refuse, including market sweepings as well as dustbin contents, is destroyed per cell per 24 hours. There is an economiser of 96 tubes in connection with the boiler, but the dampers in the flues are so arranged that the gases can pass directly to the chimney. As the combustion of the gases in the cells is perfect, there is no need for scrapers to the economiser tubes. The boiler is of the Lancashire type, and is pressed to 140 lb. per square inch. It is 30 ft. long and 8 ft. in diameter, the flues being 3 ft. 2 in. in diameter.

In 1893 Mr. Binnie, the Chief Engineer, and Dr. S. F. Murphy, the Medical Officer of Health to the London County Council, were instructed to make a thorough inquiry into the whole subject of dust destructors. In their report, among others, they referred to the Horsfall destructor, pointing out that in detail it differed from other forms, "more particularly in regard to the outlets for the products of combustion. These are placed at the opposite end to that at which the material to be burnt is introduced, and consequently the gases have to pass over the hottest part of the furnace; moreover, a steam blast is used in connection with a closed ashpit, and as a result the temperature of the furnace is so high that at Oldham the lining was observed to be glowing, and there can be no doubt that in furnaces of this type the decomposition of the organic and combustible matters is so perfect that no nuisance is likely to arise from its use."

Mr. Charles Estcourt, the Public Analyst to the City of Manchester, has analysed the gases from the Oldham destructor, with a view to finding the effect of the steam blast on combustion. The results arrived at are instructive. The carbonic acid when the steam jets were not in use was only 2 per cent., while with steam half on it rose to 9 per cent., but when the steam was turned full on the carbonic acid rose to 14.6 per cent., "thus proving," as Mr. Estcourt said in his report, "that this steam draught had the effect of getting full value out of the air used." The analysis with full steam on was:

	Per Cent.
Carbonic acid	14.6
Oxygen	5.4
Nitrogen	80.0

One advantage of the perfect combustion is that the high chimney often used with destructors (and which, after all, is only the means of spreading the nuisance afar) is not needed, there being neither smoke nor fumes.

When we inspected the Oldham destructors we found that no smoke or perceptible dust came from the chimney when they were being fired in the ordinary way over a considerable period, a large quantity of market refuse being burnt at the time; indeed, so far as could be judged from inspection, the destructor in working bore out the claims made on its behalf. This view is supported by several sanitary authorities, in addition to those already quoted, copies of whose letters have been put before us by Mr. Watson. Mr. Thomas Hewson, borough engineer of Leeds, reported some years ago to the corporation that the Horsfall destructors under his charge burn "9 tons of refuse per cell per day, and that, too, when most of the refuse is wet. . . . Horsfall's destructor is certainly a saving in capital account of 50 per cent. and of 1½d. per ton in labour over the old cells." Mr. Hardaker, Chairman of the Bradford Sanitary Committee, speaks of the advantage of the forced draught system, saying that "the steam jets attached to the refuse destructor cells for the Bradford Corporation have proved of great service. The heat in the cells has been very much increased, the fires burn brighter, and the refuse has been more effectually consumed." Mr. C. W. Evington, sanitary inspector for Hull, writes to much the same effect, saying, "the refuse is destroyed in about half the time, and the clinkers contain no undestroyed refuse or organic substances, which was very frequently the case in the old system. The apparatus is a complete success, and has been the means of reducing the working hours to about one-half." Mr. Jessop, of Oldham, Mr. Blackburn, chairman of the Highway Committee of Heckmondwicke, and Mr. Thomas Fairley, borough and county analyst of Leeds, also bear testimony to the successful working of the Horsfall furnace.

Tucuman.—The plant and machinery for a cotton mill about to be built in Tucuman is expected shortly from England. The outlay contemplated is about 100,000*l*.

Horticultural Exhibition at Hamburg, 1897.—The committee of this general exhibition invite competition for heating and ventilating commercial hot-houses and forcing beds. Not to put the inventors to unnecessary expense, nor to overcrowd the exhibition grounds, it is proposed that designs should be submitted under motto by April 1. The committee will then decide whether the designer shall be accorded space to show his system in operation. If the competitor should not desire to do so, the committee may proceed on their own account. In the latter case, however, the competitor loses his claim to the gold cup or the equivalent of 50*l*. offered. There are other prizes. Fuel and water for the comparative trials, which will extend over at least three days, will be supplied. The committee suggest that designs should be made for three types of structures: A house 66 ft. by 16 ft., with glass roof, divided into three sections to be maintained at temperatures at 5 deg., 10 deg., and 25 deg. Cent. (41 deg., 50 deg., and 77 deg. Fahr.) respectively; a smaller house, 33 ft. by 10 ft.; and a bed 33 ft. by 6.6 ft. for a constant temperature of 41 deg. Fahr. These temperatures are to be guaranteed within limits with the atmospheric temperature at −20 deg. Cent. (−4 deg. Fahr.). The floors should be about a foot below ground. Competitors will receive notice by May 1, and are to hold themselves ready for the trials by July 1.

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COMPILED BY W. LLOYD WISE.

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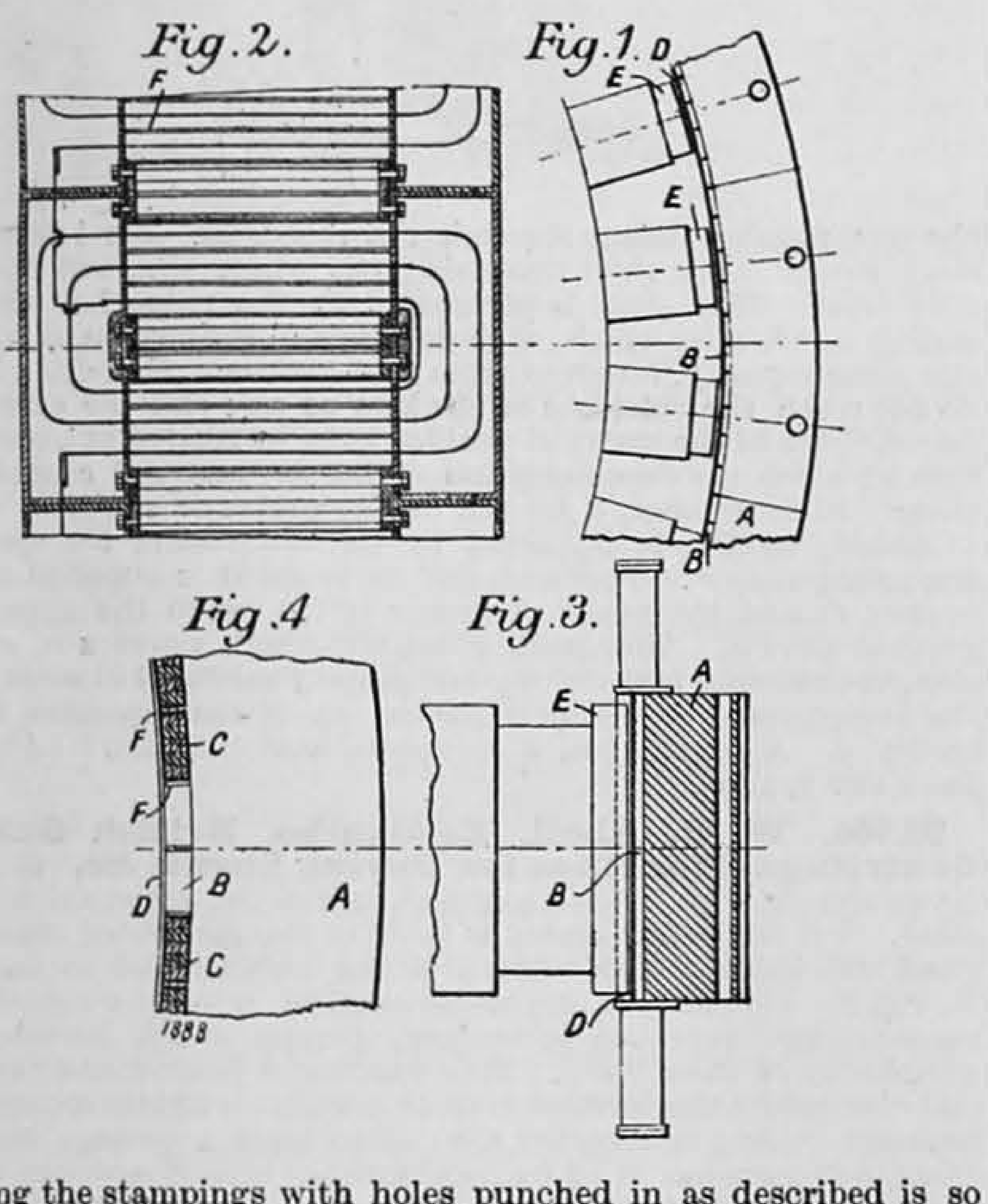
ELECTRICAL APPARATUS.

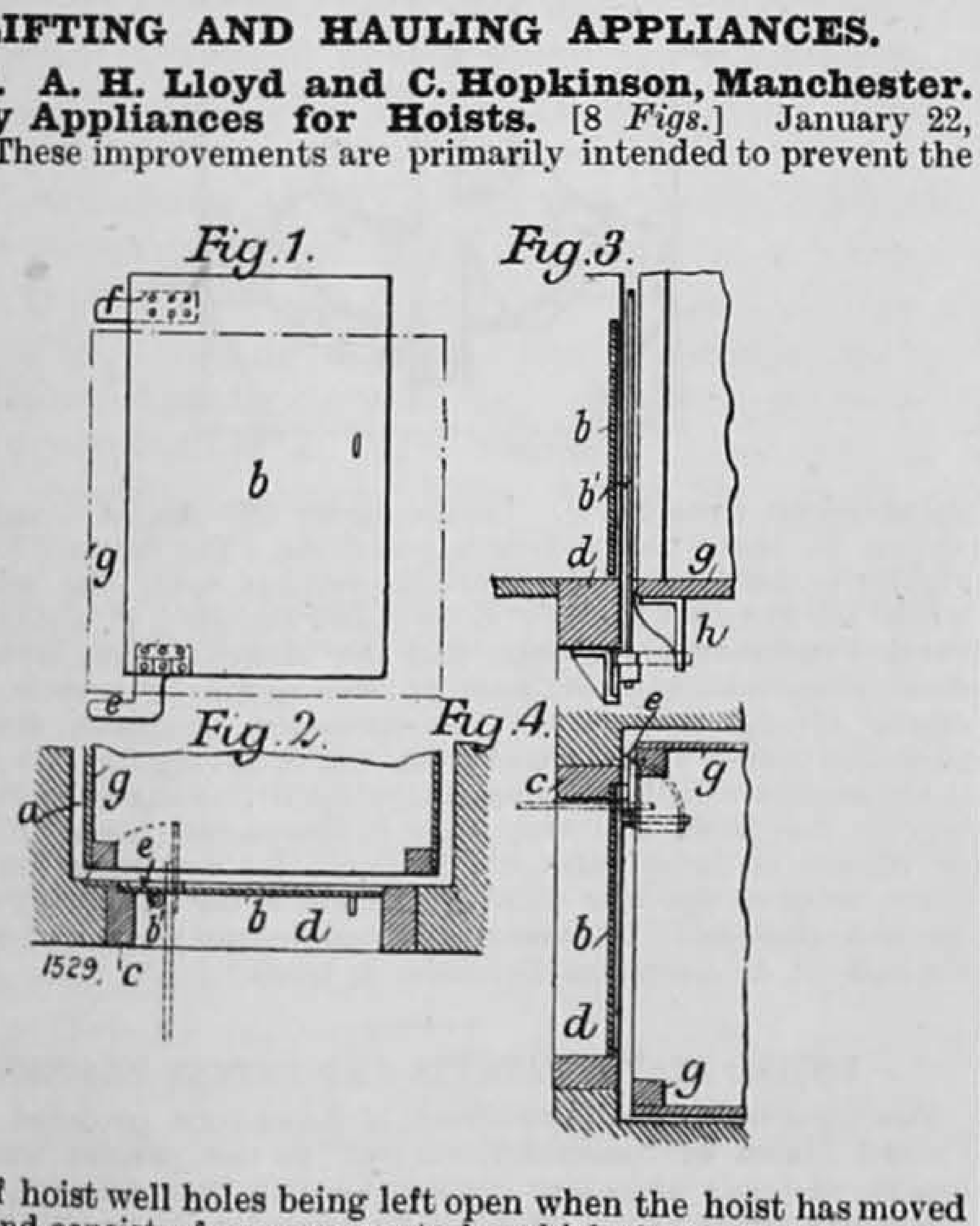
1888. S. Z. de Ferranti, London. Dynamo Electric Machines. [5 *Figs.*] January 27, 1896.—This invention has for its object improvements in the armatures of dynamo electric machines, where iron is used in the armatures, and also has for its object the building of armatures in such a way that the conductors are mechanically driven and inclosed so as to be protected from injury, and yet so arranged as not to suffer from the principal disadvantages of sunk winding. According to this invention the standing or revolving armatures of dynamo electric machines are built of laminated iron. These plates A are pierced with holes B round about their edges nearest to the magnetic field, but these holes or slots, instead of having their greatest dimension radially, have their greatest dimension in the direction of rotation. The object of this is to get the equivalent of a smooth-cored armature, then a space for the conductors G (Fig. 4), then a further ring of iron D round about the conductors through which the magnetism passes, and which is exposed to the pole-faces E. The object of



making the stampings with holes punched in as described is so that very thin pieces of iron F between the holes B, which pieces F support the outer ring D, may act as drivers or supporters of the coils of the armature. Where the machine so constructed is a single-phase alternator, such as is shown in part in the figures, the coils are wound through a portion only of the holes, so as to leave the other holes empty. This is shown in Fig. 2 by the thick lines which represent the wires threaded through the holes. The effect of this is to get a machine similar in its characteristics to a plain face wound one, as opposed to one in which the magnetism is largely varied by the shape of the armature stampings or by the demagnetising effect of the armature coils, when the relative positions of these coils to the magnets are such as to facilitate this effect. In some cases where the discs or sections are punched from laminated iron to form the armature, there is inserted by means of pressing a number of small brass or other non-magnetic metal tie-pieces between the outer ring and the main body of the plates. (*Accepted December* 9, 1896).

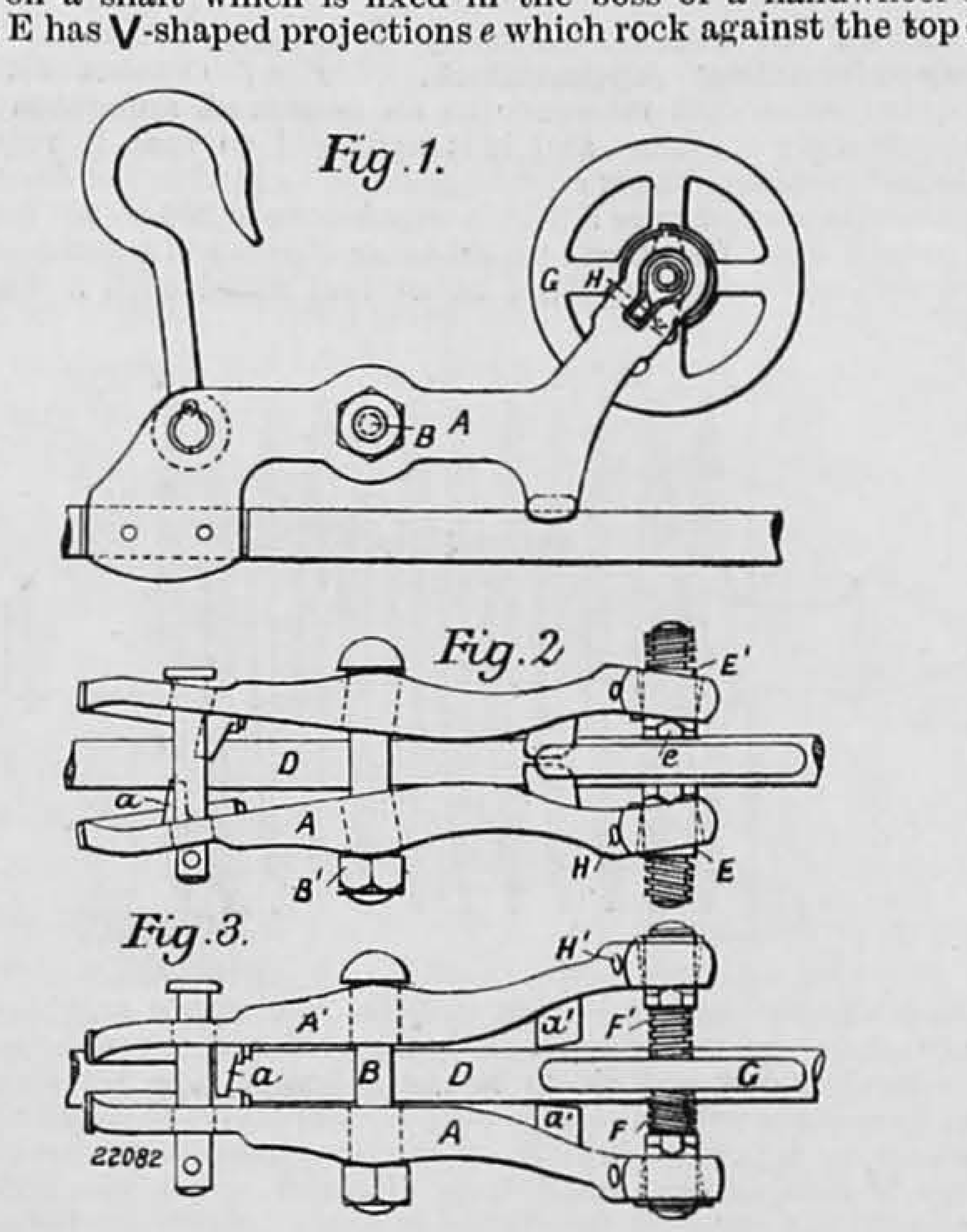
LIFTING AND HAULING APPLIANCES.

1529. A. H. Lloyd and C. Hopkinson, Manchester. Safety Appliances for Hoists. [8 *Figs.*] January 22, 1896.—These improvements are primarily intended to prevent the



doors of hoist well holes being left open when the hoist has moved away, and consist of arrangements by which the hoist door, when opened, locks the cage of the hoist so that the hoist cage cannot move up or down until the door has been closed. In some cases, instead of preventing the movement of the cage, the cage may be made to automatically close the door as it moves away. In Figs. 1 and 2 *a* designates the hole or opening of the hoist well, *b* the door, *c* the jambs, *d* the threshold, *e* the arm fixed to the bottom of the door, *f* the arm fixed to the top of the door, and *g* the hoist cradle or cage. The rigid arms *e*, *f* are fixed to the bottom and top respectively of the door *b*, which is hinged or pivoted at b^1 to the threshold *d* or to the jamb, and similarly to the lintel, not shown. When the door is closed as shown in full lines, the arms *e*, *f* lie back flush with the wall of the hoist well and out of the way of the cradle *g*; but when the cradle has stopped in its correct position opposite the door, and the latter is opened, as indicated by dotted lines, Fig. 2, the arms *e*, *f* turn with the door respectively under and over the cradle *g*, and the latter cannot move away either up or down until the door has again been closed and the arms removed out of the way. In Figs. 3 and 4 the door *b* is pivoted preferably on a shaft b^1 on which is fixed near the bottom the rigid arm *e*. On the under side of the cradle *g* is fixed a helical or other suitably shaped cam *h* to act on the arm *e*, and a similar but reversely set cam (not shown) is fixed on the upper side of the cradle *g* to act on the arm *f* (not shown), which is fixed near the top of the shaft b^1. The length of the cam must be suitable to the weight of the door; the heavier the door the more gradual must the taper or pitch of the cam be. In operation the door *b* is closed automatically by the cam *h* acting on the arm *e* when the cradle *g* moves downward; and in like manner it is closed by the other cam *h* and arm *f* if the cradle moves upward. (*Accepted December* 9, 1896).

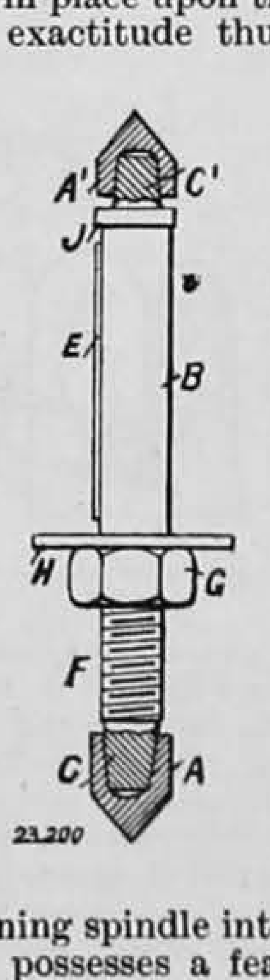
23,082. J. W. Smallman, Nuneaton, Warwick. Haulage Clip. [5 *Figs.*] December 3, 1895.—This invention relates to an improved clip for enabling tubs or wagons to be readily attached to and detached from an endless wire haulage rope travelling continuously. A and A^1 are the two side-pieces B is the transverse bolt furnished with a nut B^1. C are steel liners which fit against the rope D. Each liner is secured by two rivets to the grooved lower portion of one of the side-pieces. E and E^1 are nuts held by the side-pieces. F and F^1 are left-hand and right-hand screws working in the nuts E and E^1. These screws are cut on a shaft which is fixed in the boss of a handwheel G. The nut E has V-shaped projections *e* which rock against the top of



the side-piece A. H is a rivet that passes with a considerable amount of play through a hole e^* in a projection e^1 on the nut E. This rivet merely serves to keep the nut in the side-piece. The nut E is prevented from turning by the projection e^1. The nut E^1 corresponds with the nut E, and is retained in the side-piece A^1 by the rivet H^1. *a* and a^1 are projections which lie on the rope and support the clip until the side-pieces have been caused to grip the rope. J is a coupling hook for connecting the clip to the tub or wagon. The clip is adjusted to fit any particular rope or to compensate for wear by turning the nut B^1. The holes in the side-pieces through which the bolt B passes are rectangular. The bolt B has a square neck, and the head of the bolt may be on either side of the clip. (*Accepted December* 9, 1896).

MACHINE AND OTHER TOOLS, SHAFTING, &c.

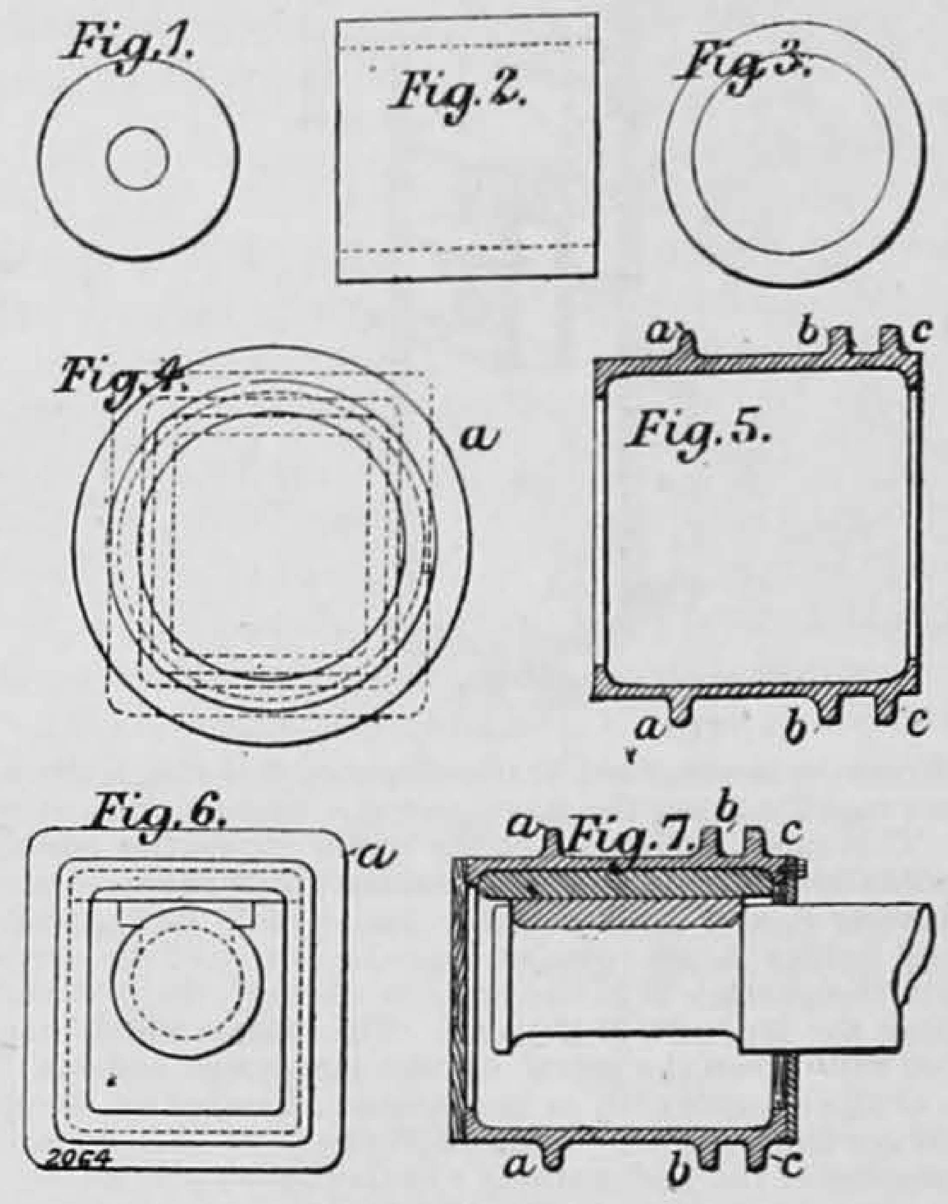
23,200. W. Pangratz, Teplitz, Austria. Bearing Points of Rotary Spindles on Shafts. [1 *Fig.*] October 19, 1896.—In the spindle shown the points A, A1 are not welded upon the spindle body, but are produced separately and bored in such a manner that they can be driven upon the truncated conical ends C, C1 of the spindle B, so that the friction between the interior of the point piece and the spindle body prevents the point from turning upon the spindle. It is preferable to grind the point pieces A, A1 when in place upon the ends of the spindle on account of the greater exactitude thus obtained. The spindle



shown is a vertically running spindle intended especially for glass-grinding wheels, and it possesses a feather E for engaging the pulley and the grinding disc. F is the screw thread for the fastening screw nut G, and H is the protecting collar. When the points are injured or worn out it is sufficient merely to screw the nut G back in order to press against and loosen the point A, whereupon it can easily be taken off and exchanged; and to drive a wedge-formed fork between the point A1 and the pulley collar J of the spindle, whereby also the point A1 will be loosened and removed. The points can thus be exchanged very quickly and easily without the pulley and the grinding disc being taken off. When the points are worn they can be turned and again used. (*Accepted December* 2, 1896).

MINING, METALLURGY, AND METAL WORKING.

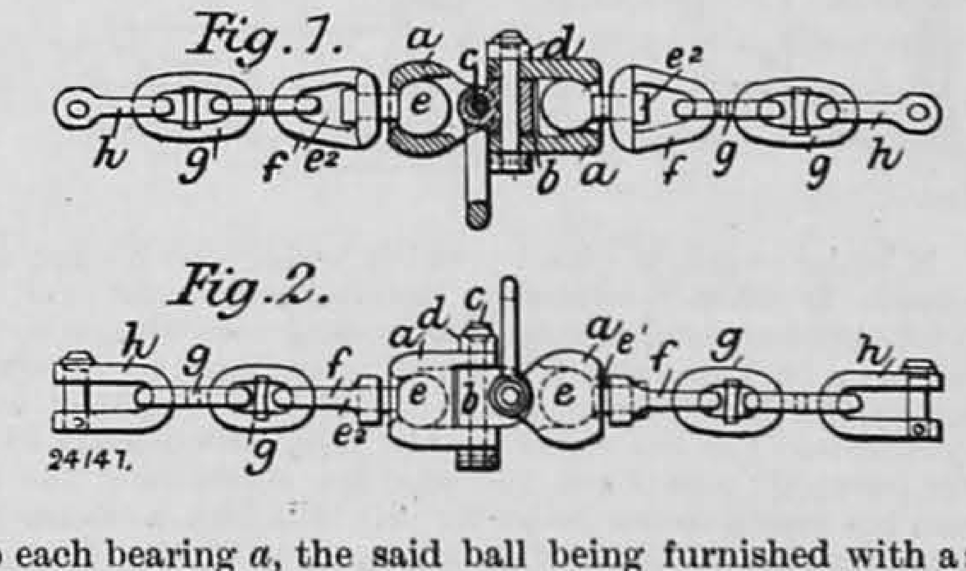
2064. A. J. Charlton, Fairfield, Lancaster. Manufacture of Axle-Boxes. [7 *Figs.*] January 29, 1896.—This invention relates to the manufacture of a solid, rolled, or forged axle-box from wrought iron or steel scrap, or a cast ingot, or a solid bloom, formed into a tube of suitable thickness for the process. The tube from which the axle-box is to be formed may be welded or (preferably) weldless. The tube may be formed from wrought iron or steel scrap by hydraulic or other pressure at a welding or other suitable heat, or a hole may be punched through a solid bloom, or an ingot may be cast, as shown in Fig. 1, and the tube be rolled out or expanded into the form shown in Figs. 2 and 3, or an ingot may be cast in this form. This tube is then rolled or forged by means of grooved rolls so formed as to reduce the



same to the section required, to form the necessary indentations and projections, and to give strength and solidity where necessary, but still in a circular or cylindrical form, with three projecting circumferential bands *a*, *b*, *c*, as shown in Figs. 4 and 5. This cylinder is then squared or squeezed up by hydraulic or other pressure with suitable tools or dies, into a rectangular form (as represented by the dotted lines on Fig. 4) to the desired shape to form the completed axle-box, which may afterwards, if required, be further finished either by hand or power. Figs. 6 and 7 show the finished axle-box. The space between the projecting bands *a* and *b* at the top forms the seat for the spring, and the space between the bands *b* and *c* at the sides forms the vertical grooves to receive the two horns of the axle guards. (*Accepted December* 2, 1896).

SHIPS AND NAUTICAL APPLIANCES.

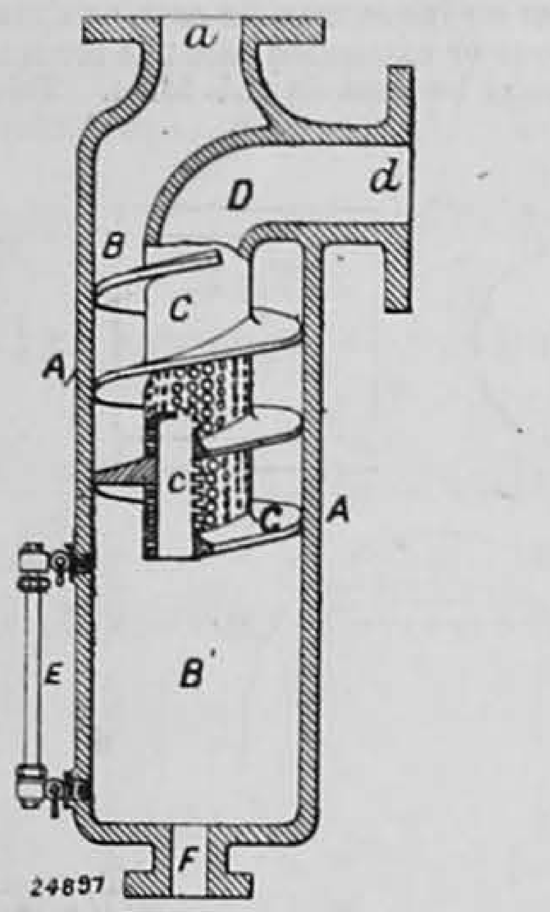
24,147. O. Klatte, Neuwied, Germany. Chain Coupling for Mooring Chains. [2 *Figs.*] December 5, 1896.—The improved coupling device comprises two ball and socket joint bearings *a*, *a*, each of which has two perforated ears a^1, a^1 arranged opposite one another. The bearings *a* are so arranged relatively to each other that the ears a^1 of one bearing are placed at an angle of 90 deg. relatively to the ears of the other. Between the four ears a block *b* is placed which is provided with two holes or bores at right angles to one another. One of these bores is co-axial with the holes in the ears of one bearing, while the other bore is co-axial with the holes in the ears of the other bearing. The bores may be located at any suitable distance from one another, the block *b* being made longer or shorter, as the case may be. As shown, the bores are located as closely together as practicable. Through the holes provided in the ears of each bearing and through the adjacent bore provided in the block *b* a bolt *c* is passed, to the outer extremities of which a shackle *d* is attached. Before the block *b* is put in place, a ball *e* is inserted



into each bearing *a*, the said ball being furnished with a stem e^1. This stem e^1 is passed through a central hole provided in the bearing *a* and through an axial hole of the chain swivel *f*. The stem e^1 is provided with a head e^2 located in the central opening of the swivel link *f*. To the outer extremity of this swivel link *f* two chain links *g*, each provided with a cross-piece, are connected, and to the outermost of the said chain links an ordinary shackle *h* is linked. The links *f*, *g*, *g* may be made of the same material and from one piece, and be produced either by rolling, pressing, forging, or any other suitable operation. If the coupling device is required to be detached from the extremities of the chain, it is only necessary to force out by striking it, one or the other of the two hinge-bolts *c* or one of the bolts of the ordinary shackles *h*. This coupling device in connection with the shackles *d* arranged on the hinge bolts *c* serves, owing to its swivel and pivotal action, to replace the two mooring shackles commonly used. (*Accepted December* 9, 1896).

STEAM ENGINES, BOILERS, EVAPORATORS, &c.

24,897. J. A. Morris and W. T. Hatch, Manchester. Apparatus for Separating Water from Steam. [1 *Fig.*] December 28, 1895.—The improved apparatus comprises a cylindrical casing A with an inlet passage or opening *a* through which live steam may enter. In the chamber B formed in the interior of this casing A, there is cast or otherwise fitted a hollow screw C preferably of Archimedean shape. The tops of the threads join or fit closely against the interior of the casing A, thus forming a spiral passage through the chamber around the centre of the screw. In the bottom of the chamber sufficient space or a second chamber B^1 is provided in which water can collect and from which it can be drawn off. The screw C is made tubular or with a hollow centre, and at the lower end is perforated to allow for the passage of the steam into the interior. The steam enters the passage D in the interior through the perforations *c*, and thus the force of the current of steam is gradually reduced so as not to be forced downward to impinge upon the water which collects in the lower chamber B^1. The dry steam is withdrawn through the outlet *d*. The threads of the screw are made inclined outwards on the upper side to drain the water as it collects away from the perforations to prevent it entering the central steam passage. The lower chamber B^1 is fitted with a gauge-glass E and a draw-off pipe F, through which the waste water is carried away. A steam trap may be connected to the pipe F to draw off the water as it collects.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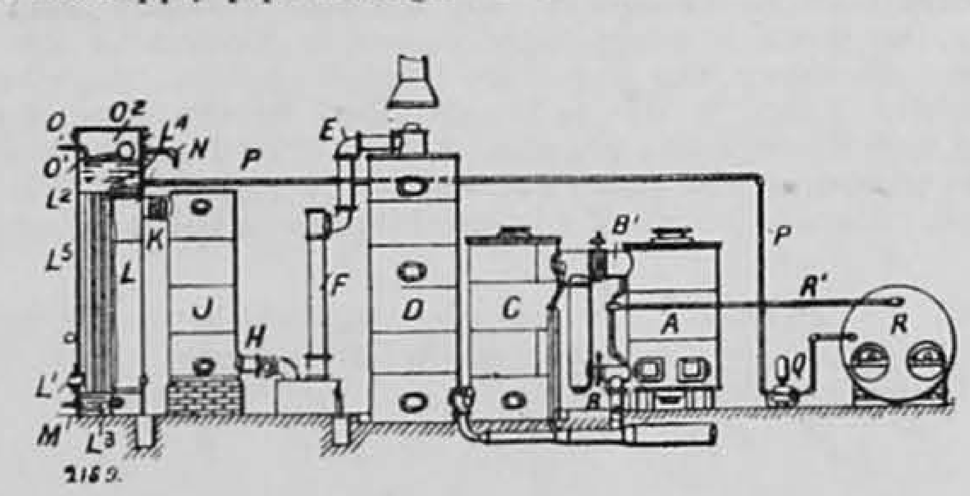
In action steam is admitted to the chamber B through the inlet *a*, and flows rapidly along the spiral passage therein formed by the screw. This rapid movement of the steam causes the particles of water contained therein to be thrown outwards against the casing A of chamber B, and there coalesce and trickle down, whilst the dryer and lighter steam remains near the centre of the screw and flows into the passage D in the interior through the perforations *c* or through the aperture in the end. The water which has been separated runs down the spiral of the screw and collects in the bottom of the chamber B^1, or in a second chamber or steam trap provided for the purpose. A special feature of this apparatus is the formation of the perforations *c* in the hollow screw C by which the force or velocity of the current of steam is gradually reduced before it reaches the end of the spiral passage, and so does not again take water from the chamber B^1 after it has been separated. (*Accepted December* 2, 1896).

2183. A. G. Glasgow, London. Utilising the Heat of Gas for Heating Boiler Feed Water. [1 *Fig.*] January 30, 1896.—In the manufacture of water gas and other gas for general distribution, it is usual to cool the gas down to about 60 deg. Fahr. before passing it into the holder and mains, and this cooling is frequently effected by means of surface condensers, the hot water from which is either allowed to run to waste or is cooled for re-use in the condenser. Now, according to the invention, the gas is cooled in a surface condenser by water which is subsequently used in a steam boiler, and hence by one apparatus there is accomplished the double object of cooling the gas and of heating boiler feed water. In the figure which illustrates this invention as applied to a water-gas apparatus, A is the generator having gas take-off pipe B and B^1; C is the carburetting chamber; D is the fixing chamber; E is the pipe for conveying the water gas to the washer F, whence the gas passes through the seal box H to the scrubber J, and thence through the pipe K to the surface condenser L, on its way to the receiver apparatus and mains. The surface condenser L is of the usual construction; at the ends of the portion through which the gases pass, it has heads L^1 and L^2, connected by tubes L^5 extending from the water-receiving chamber L^3 to the water-delivery chamber L^4, which serves as the receptacle from which the boiler draws its feed water. M indicates the supply pipe throngh which water is forced into the con-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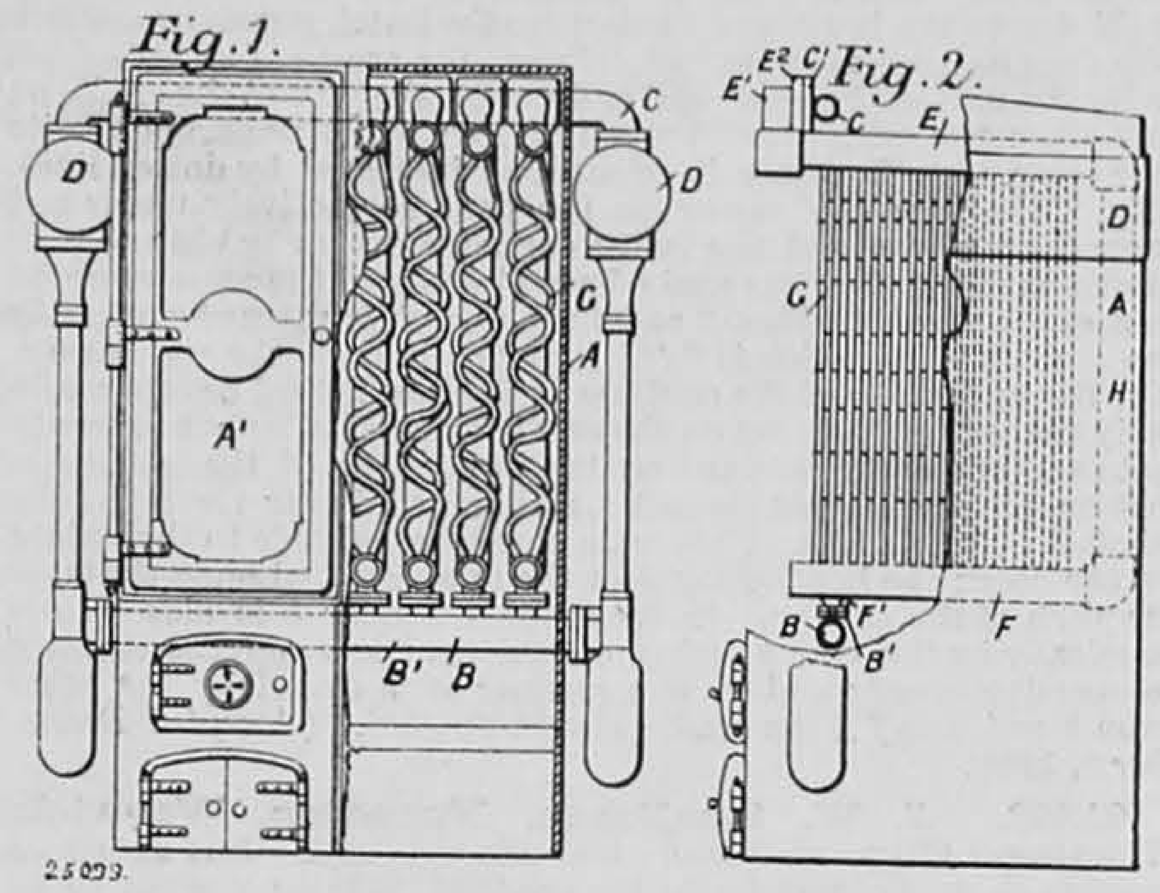
denser. N is the overflow pipe by which water can escape from the receptacle L^4 when it exceeds a determined height. O is an auxiliary or supplemental supply pipe leading into the receptacle L^4 and having a cock or valve O^1, which is arranged to be opened and closed by the float O^2 in accordance with the height of water in the receptacle. P is the water supply pipe which leads to the feed water pump Q; and P^1 is the pipe for conducting the feed water from the pump to the boiler R. R^1 indicates a steam pipe leading from the boiler to the gas-making apparatus. The gases produced in the generator A, after passing through the carburetting and fixing or superheating chambers and through the washer and scrubber, pass through the surface condenser L and are cooled by the water forced upward through the tubes L^5, the heated water from these tubes passing into the receptacle L^4 placed upon the top of the condenser. From this receptacle the pump Q draws feed water for the boiler through the pipe P, and in case the supply of water entering the receptacle L^4 is excessive, the excess escapes through the pipe N, while, if the supply from the condenser is not sufficient to feed the boiler, the falling of the level of the water in the receptacle L^4 will lower the float O^2 and open the cock O^1, and permit additional water to flow from the pipe O into the receptacle until the normal height of water is insured therein. (*Accepted December* 2, 1896).

25,033. F. G. Hampson, London. Water-Tube Steam Generator. [2 *Figs.*] December 31, 1895.—Across the casing A run two tubes B and C, the lower one of these, B, being that into which the feed is introduced, while the upper one C collects the steam and conveys it to the steam drum D. The tube B is provided with a series of upwardly directed openings provided with flanges B^1. The tube C is provided with a similar number of openings which face towards the front of the boiler, these openings being likewise provided with flanges C^1; these flanges B^1 and C^1 serve for the connection of the several elements to the pipe B and C. The elements which form the main portion of the boiler each comprise upper and lower tubes, which in the example illustrated are approximately horizontal and are connected by suitably shaped smaller water tubes. The front end of the upper of these tubes E is curved round as at E^1 and provided with flange E^2, by means of which it is bolted to one of the flanges C^1 of the tube C. The lower tube F is provided at its under side with an opening and a flange F^1, by means of which it is bolted to one of the flanges B^1 of the tube B. Each element preferably has a double row of smaller water tubes G; these may be bent as shown to serpentine



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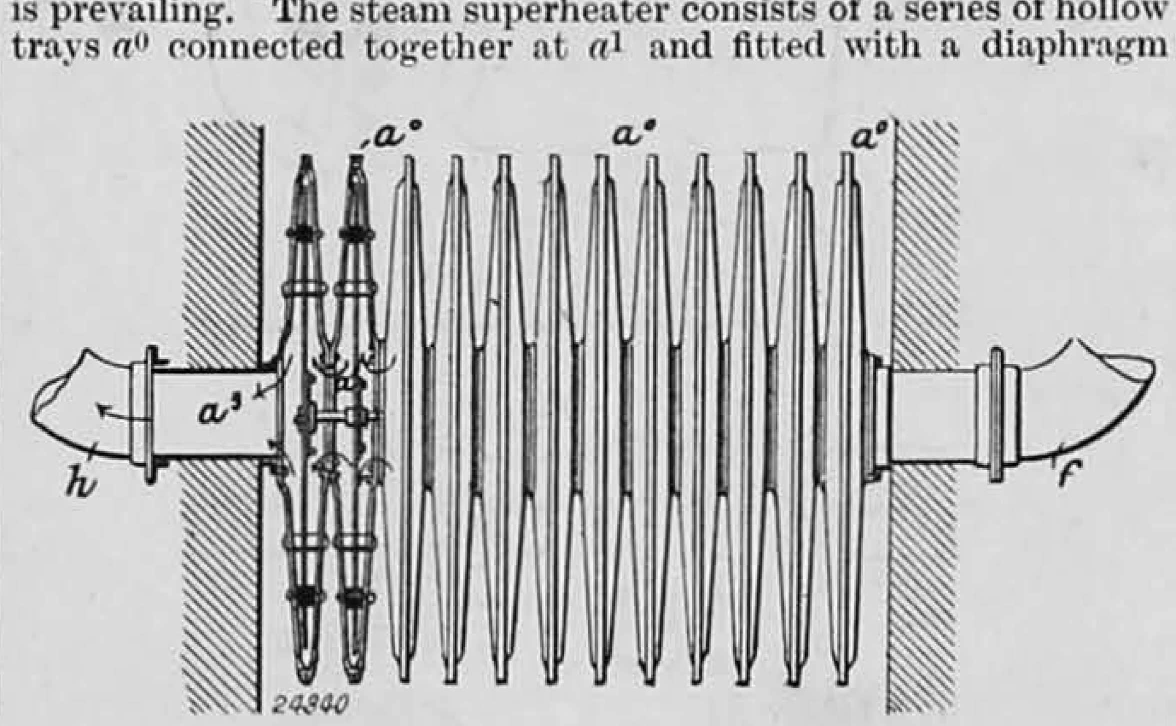
form, the tubes of one row being so arranged relatively to those of the other row that the curves of the one cross those of the other. If desired, a downcomer tube H may form part of each element connecting the hinder ends of the horizontal tubes E and F. Each individual element situated vertical in the boiler may, after disconnection with the tubes C and B, be drawn straight out from the front of the boiler. (*Accepted December* 2, 1896.)

24,340. J. von Grubinski, Warsaw, Russia. Steam Superheating Apparatus. [1 *Fig.*] October 31, 1896.—This invention has reference to an improved apparatus for the superheating of steam, and it is arranged so that it requires no special fireplace, but is advantageously located in the flues leading to the chimney, where a high temperature of 300 to 400 deg. Cent. is prevailing. The steam superheater consists of a series of hollow trays a^0 connected together at a^1 and fitted with a diaphragm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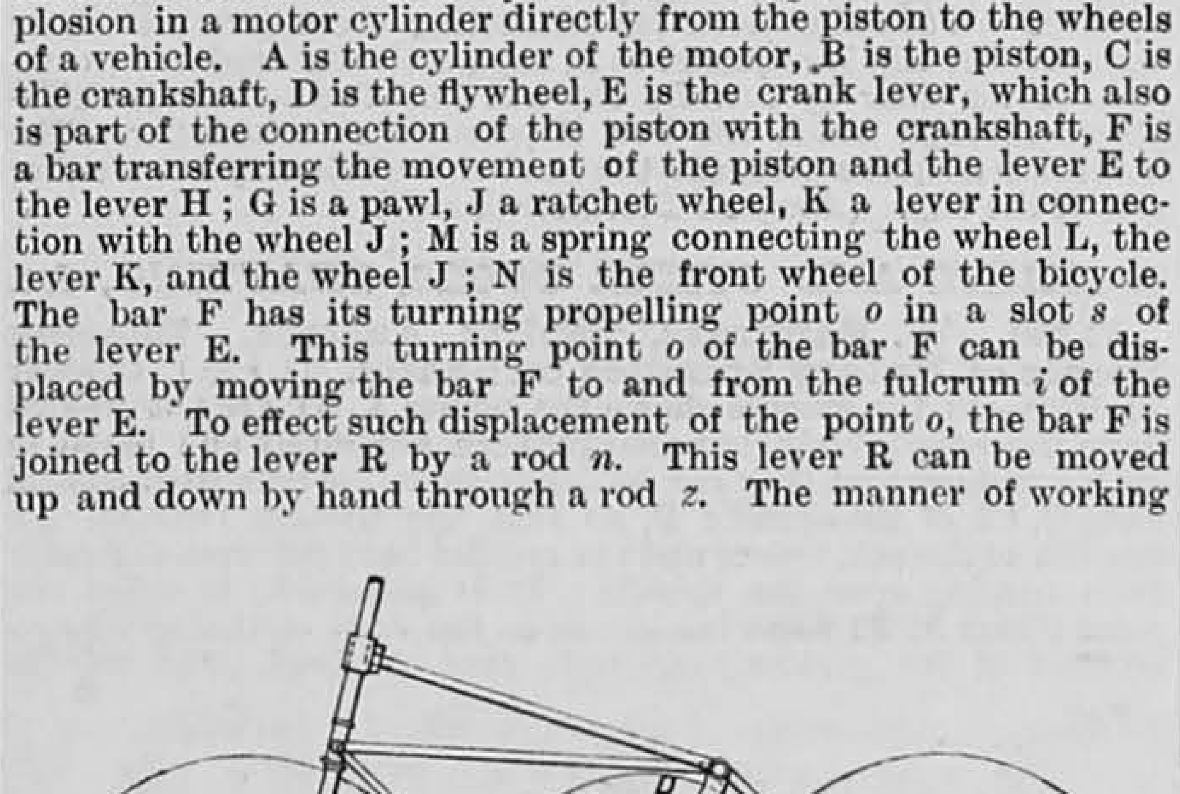
which affords communication between the upper and lower compartments, the said diaphragm being stiffened or strengthened by a central pipe or rod a^3. *f* is the entrance pipe for steam from any generator; the steam flowing in thin layers through the paths opened to it, leaves behind on the diaphragms a^3, presenting a large heated surface, small drops of water, which can still be evaporated, and then get through pipe *h* in a superheated state to the place of consumption. (*Accepted December* 9, 1896).

VEHICLES.

885. E. Capitaine, Leipzig-Plagwitz, Germany. Transmitting Power. [1 *Fig.*] January 13, 1896.—This invention consists essentially in transmitting the force of the explosion in a motor cylinder directly from the piston to the wheels of a vehicle. A is the cylinder of the motor, B is the piston, C is the crankshaft, D is the flywheel, E is the crank lever, which also is part of the connection of the piston with the crankshaft, F is a bar transferring the movement of the piston and the lever E to the lever H; G is a pawl, J a ratchet wheel, K a lever in connection with the wheel J; M is a spring connecting the wheel L, the lever K, and the wheel J; N is the front wheel of the bicycle. The bar F has its turning propelling point *o* in a slot *s* of the lever E. This turning point *o* of the bar F can be displaced by moving the bar F to and from the fulcrum *i* of the lever E. To effect such displacement of the point *o*, the bar F is joined to the lever R by a rod *n*. This lever R can be moved up and down by hand through a rod *z*. The manner of working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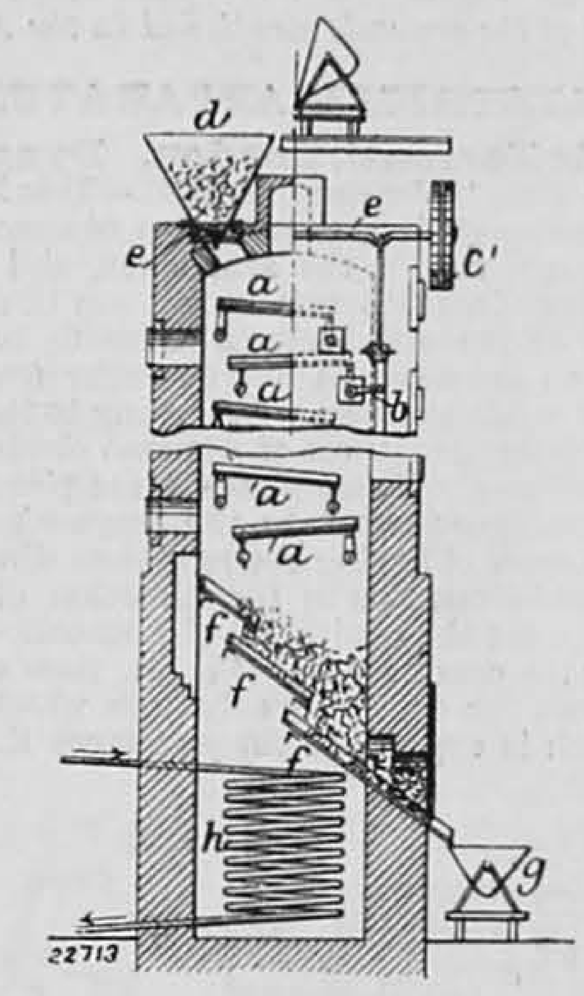
is as follows: When the piston B by the explosion in the space P is driven downwards, the wheel L is turned in the direction of the arrow *x* by means of the lever E, the bar F, the lever H, and the pawl G, and the ratchet wheel J. The flywheel D, being proportionally very light and small, is moved quicker and suddenly, that is, it has given to it a great acceleration because the spring M expands. It must here be noted especially that the ratchet wheel J with the lever K forms a connected whole, and that also the wheel J with the lever K rest loosely upon the axis *m*. The spring M is so constructed that it can only be distended by a certain pulling force. When the ratchet wheel is turned by the explosion which presses the piston downwards the spring is pulled with great force, whereby naturally the wheel L is turned. According to the resistance which the moving forwards of the vehicle offers, the spring M is more or less distended. According also to the resistance which the moving of the whole vehicle offers, it is necessary to place the point *o* more or less distant from point *i*. This moving of the driving point *o* is also necessary if it is wanted to drive quicker or slower. (*Accepted December* 2, 1896).

MISCELLANEOUS.

22,713. J. Y. Johnson, London. (*Verein Chemischer Fabriken, Mannheim, Germany*). **Apparatus for Drying Superphosphates.** [2 *Figs.*] November 27, 1895.—The invention consists in arranging in the drying kiln a number of slightly inclined sieves or grates, provided on their upper surfaces with vertical projections, blades, pins, or lugs. These sieves or grates or sifting frames may be formed of barbed wire, or consist of perforated metal plates, the perforations of which have raised sharp edges, like those of a grater. The most advantageous form is one resembling a harrow in shape, with teeth pointing upwards. These harrows are preferably constructed with perforations or interstices larger than the ribs or solid portions carrying the teeth. The material introduced into the shoot, and which preferably has been superficially divided, drops upon the sifting frames or grates, which are set in oscillatory motion. The grates upon receiving the material thus dropped on to them, sift it instantly,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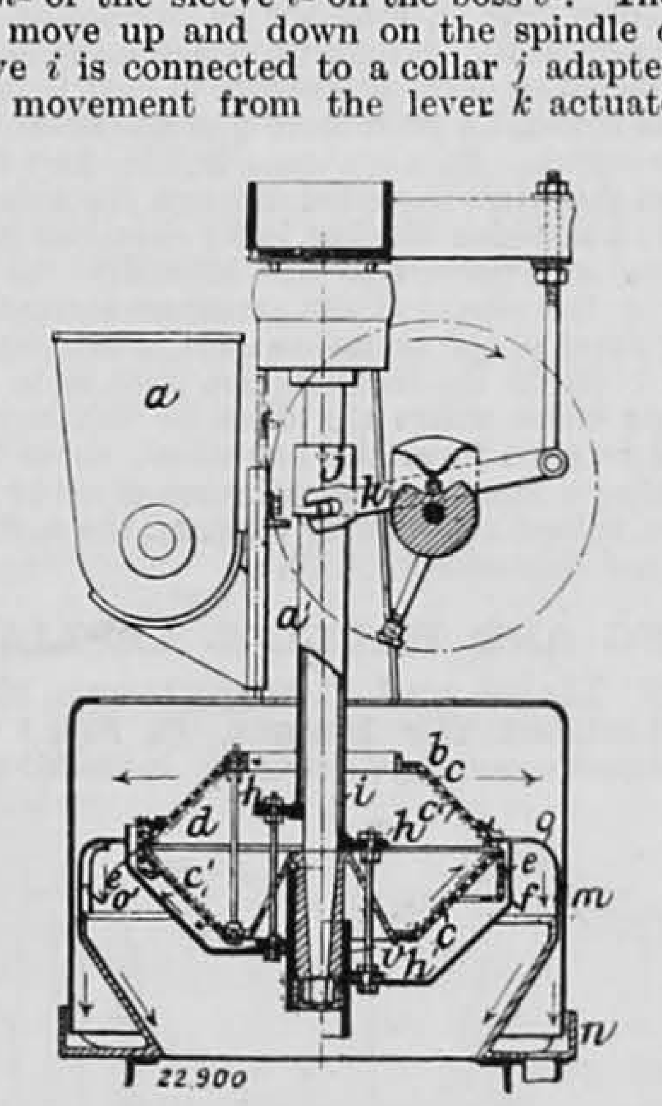
the fine powder falling through the interstices direct from one sieve to the next, thus traversing the whole kiln, and filling it with dust. This dust is permeated by the rising hot air, and rapidly dried, after which, as it descends to the bottom, it is, with the same rapidity, removed from the furnace. Half-dried lumps do not reach the soleplate of the kiln at all; and the extremely fine division of the material enables it to be treated at a temperature at which the decomposition of the dry material cannot take place. In the figures, *a* are the drying grates or sieves to which a shaking motion is imparted by the mechanism *b c* operated from the pulley c^1. The material to be dried is supplied to the hopper *d*, and by means of flaps *e* is fed on to the uppermost grate or sieve *a*. After passing down through sieves *a* in succession, the material falls on to guide-plates *f* arranged in steps, from the lowest plate of which it passes out of the apparatus into a trolley *g*. A steam coil *h* serves to heat the kiln. (*Accepted December* 2, 1896).

22,900. W. P. Abell, Essequibo, British Guiana. Centrifugal Machines for Drying Sugar, &c. [6 *Figs.*] November 29, 1895.—*a* is a pug-mill and a^1 the outlet valve of the same. *b* is the basket shown as made of two perforated cones *c*, *c*, lined with gauze c^1 and secured to one another and to the boss c^3 rigidly attached to the usual vertical spindle c^4 in such a manner that there is a permanent opening *d* left between the peripheries of their bases. This opening *d* is alternately opened and covered by the perforated door *e*, which is rigidly secured to a molasses casing or director *f*, so as to leave a passage between them, and partakes of all its movements, the said molasses casing *f* being connected to the flange *h* of a sleeve *i* on the spindle c^4 and to the flange h^1 of the sleeve i^1 on the boss c^3. The sleeves *i* and i^1 are free to move up and down on the spindle c^4 and boss c^3; and the sleeve *i* is connected to a collar *j* adapted to receive a reciprocating movement from the lever *k* actuated by a cam *l*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mounted on the shaft l^1. In the figure the sleeves *i* and i^1 are shown in their two extreme positions. The basket *b* is thus rigidly secured to, and caused to revolve with, the spindle c^4, whilst the molasses casing *f*, door *e*, and sleeves *i*, i^1, although also carried round and revolving with the basket *b*, have an independent reciprocating movement on the spindle c^4. *m* is a fixed casing arranged to receive the molasses or liquids discharged from the basket *b* direct and from the revolving director *f*, and *n* is the molasses gutter having an outlet n^1. *o* is a fixed casing to receive the dried material after it leaves the basket *b*. Strips or fringes of gauze form the "flyers" for making a grain-tight joint between the door *e* and the basket *b*, the said fringes being secured, preferably by means of the angle-iron rings and bolts, to the cones *c*, *c*. (*Accepted December* 2, 1896).

UNITED STATES PATENTS AND PATENT PRACTICE.