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house, or in some works to a cellar, where they are kept for at least a month, during which the moisture gradually dries out. They are then transferred to the furnace-house described above and placed on shelves fixed to the walls above the furnaces or melting holes until they are required. About 21 hours before that the crucibles required for one day's work are placed in an annealing grate built at one end of the furnace-house and are placed on bars with just enough space between the crucibles to allow them to be completely packed and covered with small coke until the grate is filled to the top. Sufficient fire is then put underneath the grate bars to start the coke burning at the back and bottom of the annealing grate. The fire gradually works its way forwards and upwards, until the whole mass of coke in the annealing grate, with the included crucibles or pots, is aglow. This operation has to be carefully watched, and requires judgment and experience so as to avoid over or under-annealing, known among the men as "hot-nailing" or "slack-nailing." The crucibles, in their red-hot condition, are then ready for use, that is, to be transferred to the furnaces or melting holes and the process described above.

The crucibles are generally only used twice, very occasionally three times, but in some works they are made to produce two rounds of high-speed steel and one of carbon steel, or one round of high-speed steel, one of special carbon tool steel, and a third round of file steel, as may be required, the output of the works making high-speed steel being extremely varied.

The weight of an annealed pot as used in the high-speed steel processes detailed above is, on the average, about 30 lb., occasionally more or less; whilst the quantity of material which these crucibles or pots can contain varies from 40 lb. to 70 lb.

STANDARD PROPELLING ENGINES FOR BRITISH STANDARD SHIPS.

In supplement to our article on British Standard Ships, which we published in an earlier issue (page 553 *ante*), we now give, on page 578 and on Plate LV, accompanying this issue, illustrations of the standard engines designed and built for these ships. The main engine design does not present any new features, and is fairly representative of that usually adopted for triple-expansion engines having cylinders 27 in., 44 in. and 73 in. diameter by 48-in. stroke. The outstanding feature, which indicates that the design is of Clyde origin, is the front columns which carry the piston-rod guides, as against the slipper-type guide which is a feature of the North-East Coast design. Special attention has been given to details for convenience in machining and assembling, the piston type of valve for the medium-pressure cylinder, for example, being adopted chiefly on that account. The circulating pump, which is of the centrifugal type, 12-in. bore branches, is mounted with its engine on the main engine bedplate so as to enable it with its pipes and connections, to be fitted complete in the erecting shop. The reversing engine is of the usual all-round type, and an independent turning engine is provided.

All the designs, with the exception of the auxiliary machines, were, of course, prepared by one firm, who had extensive experience in machinery of this size for cargo vessels, and were issued to the various machinery contractors complete, together with full detail specifications of all the raw material orders and the finished items which it was arranged to obtain from sub-contractors. A degree of detail quite unusual for this class of work was embodied in the drawings and information issued, so that even those firms who were not familiar with such work—some of them accustomed to a smaller class and others to the highest class of Admiralty work—would have no difficulty in knowing exactly what was required.

The advantages of manufacture to a common design were found of convenience in many ways as when, in the course of construction, one firm discovered defects in a soleplate casting; this was at once replaced by a similar casting from another firm, who were not at the time requiring that casting, failing which possibility delay of weeks would have occurred with the erection of the whole engine. Another instance was the facility with which a replace main steam pipe branch-piece was immediately despatched to a vessel ready for trial trip, when the original one showed leakage on the first steaming of the engines. The greatest advantages of this manufacture of details in multiple were, of course, experienced by the sub-contractors for these details, as they were thus enabled to proceed with a very large number of each article exactly alike instead of each differing, perhaps only in very small points, to suit the arrangements prepared by individuals, but sufficient to prevent them being used for the first firm requiring delivery.

It can readily be understood that many of the small items in a modern cargo vessel's engine-room could be manufactured to better advantage by specialists, than by large firms whose plant is generally suitable for large work, the items of which are different for each vessel, and especially so when orders for scores of these smaller items could be placed at a single time. The orders for all the auxiliary machinery, also the various valves, valve-boxes, branch pieces, cast-iron and wrought-iron pipes, &c., were consequently issued in multiple, from a single source, and placed with firms who specialise in such work so that once they had prepared patterns and templates to the drawings they could manufacture these fittings for all the vessels, drilled and ready to fit in place. For instance, the main steam pipes were finished complete by tube-makers to drawings, having been so designed that the unavoidable inaccuracies in fitting boilers and engines in place could be taken up at the joints and thus overcome the delay which otherwise invariably occurs through having pipes made to fit the place after everything else is in position.

The smaller castings for the main engines were also ordered in multiple, thus avoiding unnecessary patternmaking, as all the firms on the Clyde were supplied with those castings from two sets of patterns in all. This procedure enabled the machinery contractors to concentrate their attention on the bigger things with the knowledge that the smaller things were, so far as they were concerned, looking after themselves.

The positions of the auxiliary machinery were arranged so as to give the least work in completing the vessel after it was launched, the positions being so chosen that all erection could be completed in the shipyard before the launch, the various connecting pipes being of the simplest form while providing all the conveniences for working usually found in first-class work.

The feed filter, which is of the gravitation type using coir fibre, open to observation and replacement while the engines are working, is embodied in the main engine hot-well attached to the air pump, so that it is completely fitted in the engine works and no pipes and connections at all are required for it. The feed heater is of the well-known mixer type, and is also embodied in the main engine hot-well, the whole making a very compact arrangement with the minimum of fitting work. The evaporator is of the vertical type, capacity 25 tons per day, and conveniently arranged at the back of the main engines.

The winches are of the usual plain cargo-vessel type and number, arranged to exhaust to a winch condenser placed in the engine-room. The winch condenser is of ample size to deal adequately with the exhaust from the winches and so facilitate expeditious discharge of cargo. A general service donkey and a harbour-feed donkey are provided, both alike, of the single direct-acting type, with $9\frac{1}{2}$ in. diameter steam cylinder, 7-in. diameter water cylinder, 18-in. stroke, and capable of feeding boilers in port or at sea, the harbour-feed donkey being fitted with automatic control from a float which operates with the water from either main engine air pump or winch condenser.

The ballast donkey is of the single direct-acting type, 11-in. diameter steam cylinders, 14-in. diameter water cylinder and 24-in. stroke, to quickly discharge water ballast from the various tanks throughout the vessel.

Owing to prevailing circumstances the use of copper piping had to be avoided. Wrought-iron has been largely used throughout, only the very small pipes being made of copper. As a result the total weight of copper piping is less than one-sixth of that usual in this class of vessel.

The boilers—three in number—are of the well-established multitubular return-tube type, 15 ft. 6 in. diameter by 11 ft. 6 in. long, for 180 lb. working pressure, working under Howden's system of forced draught. They do not present any special features, although it may be mentioned that the original design, prepared for the minimum amount of workmanship and expeditious construction, had to be modified in later boilers on account of the present demands on steel works for large plates, so as to enable those available to be utilised. The principle of manufacture in multiple was adopted for boiler parts also, this applying to such items as tubes and furnaces, the latter being finished to one set of templates for all firms.

THE "RUSTON" OIL LOCOMOTIVE.

In considering the possibilities of oil-driven locomotives, one finds few large fields in the industrial world, or at least in that realm governing "crude production"—where their introduction would not make for speed and economy. In this connection one might mention mines, quarries, brickyards and forests; tea, coffee, sugar, cotton, rubber, banana and other plantations; power stations, paper mills, cable works, breweries, factories, &c., and light railways and tramways. It is hardly necessary to lay stress upon their advantages to any of the above enterprises. The fact that they can start from cold at a moment's notice, and entail no stand-by losses, will commend them to certain classes of industry, such as quarries, brickyards and factories. That by their use the inconvenience of having to transport large quantities of fuel and water for their own consumption will commend them to the managers of timber concessions and portable railways, which, mostly established in remote regions, have long experienced this bugbear of coal fuel transport service.

The fact that they are absolutely safe as regards sparks, has already attracted widespread notice, and their immediate installation in timber concessions, powder factories and mines is a foregone conclusion, as by their use there is no danger of sparks setting fire to trees, or inflammable gases or material, as has been too often the case with the use of coal or wood-fired locomotives. That the British Government is now running four in one factory is in itself sufficient assurance, not only of their absolute safety in this respect, but also as regards freedom from breakdown, and all-round adaptability.

To all, the fact that they need no skilled labour, and that any man or girl of average intelligence can run them with ease and safety, should point a way to getting the better of ever-recurring transport and labour trouble, especially as only one man, or one girl, is required to run the locomotive.

In the Government powder factory referred to above, there is a railway system of $1\frac{5}{8}$ miles in extent equipped with four Ruston oil locomotives, burning paraffin. Part of the track is old, and over it hand trucks were formerly pushed. It was the existence of this track which settled the question of gauge. It was necessary, in order to connect up two parts of the old track, to cross a river twice on swing bridges, while between the bridges a watertight concrete-lined cutting, and a tunnel under a main road, had to be made. The cutting and tunnel are close against, and parallel to, the river, the normal water-level of which is 3 ft. above rail-level at the lowest point.

The worst obstacle in this construction was the removal and relaying of the town sewer, which syphoned under the river and rose to the surface in a "swan-neck" across the line of the railway. To make matters worse, the nearest joint in the pipes was near the middle of the river, and the constant stream of navigation could not be stopped. Sufficient room, however, could just be given for one barge to pass outside the coffer dam.

The approaches to the tunnel are on a gradient of 1 in 60, this being the worst that the train has to tackle. At one end, the track leaves the river in an S-curve of 60 ft. radius in order to get a good approach to a swing bridge. The gradient is reduced to 1 in 100 at this place, in order to compensate for the curve. The pier in the river is simply a concrete block, on three 12-in. by 12-in. reinforced-concrete piles. The swing span is provided with a hand lever at the shore end, which not only locks the bridge, but at the same time puts down the signal on the fixed span to safety. Similarly, the operation of unlocking the bridge throws the signal to danger, and it is impossible to unlock it without operating the signal.

The minimum radius of curve on the old track is

25 ft., but on the new track there is nothing worse than 30 ft. radius. The 25-ft. curves are gradually being eliminated, as they are rather too sharp for the engine, which, however, makes little difficulty with the 30-ft. radius. The weight of rail used hitherto has been 20 lb. per yard on steel-pressed sleepers, but this has rather been chosen because so much of it already existed. For the extensions now in progress a 30-lb. rail on wooden sleepers is being used.

As regards the rolling-stock, the trucks are 12 ft. long, and are on bogey-wheel frames. The engine is capable of hauling nine loaded trucks, weighing 2 tons each, fully loaded over the whole course of the track. For regular working, however, the load has been limited to six trucks.

The construction of the Ruston locomotive, and its general appearance, will be appreciated from an examination of the illustrations on this and the opposite page. In Fig. 1 is a general outside view of the engine; Fig. 2, an elevation with the covers removed to show the mechanism; Fig. 3 a plan, similarly exposed; Figs. 4 and 5 show an engine in course of erection in the builders' works; Fig. 6 shows the frame laid on its side; while Fig. 7 is a view of the locomotive and train in the Government works, together with the female driver, whose figure supplies a scale to show the height of the engine.

In designing this locomotive the builders, Messrs. Ruston, Proctor and Co., Limited, of Lincoln, decided that the somewhat heavy, horizontal, slow-speed engine was far more likely to meet the demands of the case than the lightly-built, vertical, high-speed, easily-racked motor-car type of engine. It was realised that for continuous running and certainty of action the engine must be water cooled—a decision arrived at by the careful consideration of the causes leading to the breakdown of many locomotives with air-cooled engines.

The locomotive was therefore designed to be compact, low on the ground, and very rigid, with a heavily-built real locomotive framework, giving the great stiffness absolutely necessary to prevent racking, should the gauge spread, or the crossings or points get out of order, causing derailments, as it was found in the course of invenstigation that the lightly-built type could not withstand such accidents.

The locomotive (Fig. 1) is four-coupled, the two axles being coupled by a chain, which allows them much flexibility of motion. The rear axle is driven by a chain which passes over two sprocket wheels on the countershafts shown in Figs. 2, 3 and 4. Only one of the sprocket wheels can drive at a time, since they are driven by the dog-clutches seen to the left of them, and these clutches are so coupled to the lever which controls them that only one can be in gear at a time.

The gearing starts by a pinion A (Fig. 2) on the crankshaft next to the disc flywheel (Fig. 4); this pinion gears with a small wheel B on a short intermediate shaft (Fig. 3), and on this shaft there is a second pinion gearing with the large spur wheel C shown on the right in Fig. 4, and also in Fig. 2. This wheel C is on the shaft carrying the forward driving sprocket, and gears with a smaller wheel on the rear countershaft which carries the reversing sprocket. At the left-hand end of the rear shaft is a spur-wheel F gearing with a similar wheel G on the shaft carrying the forward sprocket.

The spur wheels at the right of the two sprocket-shafts are both loose, but either one can be coupled to its shaft by a coil clutch adjacent to it. Let us suppose that the large wheel C on the forward shaft (Figs. 2 to 5) is clutched, and the smaller wheel E, on the rear shaft, is free. The drive, therefore, passes to the forward sprocket, and the locomotive runs on the slow gear. The rear shaft runs idly, being driven by the tram G H at the left-hand end (Fig. 4). When the forward coil clutch is freed, and the rear clutch put in, the drive is then through the wheels C and F, and the wheels H and G again to the forward sprocket, which now runs at the top speed. To reverse, the dog-clutch on the leading sprocket is freed, and that on the rear clutch engaged.

It will be seen from the engravings on the opposite page that the locomotive is built with the weight and rigidity which are essential for the rough treatment which attends all railway work. Figs. 4 and 5 show this, while Fig. 6 reveals the solid construction of the frame. The levers are all arranged in the cab, and are so interlocked that it is impossible to damage the gear. The sliding pinions which need so much skill in motor cars are absent, and the machine makes no more demands on the intelligence of the driver than does an ordinary stationary oil engine.

The Institute of Metals.—The Council announce that the 1918 May lecture will be delivered by the Hon. Sir Charles A. Parsons, member of council, who will give an account of thirty years' experiments on the formation of diamonds. Papers or notes intended for the 1918 spring meeting should be in the editor's hands not later than December 31 next.

THE "RUSTON" OIL-ENGINED LOCOMOTIVE.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR AND CO., LTD., ENGINEERS, LINCOLN.

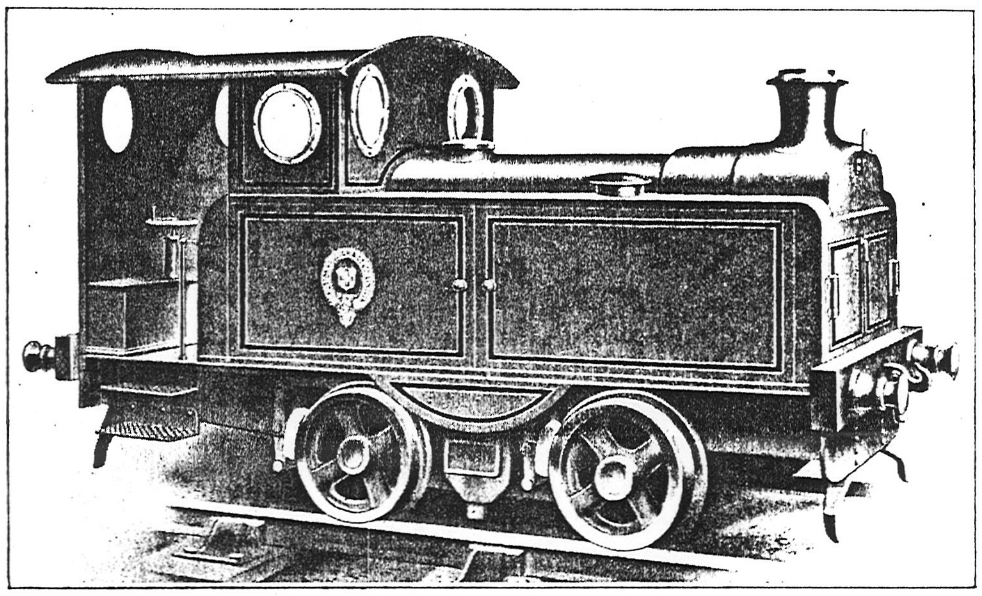
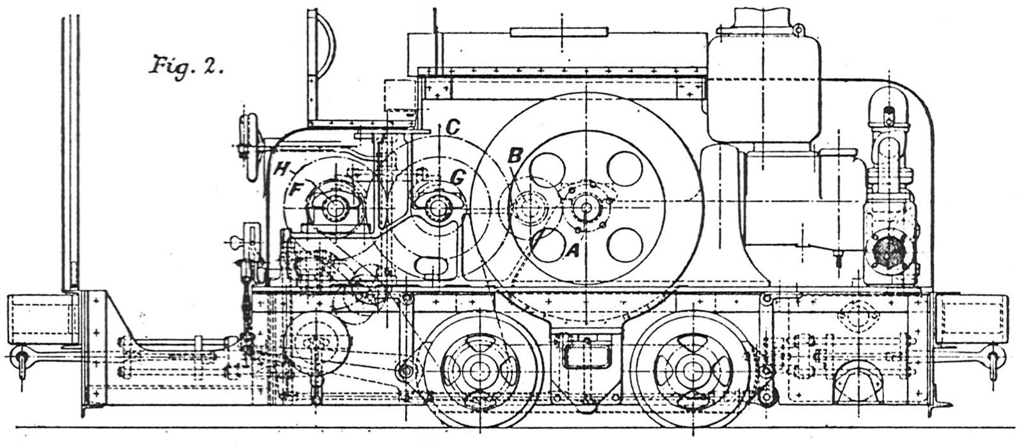
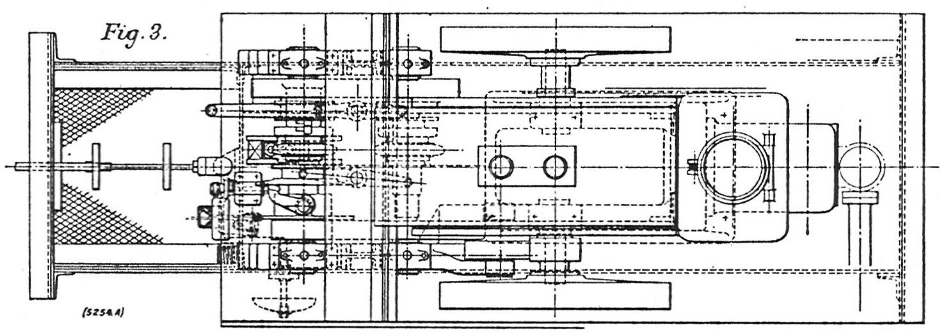


Fig. 1.





Japan's Electrical Machinery Trade.—H.M. Trade Commissioner in Australia reports, under date September 26, that the Secretary of Electrical Exploitations and the Bureau of Special Investigations, Tokio, recently arrived in Sydney with the intention of touring the Commonwealth in order to make inquiries in regard to electrical undertakings, with a view to studying the Australian market for electrical machinery and equipment, in the interests of Japanese manufacturers.

Shipbuilding in Germany.—A German paper which may claim to be an authority as regards shipping and shipbuilding matters in Germany, estimates the capacity of the German shipyards in the years preceding the war at about 400,000 tons per annum; in 1913 the output amounted to 465,000 tons. After the war it must, of course, be taken for granted, that the majority of the German shipyards will be available for the reconstruction of the reduced German merchant navy. The capacity of these yards has been materially increased during the war and further extensions may be looked for. Four large shipyards have recently been founded, and almost all the existing yards have increased their share capital and extended their plant. During the war some 35,000,000 marks have been invested in the German shipbuilding industry, private capital having been forthcoming in sufficient quantity. At present plans are under consideration for the laying down of a North Sea yard, mainly for the building of motor driven vessels, and a yard on the Baltic is extending its capacity. The building capacity of the German shipyards may be taken as having increased 50 per cent. during the war, so that the annual production after the war, when normal conditions again prevail, will amount at least to 600,000 tons. Nor would it perhaps be wise to aim at a further increase in the production, inasmuch as it is not only a question of dealing with the years following immediately on the conclusion of peace, but also with a somewhat more distant future. For in half a score of years or so the demand for tonnage may have subsided materially. A condition set down is to the effect that all German requirements of new tonnage are to be provided for by German yards, and there is probably no reason for Germany to fear that such will not be the case, since most foreign yards will no doubt be fully employed with orders for their respective countries. The German shipbuilding industry, therefore, does not appear to be needed; but, on the other hand, every facility will have to be rendered it as regards the obtaining of sufficient labour and raw materials. Steamer concerns and steamer shares are not unfrequently changing hands. Thus a syndicate acquired some little time ago, through the medium of the National Bank of Germany, a number of shares in the Rickmers Shipping and Shipbuilding Company, and these shares, it is understood, have now been disposed of, with considerable profit to the vendors, to the Orient Trading Company, in Hamburg, which now controls all the shares in the Rickmers concern.

THE "RUSTON" OIL-ENGINED LOCOMOTIVE.

CONSTRUCTED BY MESSRS. RUSTON, PROCTOR AND CO., LIMITED, ENGINEERS, LINCOLN.

(*For Description, see opposite Page.*)

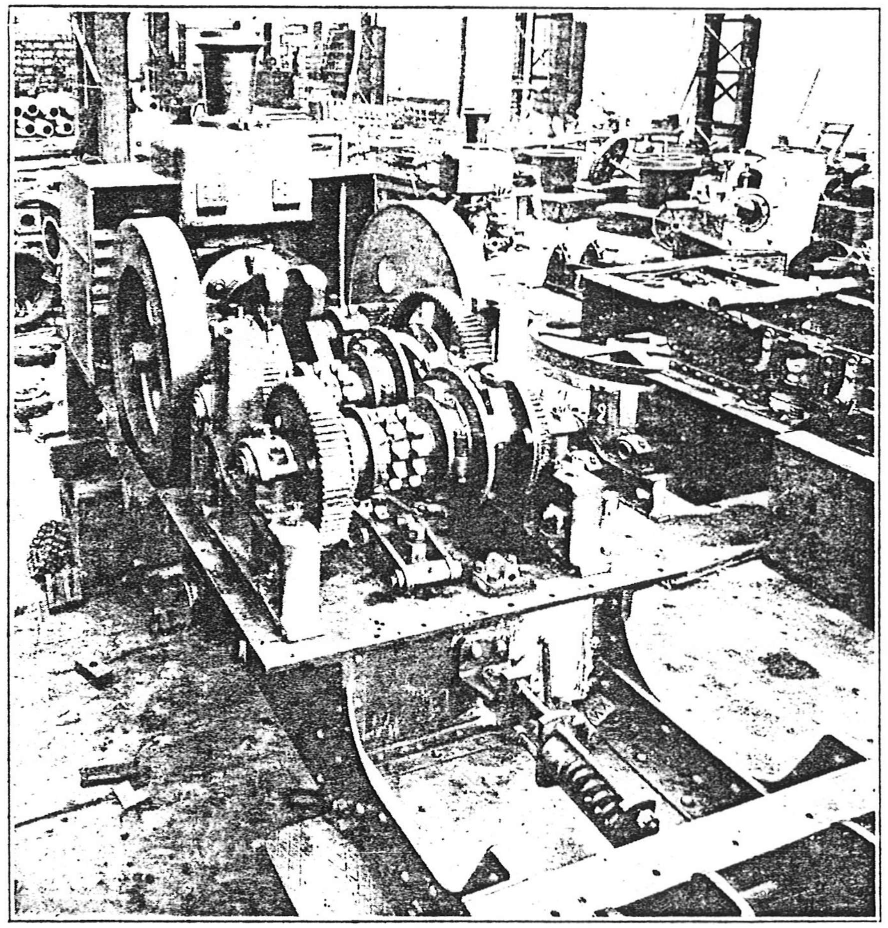


Fig. 4.

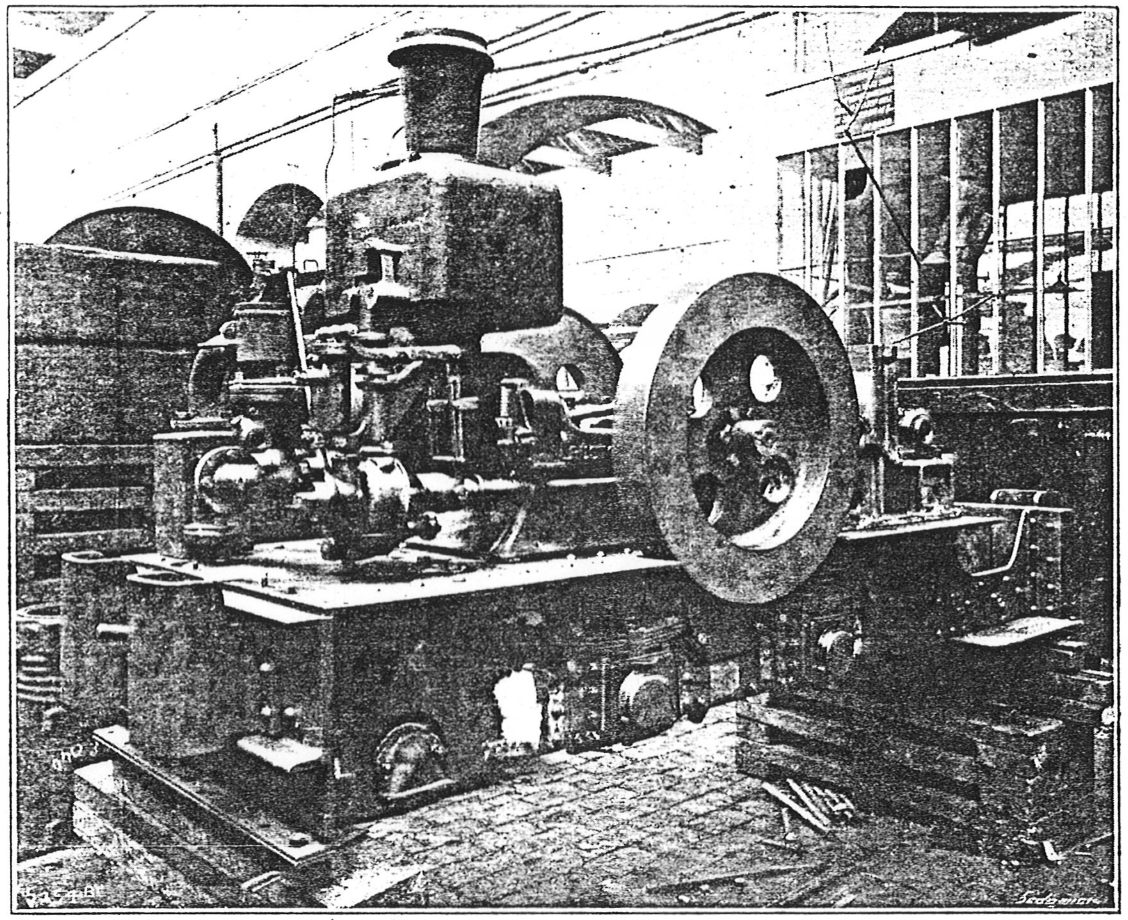


Fig. 5.

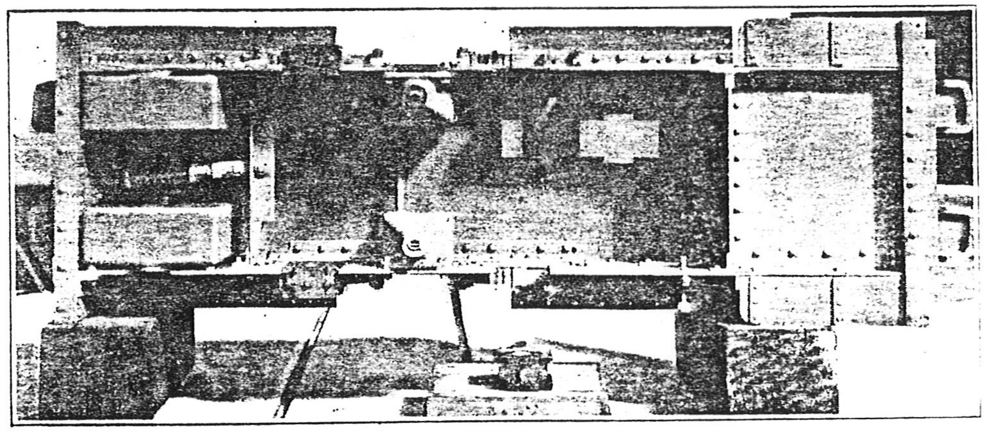


Fig. 6.

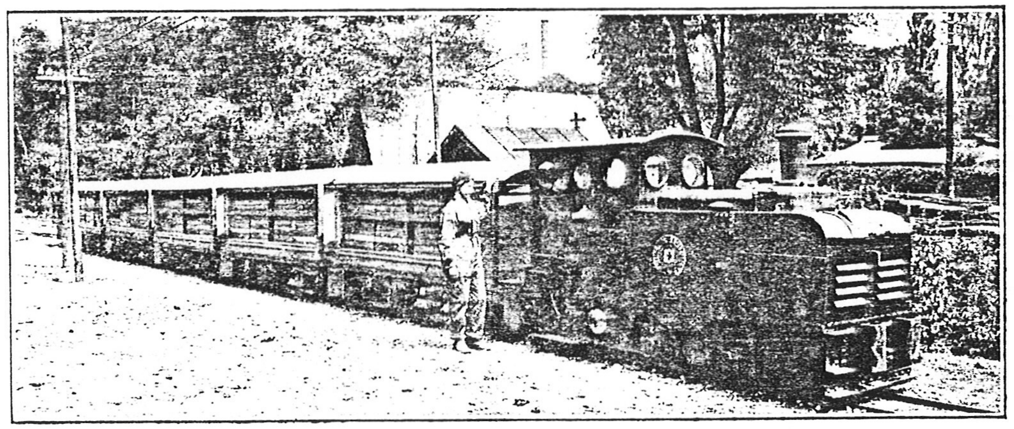


Fig. 7.