a filter. The oil level can be read off on a conveniently placed gauge. On the forward end of the engines a semi-rotary wing pump, which is coupled to the crankshaft, supplies water for cylinder and compressor cooling.

The nett weight of each main engine is 55 tons, or with all pipes, air flasks, exhaust, silencer, etc., 77 tons; the air compressor and motor weigh 6 tons, or a total of 160 tons.

The fuel consumption of each engine was proved on a forty-eight hours' run at normal working to be ·46 lb. per B.H.P. per hour, but as the pumps for the various ship purposes are driven off the main engines, the actual consumption of the latter alone is much lower.

By reference to Figure II., it will be seen that the ship is of the twin-deck type, and is provided with a double bottom over her whole length, so that the space enclosed may be utilized for water-ballast; there are four cargo-holes with deck stanchions suitably spaced for facilitating the handling of bulky cargo. The hull is provided with six water-tight bulk-heads, and is fitted with two masts furnished with booms and winches capable of dealing with goods up to thirty-five tons in weight. The oil-bunkers are disposed athwart-ships, immediately in front of the engine-room; special provision being made to prevent any leakage; they are protected by coffer-dams on each side to reduce the risk of damage from collision. The capacity of the bunkers is 700 tons. The deck machinery is operated by steam generated in a donkey-boiler placed on the upper deck and adapted to be heated by oil burners when in port and by the exhaust gases when the ship is under way. The products of combustion from the donkey-boiler are led into a small funnel at the stern of the vessel, which also serves to take the exhaust gases from the main engines. Compared with a steamship of similar size, which would require sixteen firemen the *Monte Penedo* will effect a saving of ten men, only requiring six. This reduction is estimated to effect an economy of about £700 per annum. The weight of steam machinery would be about 400 tons, while in this vessel the weight is only 160, thus effecting a saving of 240 tons. It is estimated that the reduction in bunker weight, in addition to the other economies, will effect a total saving of 900 tons, or about an increase of 15 per cent. of total deadweight capacity. The result of this will be, that, owing to the saving of space in engine and boiler-room, from 8,000 to 10,000 cubic feet can be added to the space available for cargo. During the trial at Hamburg the vessel attained a speed of 10½ knots, but it is anticipated that when a change is made in her propellers this may be improved upon. The consumption of ·46 lbs. per brake horse-power per hour, which is about one-third of the coal consumption on a steamship, is slightly higher than the result obtained in the *Selandia*, which, it will be remembered, is fitted with engines of the four-cycle type, although it must be remembered that in the case of the *Monte Penedo* the consumption includes that due to the driving of the air compressor for oil injection and air storage for starting and manœuvring purposes. The *Monte Penedo* started on her first voyage to South America on August 31st, and called at Lisbon on her way. The reports received state that her passage so far has been carried on without the slightest hitch; the average speed was between 10 and 11 knots, and after the call, the vessel proceeded on her voyage without any delay whatever.

"SUCTION" BETWEEN PASSING VESSELS.*

By PROFESSOR A. H. GIBSON, D.Sc., and J. HANNAY THOMPSON, M.Sc., M.Inst.C.E.

IN view of the general lack of experimental data as to the magnitude of the mutual forces involved in the cases of interaction between two vessels moving in parallel paths in close proximity, and as to their effective range of action, the authors decided to carry out a series of experiments to investigate these points on boats of sufficiently large size to enable the results to be applied with some confidence to seagoing vessels. The vessels used were the steam-yacht *Princess Louise* and a motor boat. Each is propelled by a single screw, and their details are as follow:—

Vessel	Length between perpendiculars.		Beam		Draught	Displacement.	Rudder Area
	Ft.	In.	Ft.	In.			
Princess Louise	88	6	13	0	6ft. forward 7ft. aft	—	—
Motor-boat ..	29	6	6	9	2 ft. 3 in.		100 sq. in.

Two sets of experiments were carried out. In the first the helm of the motor-boat was lashed amidships, with the vessels on parallel paths, and its behaviour was noted when at different lateral distances, and when the boats were moving at different absolute and relative speeds. Its position relative to the *Princess Louise* was determined by angular measurements taken from the latter vessel at intervals of fifteen seconds. Pressures at a series of corresponding points on the two sides of the motor-boat were measured at the same instants, with a view to determining the lateral forces involved.

The second series of experiments was devoted to a determination of the helm angle necessary to maintain the course of the motor-boat when in different positions relative to the larger vessel.

Owing to possible collision risks the maximum speed was limited to six knots, which, in the case of the *Princess Louise*, corresponds to eighteen knots in a vessel of the size of the *Olympic*. The results show that with both vessels moving at about this speed with helms amidships, the smaller vessel is drawn into collision from any lateral distance less than a hundred feet (three and a half lengths of the smaller vessel). The precise behaviour depends largely on the relative and absolute speeds of the vessels and on their initial distance apart and initial relative position. These points were discussed in the paper, as was the question of the helm angle required to prevent collision.

The authors are of opinion that the experiments prove conclusively that the forces involved during interaction are much greater than has been generally realized hitherto, while they have been particularly impressed by the rapidity with which collision usually follows the first sign of any interaction.

* Read at the Dundee Meetings, September, 1912, of the British Association for the Advancement of Science.

LIFEBOATS ON OCEAN-GOING-SHIPS.*

By AXEL WELIN.

THE urgent necessity for revising present regulations referring to life-saving appliances at sea has recently been brought home with terrible force to the public mind. Anticipating the ultimate results of the international deliberations at present in progress, the United States Government have already stipulated that every ocean-going passenger steamer must provide sufficient boat-accommodation for every soul on board.

To the lay mind such a rule must appear perfectly reasonable, seeing that no objection on the ground of expense can be permissible in a matter of this nature. But it must be borne in mind that the mere fact of

* Read at the Dundee Meetings, September, 1912, of the British Association for the Advancement of Science.

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carrying a full complement of lifeboats implies no guarantee of safety. Unless the boats can be readily manned and launched with a fair degree of certainty, they only constitute so much lumber uselessly carried about. And it may be categorically stated that there are a large number of ships now in commission on which boats cannot be efficiently arranged to accommodate everybody on board.

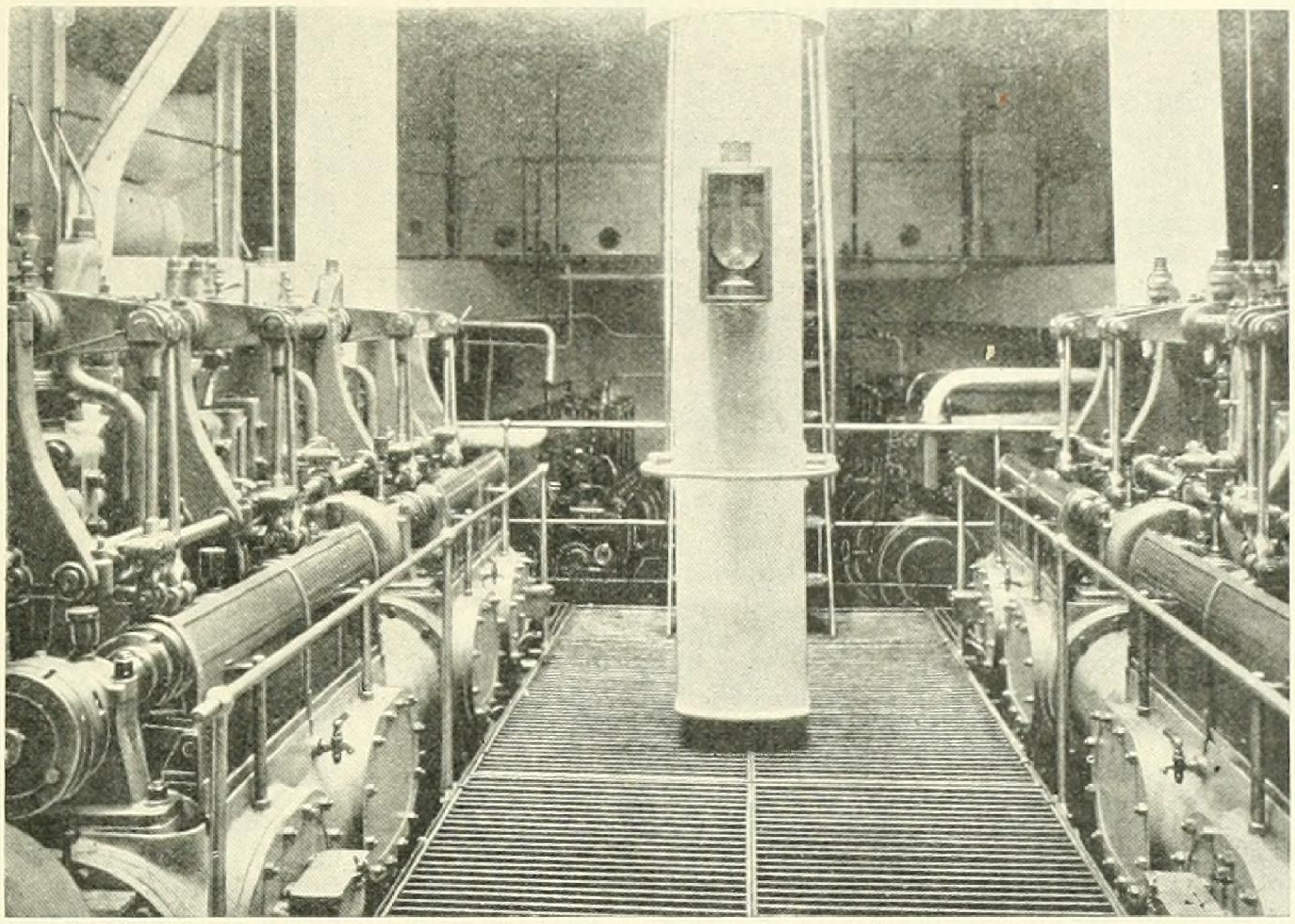

Fig. 7. Showing upper part of valve gear of main engine of the *Monte Penedo*.

Considerable improvement may, however, be effected in the conditions hitherto prevailing, and it may safely be said that all the better-class passenger-carrying companies are giving the matter most careful attention. The general adoption of wireless communication between ships, and also the success of anti-rolling tanks, have enormously augmented the value of the lifeboats in cases of emergency. The last-mentioned invention practically removes the risk of boats getting crushed against the side of the ship when lowering in bad weather, and wireless telegraphy has reduced the question to one of providing means for transferring people from one ship to another in case of disaster. Strong seaworthy boats, with the largest obtainable displacement for a given length, will now best meet the requirements, a high degree of navigability being of much less importance than formerly. Detachable deck-houses, life-rafts, and the like, are, in the author's opinion, of very limited value.

On account of the continually increasing height of modern ships, the old question of substituting wire ropes for the usual manila falls has come up again with renewed force. The problem is, however, one of considerable difficulty in view of the ever-varying conditions under which the launching of the boats may have to be carried out.

The first ship to obtain a really efficient davit installation of this nature is the ss. *Imperator*, of the Hamburg-Amerika Line, on which the majority of the boats stand some 70 feet above the water-line. The launching of boats on this vessel may be effected in from forty to fifty seconds, and a special adjusting gear permits of the boat descending at any required angle—a point of the greatest importance. The hoisting is done by means of an electrically-driven "fore-and-aft" transmission shaft provided with "friction-drivers," each boat being handled quite independently of the others. The largest lifeboats are capable of accommodating seventy-six people, and weigh, fully loaded, approximately eight tons each.

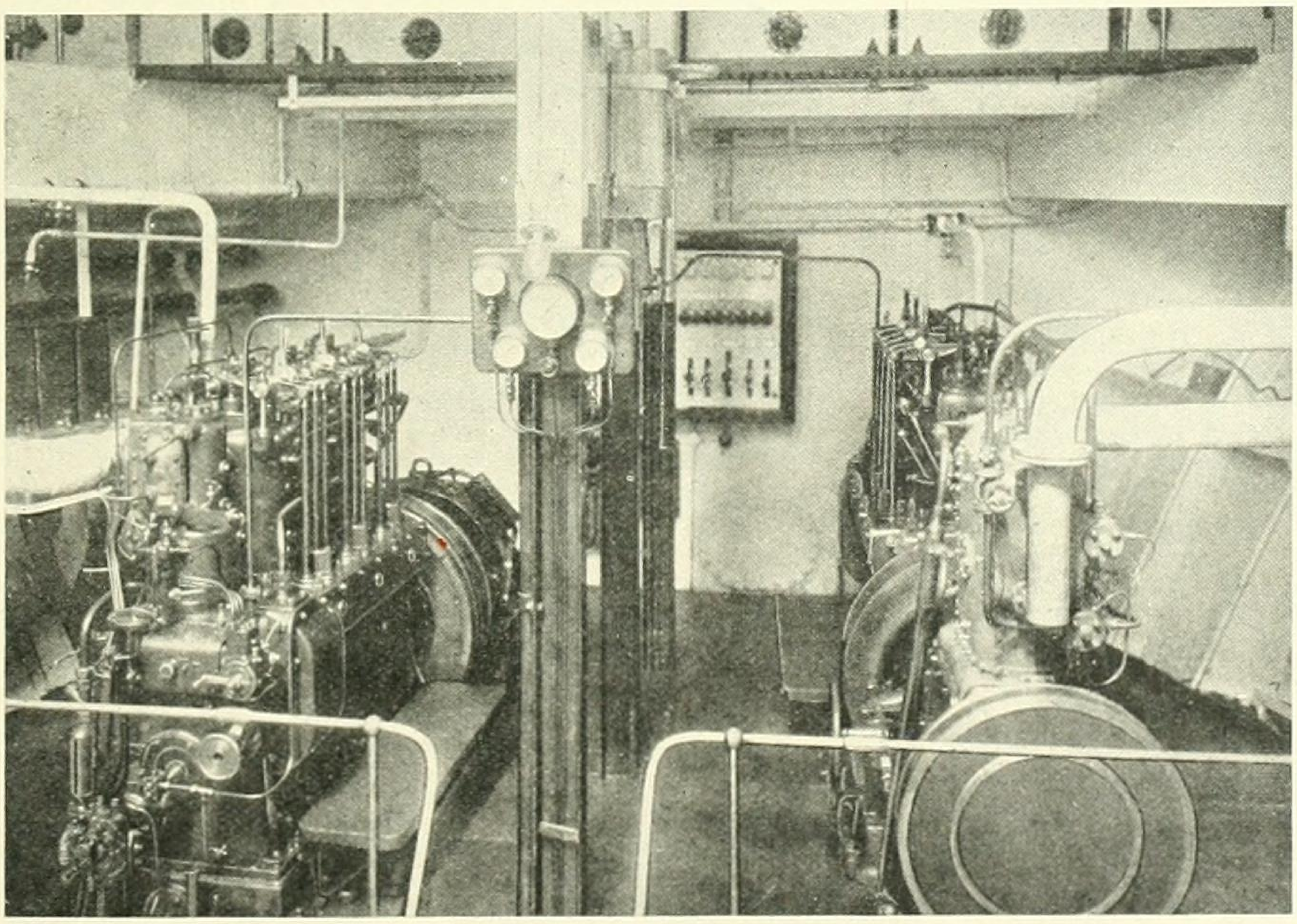

Fig. 8. Auxiliary motors of the *Monte Penedo*.

THE SUBMARINE SIGNAL COMPANY have issued a booklet containing a list of the ships throughout the world equipped with their apparatus. The list does not include naval vessels. In the pamphlet is included a complete list of the stations now installed with submarine bells.

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the subject, however, it is necessary to go into the question of expansion, which brings in the supplementary valve for this purpose, and with a chapter devoted to the important matters of setting of the valve and another containing questions and answers we come to the end of what is undoubtedly a work of much importance and founded on a moderate compass, every detail being embodied and with the reason for its use clearly stated. For examination purposes there is apparently nothing wanting here, while for the general reader the same may also be said with truth.

Modern Sanitary Engineering. By Gilbert Thomson, M.A., F.R.S.E., M.Inst.C.E. London: Messrs. Constable and Co., Ltd. Price 6/- nett.
The author of this work is the Lecturer on Sanitary Engineering in the Royal Technical College of Glasgow, and in this capacity, and as a civil engineer, is in an excellent position to deal with the engineering problems involved in the collection, conveyance and disposal of sewage as apart from the details of execution of work as is set forth so fully in many books written from the tradesman's point of view. The present volume is Part I. of the work, and is devoted to house drainage. The principles laid down are from a sanitary standpoint, applicable to any system of drainage, wherever situated, and the reader will be well repaid in a study of the subject from this work. What may be termed the dynamics of drainage are dealt with in a very clear and comprehensive manner, and no difficulty need be experienced in arriving at a conclusion as to the way not to carry out a job.

ELECTRIC PROPULSION OF SHIPS.

By HENRY A. MAVOR.

IN a paper on "Marine Propulsion by Electric Transmission," the author gave a description of the machinery installed in the *Cyclops*, *Neptune* and *Jupiter*, three colliers of about 20,000 tons displacement, which are being equipped by the United States Government respectively with reciprocating engines, two steam turbines connected to the propellers by mechanical gearing, and a steam turbine connected to the propellers by electric transmission. Mr. Mavor also gave details of an oil-electric tank barge now being constructed in this country to designs prepared by himself and Mr. John Reid, of Glasgow, for service on the Canadian lakes, to be named the *Tynemount*. The equipment, which is based largely on that of the *Electric Arc*, described by him in his paper read before the Association last year, consists of two units, each comprising an engine, dynamo and a propeller motor. The engines work on the Diesel four-cycle principle and have 12-in. cylinders with a 13½-in. stroke working at 400 r.p.m. Each has six cylinders, and the cranks are so arranged that the firing takes place at equal intervals. The electric equipment includes two three-phase generators each giving about 235 k.v.a. at 500 volts and 20 or 26·6 cycles. A single three-phase motor developing 500 b.h.p. is coupled direct to each of the propeller shafts.

THE NATIONAL TIME RECORDER CO., of Blackfriars Road, London have recently issued a nicely-printed and illustrated catalogue of their British-made time recorders. These recorders are well known, and their construction and special features are set out in the catalogue.

NOTICE TO MARINERS—Since the 17th of August, a submarine ground bell has been established in position 1 mile 2¼ cables South, or 180° True (South 16° W. Magnetic) from the Lizard lighthouse. In thick or foggy weather the bell will give four strokes in quick succession, followed by a silent interval of 30 seconds.

FUELS FOR INTERNAL COMBUSTION ENGINES.

TO engineers who have been watching the trend of events, it must be evident that internal combustion engines for ship propulsion are slowly making an entry into that field so long held by the reciprocating engine. The turbine was the first rival to appear, and while it almost immediately replaced the reciprocating engine for war vessels and steamers where high speeds were demanded, it did not make and has not made perceptible headway for the propulsion of slow-speed cargo vessels. The oil engine has now definitely entered into competition with the steam engine, not only for high-speed boats, but also in the type of steamer in which it was believed the reciprocating engine need fear no rival for many years to come. Already several cargo vessels have been working, with internal combustion engines for some time, and several others are about to begin work. It is unnecessary to give the names of these vessels, as readers will be familiar with them.

In "The Glasgow Herald" of recent date, a correspondent, writing on this subject, drew attention to the fact that although this country was making up on others which have taken the lead, it was possible that we were following lines of development, which, while leading in the right direction, might not be, and probably were not the best lines for this country. The argument followed was, that in many of the countries where great strides had been taken in the application of oil engines to ship propulsion, oil was easily obtainable in large quantities at a low price; we, on the contrary, had no oil wells and a very limited production of oil from shale; coal again was plentiful, and obtainable in large quantities at cheap prices practically everywhere throughout the country. He also drew attention to the fact that engineers had become so engrossed with the idea of oil engines and the economy of working them, that they had overlooked the fact that, on land, oil engines are rarely considered as prime movers, except in very small units, where it is possible to use suction gas engines.

It has been proved over and over again, that suction gas is not only more economical to run, but that it is much cleaner. It will be interesting to consider the fuels which are most generally obtainable for use in internal combustion engines. Petrol costs about 9d. to 1s. per gallon, and is very dangerous, so that on these two points it is never used for commercial work, except under exceptional circumstances. Paraffin oil or petroleum is safe, but except for small engines it also is too costly. Fuel oil or residue is the only oil-fuel at present worthy of consideration for use in engines of any size. This fuel has a specific gravity of ·86 to ·93 and has a flash point of from 200° to 270°F. The cost of this oil in bulk is about 2d. to 3d. per gallon, on an average.

Taking suction gas as the competitor to fuel oil, it may be well to state that anthracite, coke and charcoal are all suitable for use in the producer. Anthracite has many advantages over the others; in this country it is not so cheap as coke, but it is cleaner; it is a fuel which gives a lower consumption than coke; charcoal is far too expensive to use here. From the above statement it is clear that anthracite is the most suitable of the three, and anthracite alone will be considered hereafter as fuel when comparing oil and suction gas. The size used should be ⅜-in. to ½-in., and as the price varies considerably, due to the district from which it is produced, some districts giving a much better anthracite than others, and due to the distance from the source of production to the point of consumption, the price per ton is taken as ranging from 17s. to 23s. Bituminous producers are on the market, but so far as the author is aware, the number at sea is very limited, and no figures of recent date are available to compare the cost of working against the ordinary suction gas plant using anthracite or coke.

The usual method of comparison, with engineers, of the cost of running various engines, is so much coal or oil per H.P. per hour. The cost of running one horse-power for one hour gives such extremely small fractions of a penny that it is almost impossible to grasp the meaning of what the difference really is, consequently it might be as well to fix upon some larger unit than one H.P. hour, and it is

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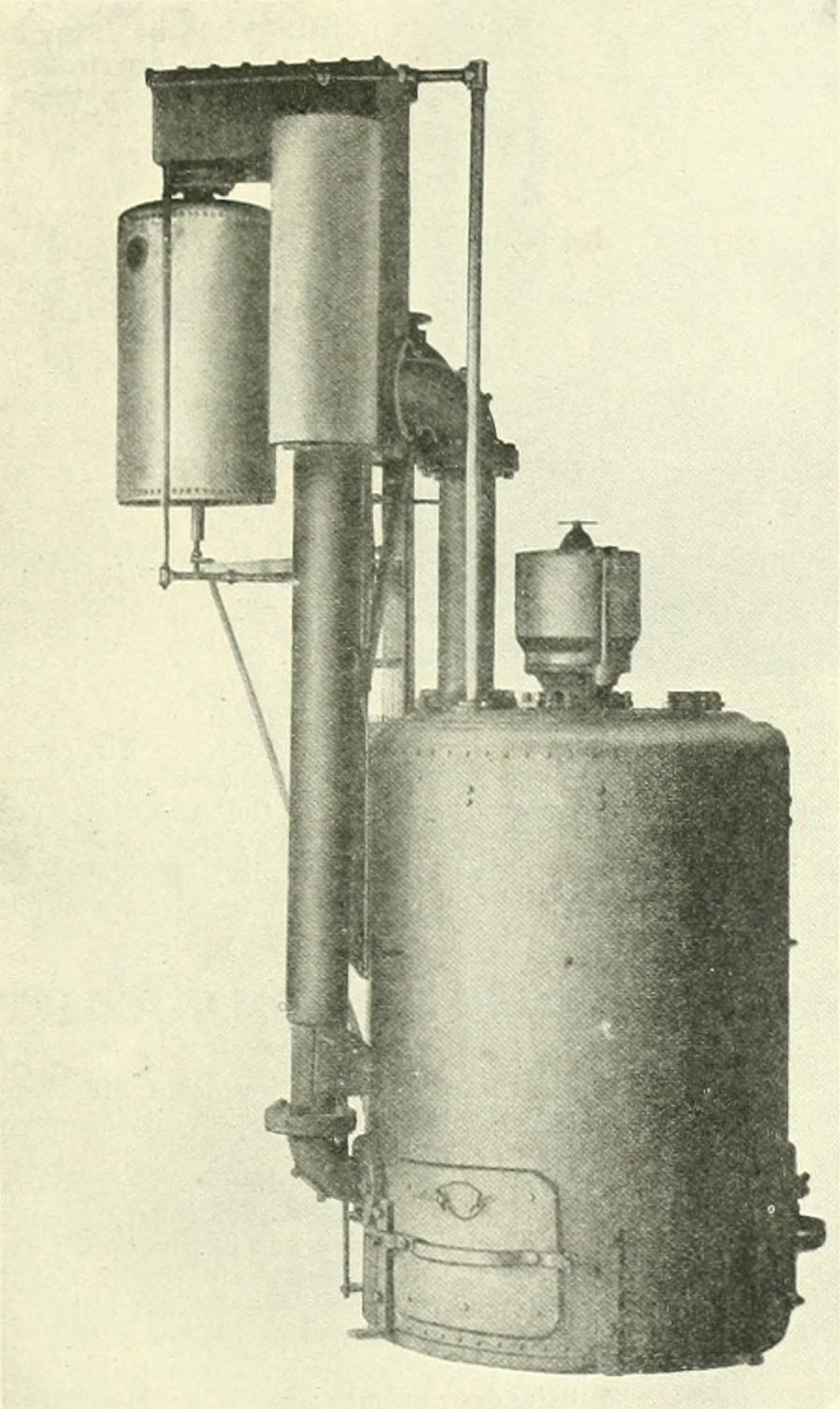
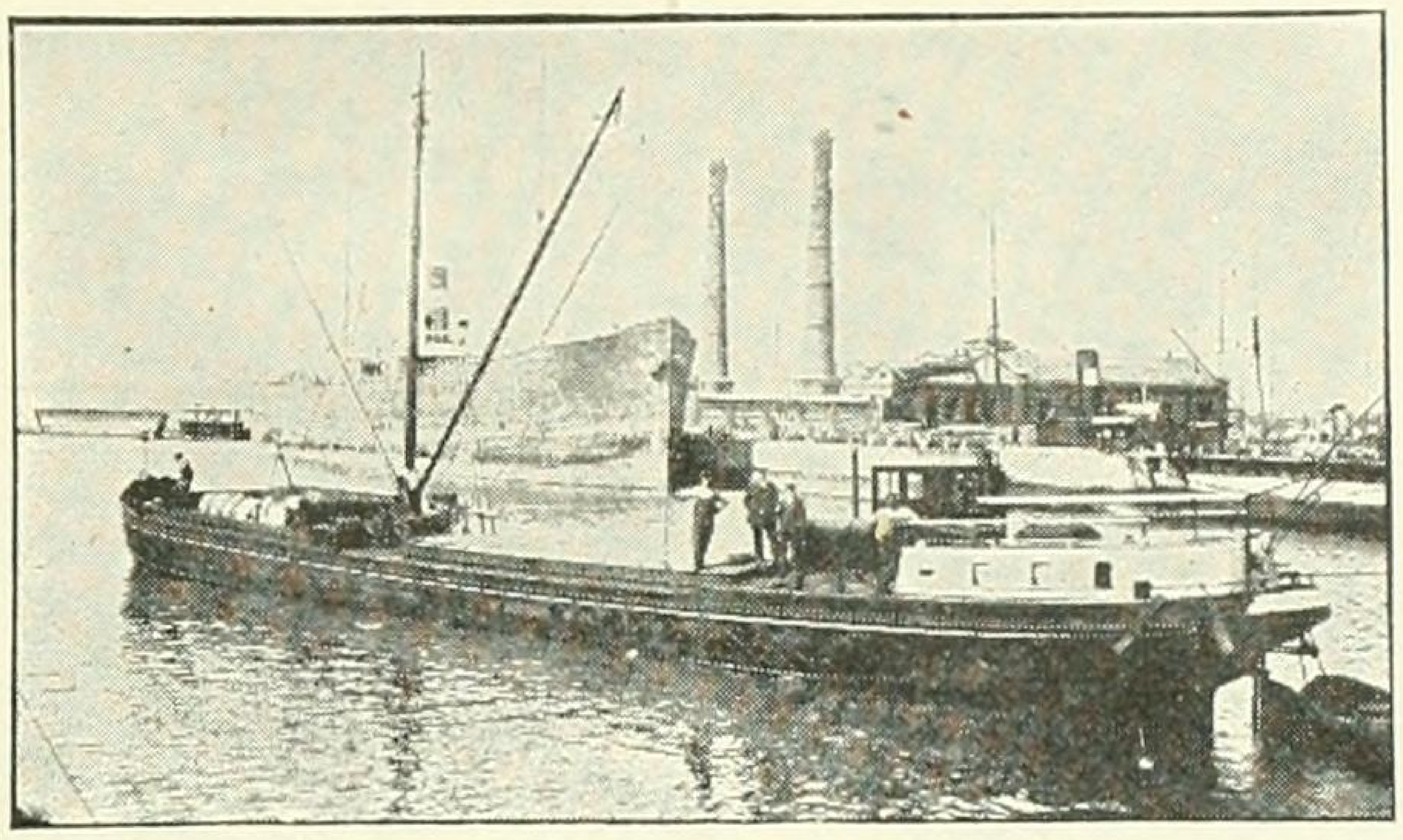
with a 36 H.P. motor, No. IV., which is 50 ft. long, 11 ft. 3 in. beam, and 5 ft. 3 in. draught, is fitted with a 75 H.P. motor and suction gas plant. The first three engines mentioned are the "Wolverine" standard oil engines, which operate upon petrol or paraffin. When using the latter fuel, it is necessary to start on petrol for a few minutes and then switch over to the heavier fuel. This method is adopted in the "Wolverine" engine when using heavy oils. The suction gas motor has some slight alteration made from the standard motor to suit the different nature of the fuel, *viz.*, gas instead of oil. This boat, *Wolverine IV.*, is used as a tug, often towing four barges, each carrying 300 tons. The consumption for the twenty-four hours, which is made up of ten to twelve hours working day and fourteen to twelve hours stand by,



40 H.P. Galusha Marine Gas Producer.

amounts to 300 to 320 kilos. (660 to 700 lbs.) of anthracite. This anthracite costs 22 francs per 1,000 kilos, and taking the value of a franc as 9½d., this amounts to 17s. 6d. for 2,200 lbs. This works out at a consumption of ·783 lbs. per H.P. per hour, making the cost ·075d. per H.P. per hour. Another boat, called the *Zeemeeuw III.*, is fitted with a 36 H.P. motor and suction gas plant. She is 115 ft. long by 16 ft. 5 in. beam, 6 ft. 3 in. draught, and carries about 200 tons. The consumption of fuel per twenty-four hours, consisting of a twelve-hour run and twelve hours stand by, is 190 to 200 kilos. (420 to 440 lbs.) of anthracite. Taking anthracite at the same cost as previously given the consumption is 1·02 lbs. per H.P. per hour, making the cost ·098d. per H.P. per hour. *Zeemeeuw III.* has been so successful that, after ten months' working, the owner, who has another boat fitted with a 36 H.P. "Wolverine" working on oil fuel,



Zeemeeuw III.

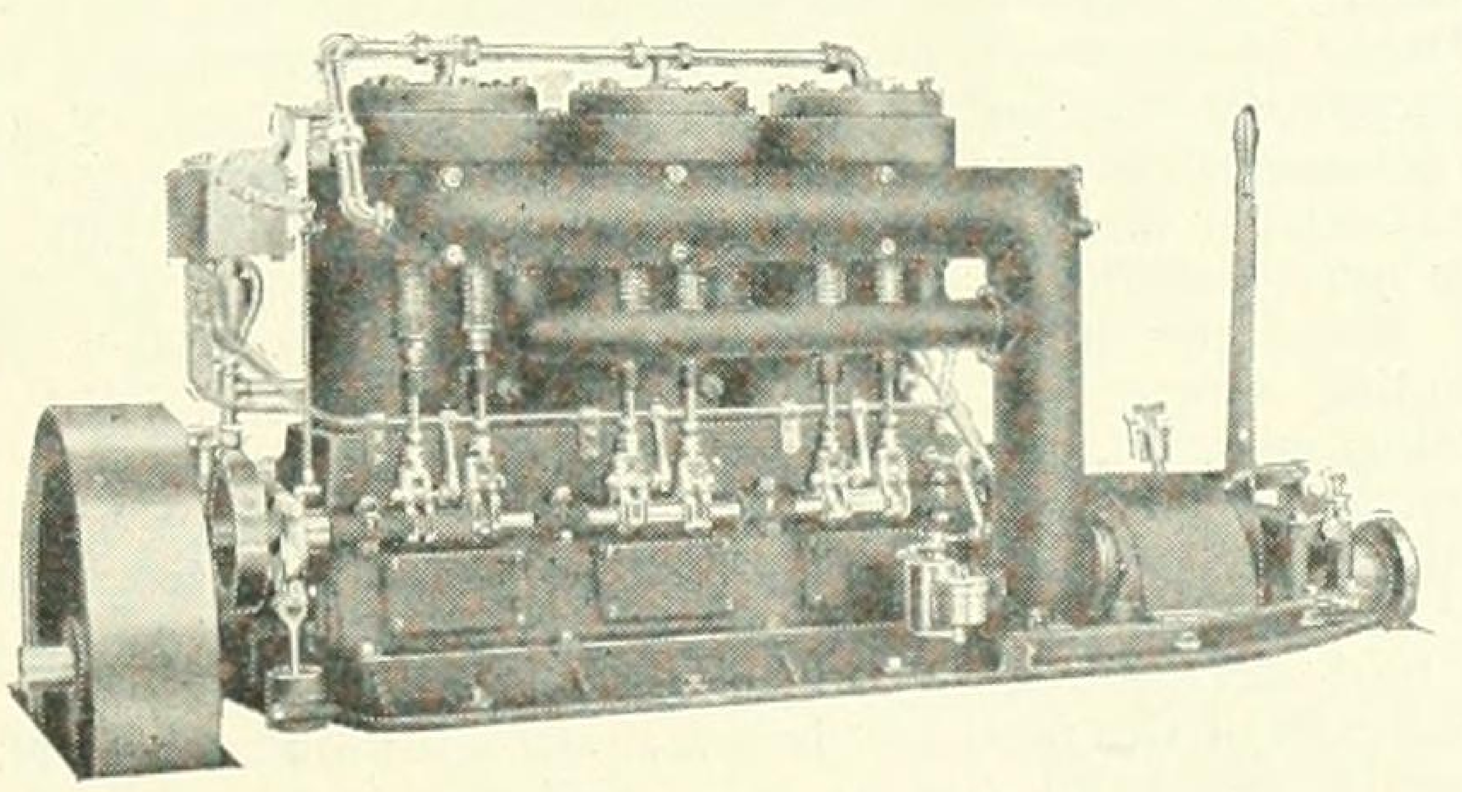
Length 115 ft., Beam 16 ft. 5 ins., fitted with a 40 H.P. Galusha Marine Gas Producer.
Speed, with 150 tons of freight, 7½ miles per hour.

decided to put in and has installed a gas producer and altered the engine to use gas, at the same time lengthened his boat to carry more cargo. Equally satisfactory results are anticipated from this boat. The producer in these three boats is built by Messrs. A. L. Galusha & Co., Dorchester Center, Mass., U.S.A.

The Wolverine Motor Works have recently completed a suction gas installation in a boat working in Florida. Previously to the change from oil, this engine, which is of 75 H.P., used £13 10s. worth of fuel on the trip from Miami, Florida, to Key West; since the change the fuel bill amounts to only £2, or a saving of £11 10s. per trip.

Among the number of boats in this country which have been fitted to run on gas, may be mentioned a canal barge belonging to Messrs. Fellows, Morton & Clayton. This barge is fitted with a Crossley Bros.' suction gas plant and a 14 H.P. engine. The engine was fitted to start with compressed air. Messrs. Thornycroft fitted a barge 72 ft. long by 7 ft. beam with a suction gas producer and 35 H.P. engine. This barge ran on the canals in the Midlands and South of England demonstrating the suitability of this fuel. H.M.S. *Rattler* was fitted by Messrs. Beardmore with a gas plant and engine. This boat was used by the Clyde Naval Volunteers as a training ship. *Pioneer*, a 40-ft. cabin cruiser yacht, was installed by her builders, Messrs. McLaren Bros., Dumbarton, with a 30 H.P. Crossley Bros.' engine and suction gas plant. Messrs. McLaren Bros. also fitted a Crossley Bros.' engine and suction gas plant in the *Electric Arc*. In this case the engine did not drive the propeller direct, but generated electricity, which was used to propel the boat on the "Mavor" electrical propulsion system.

Holzapfel I. is perhaps the most interesting, as it is the latest installation. The ship is 120 ft. long by 22 ft. beam, and 11 ft. 6 in. moulded depth; 350 tons is her deadweight carrying capacity, and the builders were Messrs. I. T. Eltringham & Co., South Shields. The engines, which were manufactured by Messrs. E. S. Hindley & Sons, Bourton, Dorset, are one set of six cylinders, 10¾ in. diameter by 10 in. stroke, which develop 180 brake horse power. The revolutions are 400 per minute, and the normal power is stated to be 156 H.P. This engine does not drive the propeller direct, but through the medium of Prof. Föttinger's hydraulic power transformer,



3-Cylinder Wolverine Oil Engine.

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