Abstracts of the Technical Press

The Steam Reciprocator.

Notwithstanding the development of the steam turbine and the heavy oil engine, the reciprocating steam engine continues to be extensively employed for the propulsion of ships, its popularity being largely due to the great simplicity of this type of prime mover, its relatively low cost and the fact that it can be successfully operated and maintained by a small and relatively unskilled personnel. An engine of this type supplied with steam by coal-fired Scotch boilers probably constitutes the most economical form of machinery installation for ships of small or moderate powers, despite its lower overall efficiency. The recognition of these facts has led to a notable increase in the interest which is being taken in the marine reciprocating engine, and it may be anticipated that this will eventually result in some improvement in its efficiency. The theoretical thermal efficiency of any heat engine can be raised by increasing the limits of temperature between which the working fluid expands, but as applied to the reciprocating steam engine both the higher and lower limits of temperature are prescribed by practical considerations. As regards the higher limit, the employment of high-pressure high-temperature steam makes it difficult to ensure adequate lubrication of the pistons and slide valves due to the instability of lubricating oils at high temperatures, while at the low temperature corresponding to a high condenser vacuum, the volume of the steam becomes so great that the dimensions of the L.P. cylinder become excessive. As regards the high-temperature end, the substitution of the double-beat poppet type of valve for the piston valve has proved effective as far as the steam chests are concerned, but the problem of cylinder lubrication remains to be overcome. It has been suggested that this difficulty might be surmounted by the use of saturated or only slightly superheated steam at high pressure, in order that the presence of moisture on the cylinder walls following expansion might overcome the difficulty of lubrication. It has also been suggested that highly superheated steam should be employed, but instead of admitting it direct into the H.P. cylinder, it should first be used for reheating the steam in the receivers between the H.P. and M.P. and the M.P. and L.P. cylinders, so that it would be in a more or less saturated condition by the time it entered the H.P. cylinder. Such a procedure would obviously result in a substantial increase of the overall thermal efficiency of engine. At the lower limit of temperature exhaust turbines have been utilised to overcome the effect of the high specific volume of the steam with a considerable amount of success, and it has even been suggested that, in addition to such a turbine, a high-pressure turbine using highly superheated steam direct from the boilers could be used, working in conjunction with the gearing of the L.P. turbine. Both the H.P. and L.P. turbines would be disconnected when manœuvring the ship in and out of harbour, all the required changes of speed and direction of the propeller being effected by the reciprocating engine alone. Such an installation could also be made highly efficient from the thermodynamic aspect, but as would largely nullify the fundamental advantage of the reciprocating engine, *viz.*, its simplicity. There remains the alternative of a fundamental change in the design of the engine itself, and in this connection attention may be drawn to the various types of totally-enclosed forced-lubrication engines which have been developed for the driving of small- and medium-sized electrical generators. Many of these engines have proved to be highly efficient in service, the use of the uniflow principle in particular yielding what was claimed to be the most efficient design of reciprocating steam engine ever built. Again, by utilising two L.P. cylinders, one or either side of the H.P. cylinder, in three- or six-cylinder engines, all cylinders being of the same diameter, the principle of standardisation can be adopted with considerable economy in the cost of production. Engines of this type are very compact, take up comparatively little floor space and require only a small amount of head room, while the power-weight ratio is very favourable in comparison with that of a normal triple-expansion marine engine. These advantages are, of course, obtained by the adoption of a relatively high speed of rotation, say in the region of 500 r.p.m., and this of necessity involves the use of some form of speed-reduction gearing.—*"Shipbuilding and Shipping Record", Vol. LXIV, No. 20, 16th November, 1944, p. 464.*

Fuel Consumption of the s.s. "Papanui".

Some fuel consumption figures relating to the New Zealand Shipping Co.'s refrigerated cargo liner "Papanui", built by Alexander Stephen & Sons, Ltd., haye recently been published. She is a single-screw vessel of about 10,000 gross tons equipped with Parsons geared turbines and oil-fired watertube boilers generating steam at a pressure of 430lb./in.^{2} and temperature of 760° F. On a voyage of 17·6 days at a displacement of 15,200 tons, the average fuel consumption for all purposes was 0·59lb./s.h.p.-hr., while on another voyage of 15·5 days it was 0·61lb./s.h.p.-hr. These consumptions compare favourably with those of the U.S. Maritime Commission's standard cargo liners, which range from 0·57 to 0·63lb./s.h.p.-hr., depending on the type of vessel. The estimated figure given for the American "Victory" ships is 0·66lb./s.h.p.-hr., whilst the O.F. consumption of the "Liberty" ships, which have reciprocating engines, is from 1·3 to 1·5lb./i.h.p.-hr., although the figure usually associated with a straight triple-expansion engine having a reasonable thermal efficiency is 0·90lb./i.h.p.-hr. It seems, therefore, that the fuel consumption of a modern steamship with turbine machinery of an orthodox design is as good as that of a vessel with very high-pressure machinery built some years ago. For instance, the O.F. consumption of the "Windhuk" and "Pretoria" of the German Africa Lines, where the steam pressure was 1,150lb./in.^{2}, was recorded at slightly over 0·60lb./s.h.p.-hr. The lowest fuel consumption so far attained by any steamship is that of the U.S. Maritime Commission's experimental cargo liner "Examiner", in which steam is generated at a pressure of 1,235lb./in.^{2} with a temperature of 750° F., the exhaust steam from the H.P. turbine being reheated to the same temperature. The O.F. consumption in this case is in the region of 0·50lb./s.h.p.-hr. These fuel consumptions will bear comparison with those recorded by modern motorships with Diesel engines using 0·38lb./i.h.p.-hr., as the fuel employed with this type of machinery is more expensive than boiler oil. Furthermore, the weight of a modern steam installation comprising geared turbines and watertube boilers has now been reduced to such an extent that there is little to choose between the two types in this respect.—*"Fairplay", Vol. CLXIII, No. 3,206, 19th October, 1944, pp. 566 and 568.*

Mirrlees 950-b.h.p. Supercharged Engines.

Although the firm of Mirrlees, Bickerton and Day, Ltd., Stockport, have been building Diesel engines for marine service for very many years, it is only recently that they have begun to construct direct-reversing supercharged engines of moderate power for ship propulsion. At the present time the firm are building four 8-cylr. pressure-charged engines of an improved type for installation in Portuguese trawlers. They are fitted with Büchi exhaust-turbo superchargers and have a normal output of 900-950 b.h.p., but the maximum rating is stated to be 1,045 b.h.p. The cylinders have a diameter of 13¾in. (349·5 mm.) and the piston stroke is 21in. (533·5 mm.). The piston speed at the normal revolutions of 300 per min. is 1,050ft./min. and the b.m.e.p. under ordinary running conditions is about 120lb./in.^{2}. The bedplate is a single casting, on which is mounted the crankcase that takes the eight separately cast cylinders with their removable liners. Each cylinder cover is fitted with a vertical air-inlet valve, an exhaust valve and a centrally placed fuel valve, the starting-air valve being horizontal, with an orifice at the side of the combustion chamber. There are six cams for each cylinder, two for the inlet valve, two for the exhaust valve and two for the fuel pumps, one of each pair being for ahead operation and the other for astern running. The fuel-pump cams also serve to actuate the air-starting valves. The engine is started by turning a manœuvring wheel to the starting position, thereby opening a master air valve. The fuel pumps and injectors are of the C.A.V. type with means for independent adjustment. Reversing of the engine is effected by a lever which moves the quadrants that carry the ahead and astern cam rollers, so that one or the other of each pair of rollers is placed in contact with the correct cam. The maximum speed of the Büchi exhaust-gas turbo-blower is in the region of 13,000 r.p.m. and during the full-power test of one of the new engines the exhaust-gas temperature was found to be 750° F., rising to 870 °F.

at the blower inlet. The maximum cylinder pressure at full load was 720lb./in.^{2} and the corresponding fuel consumption was stated to be 0·384lb./b.h.p.-hr. The engine-driven auxiliaries comprise a bilge pump and circulating pump (which are interchangeable), two lubricating-oil pumps and an air compressor, all driven from an extension of the main crankshaft at the forward end of the engine.—*"The Motor Ship", Vol. XXV, No. 298, November, 1944, pp. 256-258.*

Fairbanks-Morse Opposed-piston Diesel Engine.

Although the Fairbanks-Morse opposed-piston high-speed Diesel engine was first put on the American market over 10 years ago, its design is little known to commercial users because the entire output of these engines has been taken by the U.S. Navy. It is now anticipated that engines will be available for commercial use in the near future. Although the F.M. engine embodies the opposed-piston principle which is such an outstanding feature of the slow-speed Doxford marine engine, its design and principle of operation differ radically from those of the latter unit. The F.M. engine has two crankshafts, one above and one below the cylinders, connected by a vertical shaft and bevel gears so that the motion of the upper and lower shafts is synchronised. The principle of operation is as follows: Starting with the two pistons in any one cylinder at their extreme outer position, both the pistons move inward and compress the air between them. Near the end of this inward stroke fuel is injected through an opening in the cylinder wall at the middle of the cylinder and combustion begins. The resulting pressure forces the two pistons outwards, the upper one turning the upper crankshaft and the lower piston the lower shaft. The vertical shaft and bevel gears connecting the two shafts transmit the power of the upper one to the lower crankshaft, the latter being connected to the propeller shaft. As the pistons approach the ends of their outward strokes the lower piston uncovers a row of exhaust ports in the cylinder wall which enable the gases to escape to the exhaust manifold. Shortly after this the upper piston uncovers a row of scavenging ports in the upper end of the cylinder and scavenging air from the scavenging manifold blows through the cylinder, forcing out the remaining gases and filling the cylinder with fresh air, after which the cycle of operations is repeated. The scavenging-air ports are positioned tangentially to the cylinder bore, in order to give the entering air a swirling motion. Practically no cast iron is used in the engine structure, the bedplate and frame being of welded steel construction. The top and bottom of the crankcase are formed of diaphragms or division plates which are bored to receive the cylinders. Each cylinder unit comprises a C.I. liner and a steel water jacket, the latter being rolled from sheet steel and welded before being hydraulically pressed on the liner. The complete cylinder is then inserted in the bore in the crankcase housing. Three trunks are formed in this housing, two of them located in way of the exhaust ports and constituting exhaust trunks, whilst the third surrounds the scavenging ports and serves as a scavenging-air receiver. The exhaust trunks are connected to two water-cooled elbows bolted to the front of the crankcase housing. The ends of the cylinder liners extend through the scavenging-air receiver and are provided with external fins to promote cooling of the liners by air. The chrome-nickel-molybdenum steel crankshafts run in forged-steel bearings lined with whitemetal. At the forward end of the lower shaft is a gear train that drives a pump assembly comprising two circulating-water pumps and an oil-circulation pump, and a vertical shaft which operates the hydraulic governor. The pump assembly and governor are mounted on the outside of the crankcase housing, the former below and the latter above the exhaust elbows. A vibration damper is fitted between the auxiliary drive and No. 1 crank. The flywheel, with the hand turning gear, is at the after end of the engine. The two camshafts, mounted inside the housing just below the level of the upper crankshaft, are chain driven from the forward end of the latter. On a small extension from this end of the crankshaft is mounted the starting-air distributor. On the after end of the upper crankshaft is a helical spur gear for driving the scavenging-air blower and a short distance forward of it is a helical bevel gear, which, with a similar gear on the lower crankshaft, forms a part of the connection between the two shafts. Meshing with these gears are two pinions, one on each end of a vertical shaft mounted in roller bearings. This vertical shaft is made in two parts, connected by a flexible coupling. The C.I. oil-cooled pistons are chromium plated and are each fitted with seven rings, four pressure rings near the top end and three scraper rings in the skirt. A separate fuel-injection pump is provided for each cylinder. It is mounted on the side of the cylinder it serves, immediately under the camshaft. The pump plunger is actuated directly by its cam and the usual pump arrangement is reversed, the discharge being at the bottom end of the pump instead of at the top. This arrangement reduces the length of the connection to the fuel-injection valve which is located horizontally in the cylinder wall. The scavenging-air blower is of the multiple-spiral-lobe, positive-displacement type, and forms a self-contained unit in a housing bolted to the after end of the engine housing. Although the engine is totally enclosed, its various moving parts are readily accessible through large removable plates. The Fairbanks-Morse engine, commonly referred to as the DP type, is made in a range of sizes with from three to ten cylinders, the largest model having a continuous power output of 1,500 b.h.p. The output per cylinder at 720 r.p.m. is about 150 b.h.p. The cylinders in the standard models have a diameter of 8½in. (216 mm.), with a stroke of each piston of 10in. (254 mm.). The weight of the bare engine is approximately 25lb./b.h.p. As all the U.S. submarines with F.M. engines are electrically driven, their engines have not had to be made reversible.—*"Motorship", Vol. XXIX, No. 9, September, 1944, pp. 790-794.*

Minimum Number of Cylinders for Marine Diesel Engines.

That any Diesel engine should have 12 cylinders would seem to be unnecessary, especially if it is of the two-stroke type; yet the two-stroke engines of the Dutch liner "Oranje" have this number of cylinders. Among the various factors affecting the problem of how many cylinders to employ for a given type of Diesel engine is the vibration due to the reciprocating parts being out of balance and to the thrusts on the guides (or the cylinders of trunk-piston engines) produced by the obliquity of the connecting rods. Obviously, the greater the number of thrusts on the guides or working strokes per minute for a given power, the less the force of each. Therefore, in a two-stroke engine with every down-stroke a working stroke, there is only half the vibration experienced with a four-stroke unit having the same number of cylinders and running at the same r.p.m. The fact that four-stroke engines can be run at higher speeds is scarcely applicable to direct-coupled engines in ocean-going ships. In the case of a three-cylinder steam engine it is possible to achieve almost complete balance of the reciprocating parts by making the pistons of the same weight, but as such an engine is double-acting, a single-acting two-stroke Diesel engine would have to have six cylinders to obtain equally small thrusts on the guides. Alternatively, a three-cylinder engine must have 12 cylinders to give such small thrusts on the guides, but the balancing would be perfect. As regards the balancing of the reciprocating parts, the opposed-piston type of engine in which the moving parts for the upper piston balance those for the lower one, is perfectly balanced with a single cylinder. The intensity of the thrusts on the guides, however, is governed by the number of working strokes per minute, and partly because of this, the minimum number of cylinders employed in any Doxford engine is three. All structures have some spring in them and if flexed one way will spring to and fro with a certain frequency per second. However much the foundation for an engine in a ship is strengthened, the engine will rock slightly on it, due to the thrust on the guides. If the frequency per second of the engine rock is a multiple of the thrusts on the guides, excessive vibration may occur. For example, should the natural frequency of the engine rock be 144 times a second and the thrusts on the guides be 12 times a second, the rock on the engine may build up until excessive vibration occurs. Most marine engines have critical speeds at which this takes place, and the aim of the designers is to avoid critical speeds near the normal running speed of the engine. Not only may an engine rock on its foundation, but the structure of the ship may twist with it, especially if the engine is installed aft. Some of the early Diesel-engined cross-Channel ships vibrated badly because their four-stroke engines had too few cylinders. At the present time only three British engine-builders are making large four-stroke propelling engines and all of these have at least eight cylinders, but it is doubtful whether eight-cylinder four-stroke direct-coupled engines are sufficiently free from vibration for passenger ships at their usual speed of round about 115 r.p.m. As regards direct-coupled engines generally, six cylinders should give smooth enough running for two-stroke engines, and 12 cylinders for four-stroke engines, these numbers giving 690 working strokes per minute. In twin-screw ships there is always the chance that the thrusts on the guides will synchronise in both engines, so that it would not be safe to reduce the numbers of cylinders. Another factor affecting the numbers of cylinders is the power required. Most engine-builders make a limited number of cylinder sizes, but by juggling with the numbers of cylinders and modifying the r.p.m., they can quote for any power that may be asked for. From the point of view of fore-and-space taken up by machinery, however, the minimum number of cylinders is advantageous.—*W. O. Horsnaill, "Shipping", Vol. XXXIII, No. 388, November, 1944, p. 30.*

A Remarkable Diesel-engine Bedplate Repair.

Some time ago, a disastrous fire occurred in the engine room of the Anglo-Saxon Petroleum Co.'s tanker "Trocas", while she was in a New Zealand port. The ship in question is a single-screw motor tanker of 7,400 gross tons with a 6-cylr. Werkspoor engine developing 3,500 b.h.p. at 92 r.p.m. The cylinders have a diameter of

820 mm. and the piston stroke is 1,500 mm. An immense amount of damage was caused by the fire, and an examination of the massive cast-iron bedplate of the main engine revealed the existence of numerous cracks—some ¼in. or more in width—distributed over its entire length. These cracks were caused by the rapid influx of cold water, the chilling effect of which on the heated bedplate led to rapid and non-uniform cooling, sufficient to create high temperature stresses. The six-throw crankshaft is in two parts, connected by a coupling at the centre of the engine and weighing over 70 tons. The C.I. bedplate is of the box type, with internal stiffening diaphragms and webs. It was made in four sections, bolted together, and the whole bolted to the tank, the total weight of the casting being just under 96 tons. Fortunately, the crankshaft had suffered practically no distortion, the misalignment being no more than 0·004in. at the centre coupling. The deflection of each crank was carefully measured, with satisfactory results. To prevent any extension of the cracks, a ½-in. hole was drilled at the end of each, after which the cracks were drilled at intervals, and 1-in. Whitworth plugs were inserted in the holes to prevent the approximation of opposite edges under the influence of the binding members, subsequently applied. It was decided to encase the entire bedplate in a fabricated shell of ⅞-in. steel plates secured to the sides and ends of the bedplate, the whole structure then being bound together by external members in the form of fabricated T-bars. The bottom horizontal flange of the bedplate, through which the holding-down bolts passed, was first reinforced by the addition of a horizontal plate, 1⅛in. thick and extending 6in. beyond the outer edge of the existing flange. This involved the employment of new and longer holding-down bolts. End and side panels of ⅞-in. steel plate, prepared from templates, were then fitted to cover the exposed surfaces of the bedplate, being cut away at the lightening holes to accommodate the rims of the latter. Each of the side panels was in four sections, corresponding to those of the bedplate, the plate panels and end plates being secured to the bedplate by fitted bolts. Welds were made at the junctions of the end and side panels, and connection between the lower edge of the vertical panels and the inner portion of the additional flangeplate and the base was likewise made by a run of welding. The top of the bedplate was reinforced by the addition of 1⅛-in. horizontal flanges, secured by 1-in. Whitworth bolts and projecting 6in. beyond the exposed faces of the vertical side panels, to which they were attached by fillet welds (on the underside), the projecting edges being supported from below by vertical brackets welded to the vertical panels and to the underside of the new flange plate. In order to guard against the possibility of any "working" of the bedplate due to the presence of numerous cracks, it was thought desirable to add tension members to the structure in order to ensure its rigidity. Two heavy T-bars —an upper and lower, fabricated from steel plate (6in. by 1in. in section) by welding—were fitted at each side for the full length of the bedplate, with extensions round its ends. To begin with, these T-bars were freely supported in position by temporary cleats, lightly tacked to the vertical panels, but they were not themselves directly attached to the structure. The T-bars were divided at the mid-length of the bedplate, where they terminated in double eyes arranged to take 3-in. diameter shear bolts or shrinking pins. Initially, these holes were non-concentric, the T-bars being about ¼in. short as a result of the contractions which had occurred during the making of the welded joints of these members. This had, of course, been foreseen and was provided for. In addition to these external reinforcements, the end plates were tied together by internal longitudinal T-bars (fabricated from 9-in. by 1-in. plates) at the level of the lower external T-bar. These internal members were in four sections, corresponding to the four sections of the bedplate, and were welded at their extremities to the end plates and to the 1⅛-in. plates bolted to the vertical transverse webs at the junctions between contiguous sections of the bedplate, where bridge or saddle pieces, bolted to the vertical webs of the internal T-bars, were fitted to assist the maintenance of continuity across the web. Intermediate transverse webs within the bedplate were notched to accommodate the horizontal flange of the T-bars, which were supported by diagonal bracing from the underside of the top of the bedplate. These internal longitudinal members were fitted to counteract the leverage effect on the end plates, of the external T-bars, which were eventually to be put in tension. When all this work had been completed and all bolts securely tightened, semi-circular sheet-metal casings were suspended over the top and bottom longitudinal stiffeners in turn, and the flame from a large blow-lamp was directed fore-and-aft from the centre through these shrouds. In less than one minute the rise of temperature was sufficient to cause the T-bars to expand ¼in., thus making up the amount of the shortage previously referred to. The shear bolts were then dropped into their holes and lightly knocked "home", after which all the bolts and plugs were tested to ensure that conditions were everywhere satisfactory. The concluding operation was the welding of the stressed longitudinal T-bars to the side panels in order to bind the whole structure firmly together. The repair work was then regarded as complete, and the temporary cleats were removed. Frequent checks of alignment and defection were made as the work proceeded and never at any time was there any detectable movement of the structure. A further examination was carried out on completion of the work, with highly satisfactory results, whereupon the crankshaft sections were recoupled. The alignment was again subjected to test after dock trials had been carried out, when a thorough examination of all bearings was also made. Nowhere was there any sign of overheating, and the alignment remained accurate. The "Trocas" thereupon proceeded to sea under her own power and made a lengthy voyage, without incident, before her arrival at a British port to discharge a full cargo. The whole of the repair work described above was carried out under the direction of the owners' technical staff by local repairers working in conjunction with the E.R. staff of the ship under the chief engineer, Mr. W. H. Ryland, O.B.E.—*"The Shipbuilder", Vol. 51, No. 427, November, 1944, pp. 385-389.*

Gearing and Direct Drive Compared.

Although more than 1,000 Victory ships are to be constructed, of which over 500 are already built or building, it would appear that only one is to be propelled by Diesel machinery, *viz.*, by a s.a. two-stroke Nordberg engine of 6,000 b.h.p. designed to run at a normal speed of 160 r.p.m. and directly coupled to the propeller shaft. It is reported that U.S. engine builders favour the employment of geared Diesel machinery or Diesel-electric drive for installations of this power, and that the order for the direct-drive 6,000-b.h.p. Nordberg engine was to be considered as more or less experimental, with a view to an investigation of the possibilities of the direct drive. An installation of this power comprising two smaller engines driving the propeller shaft through gearing would give greater flexibility and should be easier to maintain. Furthermore, the propeller would normally run at only 90 r.p.m. As against this, the geared Diesel or Diesel-electric installation would have a slightly lower propulsive efficiency than a direct-coupled Diesel engine, despite the relatively high propeller speed (160 r.p.m.) of the latter. The first cost of the direct-drive 6,000-b.h.p. would also be 10-12 per cent. lower than that of a geared or Diesel-electric installation. The overall fuel consumption of the 6,000-b.h.p. Nordberg engine is not expected to exceed 0·38 to 0·39lb./b.h.p.-hr., and the builders claim that they have demonstrated that it is capable of operating satisfactorily on "very heavy fuel oil" if the latter is properly handled and heated.—*"The Motor Ship", Vol. XXV, No. 298, November, 1944, p. 238.*

Canadian-built Diesel Engines.

The first of the 6-cylr. 200-b.h.p. Atlas Imperial Diesel engines to be built in Canada by Heaps Engineering (1940), Ltd., New Westminster, B.C., has been installed in the 78-ft. fishing boat "Western Warrior", which recently completed successful sea trials. The engine is a four-stroke unit with cylinders 10in. (245 mm.) in diameter and a piston stroke of 13in. (330 mm.). It develops its rated output of 200 b.h.p. at 325 r.p.m. The "Western Warrior" is reported to have attained a speed of 10·7 knots on trial. The Canadian builders of Atlas Imperial engines are the sole licensees in the Dominion of the U.S. makers of these units in Oakland, Cal., and produce them for Canadian Atlas Diesel Engines, Ltd., Vancouver, who are the agents for the U.S. firm. Several more such Canadian-built engines have been or are being installed in West Coast fishing craft, and a number of others have been despatched to Ontaria where they are fitted in some new tugs under construction there for British owners.—*"Canadian Shipping and Marine Engineering News", Vol. 16, No. 2, September, 1944, p. 68.*

Lighter Lubricating Oil for Diesel Engines.

Whereas it used to be believed that the more viscous and heavy the lubricating oil, the more suitable it was for large slow-running Diesel engines, it is now recognised that lighter lubricating oils are in many cases more satisfactory for this service because they reduce the amount of carbon deposited around the exhaust ports of 2-stroke engines, and do not give rise to fires in scavenging trunks, such as are liable to occur with heavier lubricating oils. It is generally considered that these fires arise when the scavenging belt is maintained dry, and that if the belt is kept slightly wet with lubricating oil, the fires do not occur. This belief has impelled some engineers to keep the belt wet by using an excess of lubricating oil (thus increasing the consumption), although this practice, where heavy oil is utilised, causes sludge deposits of considerable depth to accumulate in the scavenge trunk. By using lighter oil, however, it is possible to maintain the same degree of wetness with a smaller excess (probably due to a better permeation of the oil), thereby eliminating the risk of scavenge-trunk fires without the accumulation of heavy sludge deposits. The lubricating-oil consumption when employing the lighter oil is therefore lower, and, moreover, the same grade of oil can also be used for the bearings. In the case of a twin-screw motorship with d.a. 2-stroke machinery of 12,000 b.h.p., the lubricating-oil consumption was 25 gall./day when using heavy cylinder oil with a viscosity of 340 secs. at 140° F., and there were heavy carbon deposits as well as occasional scavenge-trunk fires. A six-months' trial was then given to an oil with a viscosity of 270 secs. at 140° F., and this, it was found, reduced the consumption to between 20 and 22 gall./day, with less carbon deposit and fewer fires in the scavenge belts. Further tests were then carried out with oil having a viscosity of 197 secs. at 140° F., and this reduced the daily consumption to 16-18 gall., with little or no carbon deposit and not a single scavenge-belt fire throughout the trial period of six months.—*"The Motor Ship", Vol. XXV, No. 296, September, 1944, p. 171.*

Partially-insulated British Standard Cargo Ships.

The urgent demand for additional refrigerated tonnage made it necessary to adapt a number of the M.W.T. "B" type standard cargo steamers for the carriage of frozen meat, for which a temperature of 15°-16° F. is necessary. The vessels in question were therefore fitted with refrigerating machinery for the maintenance of this temperature in three of their cargo holds and associated 'tween-deck spaces, which were insulated for the purpose and equipped with the requisite air trunking, etc., as shown in the accompanying sectional elevation and plan (Fig. 1). The total net insulated capacity of these spaces varies slightly in individual ships, the average being about 288,000 cu. ft. The shortage of certain materials normally used for insulating cargo spaces in ships made it necessary to employ alternative substances for this purpose. Thus, slag wool of a water-repellent type was utilised for the ship's side and bulkhead insulation instead of the granulated cork which is ordinarily used for these surfaces, while composite boards of hardwood and fibre (consisting of a $\frac{3}{16}$-in. facing of hardwood bonded to $\frac{1}{2}$-in. compressed fibre board) were used instead of wood for the insulation lining. The fact that only one temperature had to be maintained throughout the refrigerated spaces made it unnecessary to insulate the second deck independently of the hold, but in order to reduce the heat-input from the ship's sides through this deck, the insulation on the underside was carried inboard for a distance of about 3ft. 6in. from the shell. A considerable saving in the amount of timber (white-wood) required for the insulation grounds was effected by the adoption throughout of a standard timber scantling of 3in. by 2in. at the ship's sides, bulkheads and overhead. The tank-top insulation consists of two 3-in. thicknesses of slab cork, set in bitumen, directly on the inner-bottom plating, overlaid with 2in. of asphalt in two layers, the upper one ($1\frac{1}{4}$in. in thickness) being reinforced with steel mesh. The arrangements at the bilges follow normal practice, the insulation consisting of granulated cork between tongued and grooved boards. The shaft tunnel is insulated in the same manner as the ship's sides, except that timber (or, in some of the vessels, steel plating) replaces the laminated board. Normal type insulated hatch plugs of simplified construction are employed for the upper-deck cargo hatchways, tank-top manholes and bilge limbers, but no insulated plugs are fitted to the second-deck hatchways, the covers of which are of the usual wood type. A freezing temperature is maintained in the refrigerated-cargo spaces by the circulation of cold air on a closed system. Two fans and two air-cooling batteries are provided for each of the three pairs of refrigerated holds and 'tween-deck compartments, the air drawn from these spaces being delivered through the coolers to overhead perforated trunks adjacent to the cargo hatches and to similar transverse ducts at the bulkheads. The capacity of the fans is such that 20 changes of air per hour in the holds and 30 changes of air per hour in the 'tween-deck spaces can be provided, the actual quantity of air delivered to any one compartment being controlled by means of baffles and shutters in the trunking. The air-cooling batteries are of the cross-grid, direct-expansion type, whilst the motor-driven fans are of the screw type. The latter are reversible and their motors are fitted with controllers. The ammonia refrigerating plant is installed in a 'tween-deck compartment abaft the engine room, and includes two NH_3 compressors, each driven (through V-belting) by a 75-h.p. vertical compound steam engine; two coil-type condensers with C.I. cylindrical casings; one horizontal, centrifugal S.W. pump, capable of delivering 25,000 gall./hr. against a head of 20lb./in.^{2}, and directly driven by a 10-h.p. electric motor; and the necessary NH_3 stop valves, separators, gauges, master regulators, etc. The NH_3 plant is capable of maintaining a uniform temperature of 15° F. throughout the insulated spaces under tropical conditions with a sea-water temperature of 85° F. The ships concerned have already completed a number of voyages, and it is authoritatively stated that the condition of the refrigerated cargoes which they have discharged in various ports in this country has always proved to be eminently satisfactory.—*"The Shipbuilder", Vol. 51, No. 427, November, 1944, pp. 390-394.*

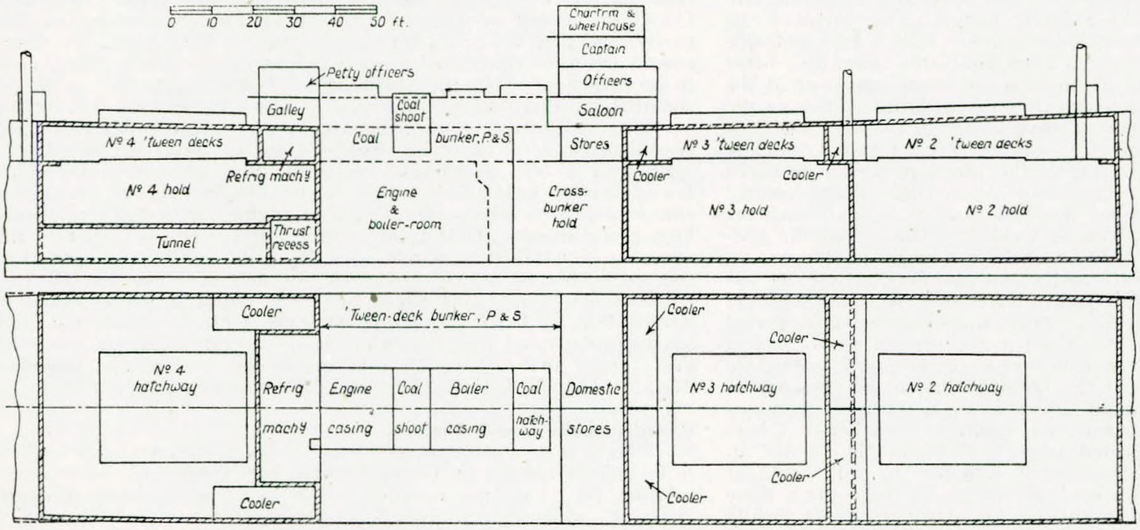

FIG. 1.—*Typical Disposition on Insulated Cargo Spaces.*

Development, Principles and Application of the Combustion Turbine.

The paper begins with an outline of the historical development up to about 1900, after which more recent developments are discussed in some detail and against the contemporary background of technical progress. Descriptions are given of installations employing combustion at constant volume and at constant pressure, and a comparison is made between the pressure and temperature conditions in the two types. The principles governing the operation of constant-pressure installations are explained, and examples are given of modern types and applications. Comparisons are made, as regards fuel consumption and air utilisation, of eleven possible combinations of components. The conditions under which marine installations would be required to operate are analysed, special consideration being given to air temperatures. Methods of meeting this requirement are suggested, and the main features of a typical installation for a merchant vessel are given by way of example. In conclusion, the design of the necessary components is considered and the requirements of satisfactory performance from each component are discussed, as well as the influence of each on the overall efficiency of the plant.—*Paper by S. J. Davies, D.Sc.(Eng.), Ph.D., and M. I. Fawzi, Ph.D., "Transactions of the Institute of Marine Engineers", Vol. LVI, No. 12, pp. 239-251.*

Some Factors Affecting I.C. Engine Lubrication.

The author states that his purpose is the provision of a few notes on lubrication which should be of interest to users of oil engines. The various sections of his paper deal with types of lubrication; the aim of the engine designer; viscosity of lubricating oils; forced-lubrication pumps, oil coolers and automatic by-pass valves for same; conditions in the lubricating system and bearings of the engine; and some suggestions for improving starting conditions. The author advocates the employment of a hydraulically-operated "spill" valve or monitor instead of a relief valve of the orthodox type for the engine-oiling systems of heavy oil engines, and the concluding part of the paper is devoted to a description, illustrated by means of a schematic diagram and graphs, of the arrangement and operation of a "Tanway" pressure monitor as applied to a forced-lubrication system of such an engine. Some details of the design and construction of this type of pressure monitor, together with a number of illustrations, are likewise given.—*Paper by C. C. Higgens, read at a meeting of the Diesel Engine Users' Association on the 9th November, 1944.*

Diesel-engined Patrol Craft for Rescue Service.

Among the smaller types of naval vessels recently built in America are 20 Diesel-engined patrol and escort craft constructed by the Pullman-Standard Mfg. Co., Chicago. Although primarily designed for patrol and escort duties, these ships are specially equipped for the accommodation of rescued personnel from vessels sunk during an ocean crossing. They are twin-screw craft with a displacement of about 800 tons and an o.a. length of some 180ft. Their armament includes a 3-in. gun, a number of 20-mm. A.A. guns, depth-charge racks and throwers. Accommodation for about 100 passengers is arranged for in an extended deck-house. Several of these PCEs (as they are designated) have been further adapted to serve as hospital ships while on convoy duty. The PCE (R) 853, for instance, has bunks for 57 passengers and very complete hospital equipment, including a medical officer, operating theatre, dispensary and X-ray machine. Such a ship, it is claimed, may save many injured men the ordeal of long hours at sea without adequate medical attention. The propelling machinery of these craft consists of two G.M. Diesel engines in separate engine rooms and driving the propeller shafts through reduction gearing. The speed is approximately 20 knots. Electric current is furnished by three Diesel-driven generators. The complement numbers seven officers and 100 men, and the total cost of each vessel is stated to have been between $1,000,000 and $1,500,000. Several of these PCEs have been turned over to the Royal Navy, and one—H.M.S. "Kilbirnie"—is reported to have destroyed one or more enemy aircraft in a recent action.—*"Motorship", Vol. XXIX, No. 9, September, 1944, pp. 784 and 821.*

The Motorship "Royal Scotsman".

A recent Admiralty statement has drawn attention to the valuable services rendered during the present war by the Burns and Laird motorship "Royal Scotsman", which like her sister ship "Royal Ulsterman", was built in 1936 by Harland and Wolff for the company's passenger and cargo service between Glasgow and Belfast. These 3,250-ton vessels are each equipped with two Harland-B. & W. standard s.a. two-stroke engines developing a total of 5,500 b.h.p. and giving them a maximum speed of 19 knots. The "Royal Scotsman" was at the evacuation of Narvik and Bordeaux, being packed to the E.R. platforms with troops and civilians of many nationalities. She transported troops to Iceland and West Africa before being converted to a landing ship (infantry) in readiness for the North African operations. After this campaign, she returned to the U.K. for a minor refit and then went back to Algiers. She later proceeded to Malta and then to Bombay, after which she returned to the Mediterranean to become the flagship of Rear-Admiral Troubridge. The ship also played an important part in the invasion of France, and has covered altogether 50,000 sea miles since the outbreak of war. It is recorded in the Admiralty communiqué that the E.R. staff of the "Royal Scotsman" are proud of the fact that her engines have never broken down.—*"The Motor Ship", Vol. XXV, No. 298, November, 1944, p. 263.*

1,500-s.h.p. Diesel-electric Rescue Tugs.

As a result of the war, considerable experience has been gained in this country with high-powered Diesel-electric tugs, and some of the American-built 143-ft. rescue tugs constructed for the U.S. Navy have, it is stated, also been placed in the service of the Royal Navy. They have been operating in the Pacific and Atlantic, in the Mediterranean, the Indian Ocean, and around Iceland. Some are in Australian waters. These tugs are sturdy ocean-going craft of all-welded steel construction, 143ft. in o.a. length, 33ft. in breadth and 17ft. in depth amidships, with single screws driven by two 750-s.h.p. propulsion motors through reduction gearing. The full power of the motors is developed with the propeller turning at from 160 to 200 r.p.m., according to the nature of the tow, the necessary adjustment being effected through the variation of the strength of the main motor field. The current for the propulsion motors is supplied by two 605-kW. d.c. generators, directly driven at 750 r.p.m. by two standard type 12-cylr. G.M. Diesel engines. Current for the auxiliaries and other purposes is furnished by two 60-kW. Diesel-driven dynamos. The total amount of fuel oil carried is 196 tons, which is sufficient to permit one of these tugs to make a 25-day voyage at full speed without re-fuelling. The deck equipment includes an automatic towing winch, designed for a pull of 20,000 to 30,000lb. on automatic control, and a 100,000-lb. pull on manual control. Excellent accommodation is provided for a crew of 40 officers and men. The tugs have, it is said, already carried out a large amount of important salvage and towing work.—*"The Motor Ship", Vol. XXV, No. 296, September, 1944, p. 197.*

New Clarke Chapman Electric Winch.

Many of the merchant ships recently built in this country have been equipped with 4-ton and 5-ton cargo winches of the latest Clarke, Chapman, motor-driven type. All the working parts are enclosed and guards are fitted over the centre barrel and warp end flanges to prevent slack rope from being jammed. The contactor gear and control resistance are arranged in the bedplate, and as no ventilators are provided, the whole of this mechanism is watertight. A worm drive is taken to the winch from the motor, which, in the 5-ton type, is rated at 43 b.h.p. The 4-ton winch has a lift of 100-110ft./min., a 2-ton load being raised at 200-220ft./min., while the light hook speed is 450ft./min. The 5-ton winch has a lifting speed of 100ft./min., and with a load of 3 tons the speed is 120ft./min., while 1½-ton loads are raised at 240ft./min. The C.I. winch barrel is 20in. in diameter and 24in. long, whilst the two warping ends are each 18in. in diameter and 20in. long. The worm gear runs in an oil-bath and the shaft is fitted with roller bearings, while the adjustable bearings of the barrel shaft are or gunmetal, lubricated with grease. The forged-steel worm engages a phosphor-bronze worm-wheel rim, which is bolted to a C.I. centre. A watertight foot brake is fitted on the end of the worm shaft, and the motor is equipped with a disc type magnetic brake. The latter has means for external adjustment and is provided with a hand release. All the control-circuit windings, brake and motor shunt windings are designed for a continuous rating with a maximum temperature rise of 72° F. The motor is of the watertight deck-mounting type, and the control gear incorporates a device to ensure the correct time of acceleration should the winch operator swing the master controller handle from the "off" position to "full-on" without a pause at any of the steps. No-load and overload protection allows the controller to be moved from "full-hoist" to "full-lower", notwithstanding the load on the winch, without flashing or damage. The high speed obtainable with a light hook (and at 1½ tons' lift) is due to the provision of a load-discriminating relay. The application of the foot brake operates an automatic switch in the winch bed which brings the control back so as to make it equivalent to the first step, thereby protecting the motor from damage by stalling. The controller is of the reversing drum type, watertight and located on the top of the motor commutator cover. The winch is intended for a 220-volt d.c. supply from the ship's mains and is a self-contained unit ready for connecting to the cables on board. It is commendably quiet in operation.—*"The Motor Ship", Vol. XXV, No. 296, September, 1944, p. 191.*

Marine Electrical Work.

The theme of the inaugural address delivered on 12th October to the Installations Section of the Institution of Electrical Engineers by Mr. G. O. Watson, was the "Future of Electrical Engineering in the Merchant Navy" and, more especially, the training and education of sea-going electrical engineers. He declared that the quality and reliability of the electrical equipment in British ships was higher to-day than ever before, as comparative freedom from fires and other troubles showed, but that this fact had been used as an argument against improving the qualifications and responsibilities of electrical superintendents and electricians. This had caused the initiative in any new direction to be taken by manufacturers instead of by those whose duty it was to study operating results and capital charges in relation to economy if British ships were to maintain their competitive position. For instance, there was a tendency in some countries to adopt a.c. instead of d.c.; the advisability of departing from existing British practice and the problems which were associated with variable-speed drives should be studied in a scientific manner. The two main problems to be dealt with in organising a satisfactory system of training were (*a*) the running and maintenance of electrical installations at sea, and (*b*) progressive planning for future development and organisation at headquarters. The two problems were inseparable because executives were promoted from the lower ranks. The speaker urged that engineers educated at universities and technical colleges and drawn from manufacturers' works should be encouraged to become sea-going electricians. The present electricians had generally adopted their calling by chance, having been perhaps wiremen or contractors' charge-hands who had remained with the ship but were without any encouragement to improve their position by study. Two types of men were required, the first being professional engineers ranking as officers with a status similar to that of marine engineers and similarly graded. The junior ranks would be uncertified, but their sea service on electrical work should qualify them for promotion (which it does not now) after examination, coupled with prescribed workshop experience. Suitable qualifications would be the Higher National Certificate in Electrical Engineering or the A.M.I.E.E. examination. Youths should be allowed one free day a week to attend classes, while those at sea might undergo intensive short courses supplemented by postal tuition. The second type of electrical man should have passed a suitably modified City and Guilds examination, the course including the I.E.E. Regulations for the Electrical Equipment of Ships instead of those for buildings. This would be combined with an apprenticeship to a firm engaged in the installation or maintenance of ships' electrical equipment. The Institute of Marine Engineers had formulated proposals for the education and training of their members, and the speaker considered that similar representations should now be made on behalf of marine electricians. During the course of his address, Mr. Watson mentioned that the first record of the use of electricity in the Merchant Service (the Royal Navy had adopted it earlier) was in 1879 when the saloon of the P.S.N. Co.'s new s.s. "Mendoza" was lighted by means of a Gramme dynamo and arc lamps. In 1883 the Swan United Electric Light Co. recorded the names of 25 ocean-going steamers equipped with electric light, the largest being the Cunard s.s. "America", which had 550 Swan lamps and four dynamos. In 1891 Lloyds issued rules relating to the use of electric light in vessels, probably the first code for electrical installations ever drawn up.—*"Electrical Review", Vol. CXXXV, No. 3,491, 20th October, 1944, p. 548.*

Electric Cables in Ships.

Despite the improvements which have been made in the design and construction of electrical machinery and equipment on board ship, failures due to faults in the wiring are still liable to occur. In this connection, however, it is claimed that the recently developed mineral-insulated cables possess a number of advantages; in addition to being fire-resisting, they are mechanically strong and will stand up to all conditions of wind and weather. One common cause of failure arises from the practice of running cables over metal parts against which they rub so that eventually "earthing" occurs, irrespective of the nature of the insulation. The slinging of cables from point to point instead of supporting them over their entire length, also leads to working and eventual failure of the insulation. Again, there is a tendency for moisture to accumulate in controller boxes, etc., not so much on account of leaky glands where the cables enter, but owing to condensation of moisture in the air. Variations in barometric pressure lead to a constant changing of the air in the boxes, and as differences in temperature result in the condensation of the moisture which it contains, this moisture must have an adverse effect unless the insulation is not only water-resisting but absolutely non-absorbent in water.—*"Shipbuilding and Shipping Record", Vol. LXIV, No. 15, 12th October, 1944, pp. 338-339.*

Electrical Machinery for Use with Ships' Auxiliaries.

The author discusses the dynamical and thermal characteristics of electric motors for auxiliary services, the stray losses which occur in them and arrangements for cooling such machines by forced convection. Commutation, noise characteristics and insulation are likewise discussed, and the interdependence of some of these headings is explained. A note is given on the problems arising from the loss of lubricant from the anti-friction bearings of totally enclosed motors and from the accumulations of condensate inside such machines. The question of utilising alternating current drive for auxiliary machinery is examined, and the various types of polyphase a.c. motor which might be used for this purpose are briefly surveyed. The concluding sections of the paper deal with high-starting torque squirrel-cage motors and booster control for d.c. motors.—*Paper by R. S. Blackledge, "Transactions of the Institute of Marine Engineers", Vol. LVI, No. 11, December, 1944, pp. 215-228.*

Refrigerated Cargo Motorships for Houlder Fleets.

During recent months, two large twin-screw refrigerated cargo and passenger motorships have been added to the fleet of the Houlder Lines, the vessels in question being the "Rippingham Grange" for the Houlder Line, Ltd., and the "Condesa" for the Furness-Houlder Argentine Lines, Ltd. They are sister ships of 10,367 gross tons, built and engined by R. & W. Hawthorn, Leslie & Co., Ltd., and their general design is very similar to that of the earlier cargo liners constructed by this firm for the same owners. The "Condesa" has four continuous decks, as well as a long bridge deck. The hull is divided into nine W.T. compartments and there are seven cargo holds with a total capacity of 473,170 cu. ft. for refrigerated cargo and 115,510 cu. ft. (grain) of general cargo. The insulation of Nos. 1 and 7 holds has been temporarily deferred, but when this work is completed, the ship will have over 70 separate refrigerated compartments. Up to 2,367 tons of water ballast can be carried in addition to 678 tons of fresh water and 1,500 tons of fuel oil, the latter amount being the total capacity of the seven deep tanks forward and six D.B. tanks aft adapted for use as fuel tanks. The forward D.B. tanks are not used for this purpose because of the risk of contaminating the cargo. The cargo-handling equipment includes a large number of 6-ton and 10-ton derricks, in addition to a 25-ton derrick at No. 3 hatch. The 22 cargo winches are of the steam-driven type, as are the anchor windlass and telemotor-controlled steering engine. Accommodation for 12 passengers is arranged on the boat deck, although 22 passengers are carried at the present time. All the ship's officers are berthed on the bridge deck, whilst the living quarters for the crew are on the shelter deck amidships. The total complement of the ship numbers 95, including gunners. The E.R. staff includes 14 engineer officers, of whom four are refrigerating engineers. The propelling machinery consists of two sets of 8-cylr. s.a. four-stroke Werkspoor engines of the supercharged type. The pistons and jackets of these engines are cooled with fresh water carried in D.B. tanks and circulated by motor-driven pumps. There are altogether six cooling-water pumps of the Mirrlees-Watson type for circulating fresh water and sea water. There are three Cochran oil-fired boilers for the supply of steam for auxiliary and heating purposes. The two wing boilers take the exhaust gases from the main engines, and when these are running at full power, all the steam required for such services can be provided by this means. The boilers operate on oil fuel when the ship is in port and cargo is being worked. The ship's electrical load is unusually heavy when the refrigerating plant is in use and the air-circulating fans (some 50 in number) are running. To meet these requirements there are four 300-kW. generators which supply direct current at 220 volts to the ship's mains. They are directly driven at 480 r.p.m. by four Ruston-Hornsby 6-cylr. four-stroke engines arranged for fresh-water cooling. The refrigerating plant is located in a flat on the port side of the main engine room, at the level of the cylinder tops of the main engines. This plant includes three CO_2 compressors driven by 185-h.p. electric motors. The brine-cooling plant is in a similar compartment on the starboard side of the main engine room. The "Condesa" is commanded by Capt. R. M. Smiles, O.B.E., whilst the chief engineer of the ship is Mr. J. A. Cochran. Both these officers have been with the Houlder Line for many years.—*"The Journal of Commerce" (Shipbuilding and Engineering Edition), No. 36,425, 9th November, 1944, p. 2.*

Prefabricated Suction Dredgers for U.S. Army Service.

The U.S. Army Engineer Corps is employing a number of transportable Diesel-powered suction dredgers of very compact design and fully equipped to operate in isolated locations for long periods. The 104-ft.×29-ft.×6-in. steel hull is made up of a number of prefabricated sections which are small enough to be transported by rail on standard trucks and to be shipped overseas as hold cargo. These sections have only to be bolted together at the site of erection, to produce a completely watertight hull. The latter supports a dismountable wooden deck-house about 72ft.×20ft.×10ft. 8in. When the dredger has served its purpose in one location, it can be dismantled and shipped to another site, if necessary. The main dredging pump has a 14-in. suction and a 12-in. discharge pipe, and is designed to deal with sand, clay and silt to a depth of 16ft., discharging the material through a maximum of 1,000ft. of piping at water level, or 500ft. of piping at a 30-ft. elevation. The pump is driven by an 8-cylr. Diesel engine of 320 h.p. Electric current for power and lighting requirements is furnished by an 85-kW. Diesel-generator set, in addition to which there is a 6-kW. auxiliary set. The dredger has a 36-ft. digging ladder with an adequate margin of overload capacity, and is fitted with interchangeable cutter heads to deal with the various types of materials which may have to be handled at different sites. The unit is equipped with a five-drum hoist that gives a very high rope pull at low speeds due to the special compound gearing used. Cone friction clutches are employed and a drum switch controlling the hoist makes its operation extremely flexible.—*"Motorship", Vol. XXIX, No. 9, September, 1944, p. 812.*

Marine Engine-building Activities of C.P.R. Workshops.

Notwithstanding the great amount of repair work to railway rolling stock made necessary by the greatly increased volume of traffic due to present-day conditions, the Canadian Pacific Railway Company's shops at Angus, Montreal, have been able to construct a substantial number of marine engines of the reciprocating type for single-screw corvettes and twin-screw frigates of the Royal Canadian Navy. Contrary to statements which appeared in the Press to the effect that the condensers for these vessels were ordered outside (*see abstract on p. 49 of* TRANSACTIONS, *May, 1944*), all the condensers were in fact produced in the Angus shops. The latter are now engaged on the construction of engines and condensers for twin-screw transport ferries (invasion barges) to the order of the British Admiralty, and the contract calls for a sufficient number of these components to keep the shops busy for many months.—*Communication from H. B. Bowen, Chief of Motive Power and Rolling Stock, Canadian Pacific Railway Company, Montreal, dated 12th September, 1944.*