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Marine Engineering and Shipbuilding Abstracts

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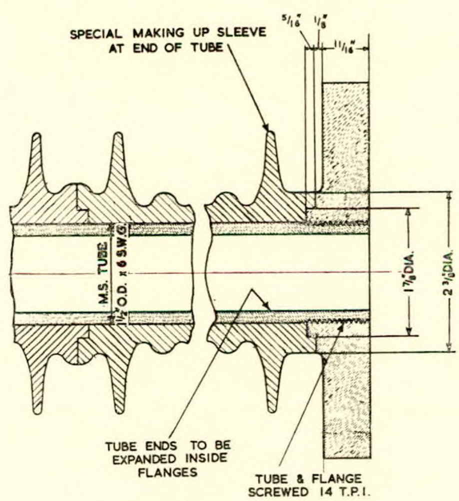
Solar Jupiter 500 h.p. Gas Turbine

The Solar Aircraft Company of San Diego has received a contract from the U.S. Navy to design, develop, test and deliver one packaged 300 kW, 60-cycle generating set, using the constant speed version of Solar's 500 h.p. Jupiter gas turbine engine as a prime mover. The set must be able to function automatically, and must be operative in ten seconds or less, after need arises. Purpose of the order is to determine the practicality of gas turbine driven generator sets for both emergency shipboard use and ships service use. In smaller vessels the unit could be used as the main source of electrical power and on larger ones as an auxiliary or emergency set. The Jupiter engine has already been under evaluation by the U.S. Navy in the 400-cycle emergency generator installed on board the experimental destroyer, U.S.S. *Timmerman*.—*The Marine Engineer and Naval Architect, September 1955; Vol. 78, pp. 361-362.*

Cast-iron Steel Tank Heating Coils

A new approach to the problem of corrosion of heating coils for cargo tanks of oil tankers is shown in the system recently introduced by E. Green and Son, Ltd., Wakefield. The heavy expenditure represented by the relatively short life of steel coils is well known to the shipping industry and this has resulted, within recent years, in the development of various types of cast iron heating coils and, more recently, the adoption of coils of light alloy. Following the use of steel tubes protected by shrunk-on cast-iron sleeves for withstanding the corrosive conditions in boiler economizers, Messrs. Green and Son have extended this practice in order to meet the requirements of tank-heating coils. The main advantage claimed is that the cast-iron shrouding gives complete protection to the steel tube without diminishing its flexibility. It is contended that there is no need for careful alignment during installation and that the whole system will adapt itself to movement of the ship's structure without imposing any strain on the flanged joints. The outer surface is designed so that the heat given by the condensing steam inside the tube can readily be transmitted to the oil and, as heating takes place by convection, the gills are disposed so that the convection currents are assisted to flow over the surface and not away from it. It is claimed that comparative tests have indicated that the heat transmitted to the oil per unit of external surface is actually slightly greater than that obtained with steel coils; it is believed that the probable reason for this is that the projection of the heating gills into the liquid assists in the formation of stronger and unresisted upward convection currents. Contending that the normal utilization of heating steam is wasteful and that owing to the condensate formations, the heat transference is at its maximum value for only a short

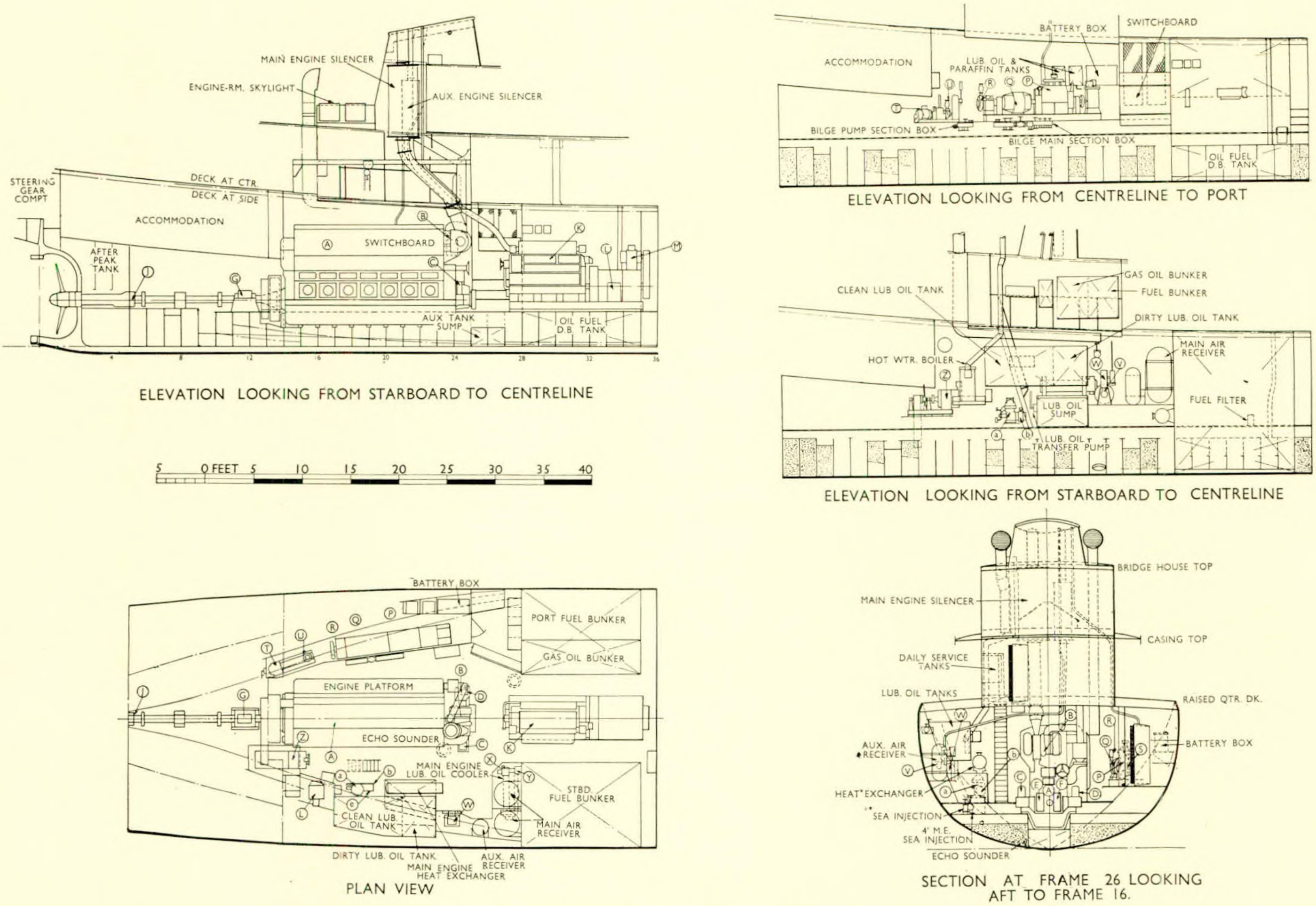


Section and details of the new heating coil

space of time, Messrs. Green and Son have developed a continuous drainage system: the individual pipe-runs fore and aft are connected in parallel to a steam inlet header and the pipe-runs fore and aft are connected in drain pots at the after end of each pipe-run. Arrangements are made whereby waterlogging is prevented and the discharge of condensate as it accumulates is almost continuous. It is said that the steam flow or the total heating time can be reduced by this system. The weight per square foot of heating surface of the new coils, allowing for supports and all ancillary material, is about 13 lb.—*The Motor Ship, September 1955; Vol. 36, p. 233.*

Trawler with High Pressure Diesel Engine

The motor trawler *Boston Neptune* was recently completed by the Goole Shipbuilding and Repairing Co., Ltd., to the order of the Boston Deep Sea Fishing Co., Ltd., of Fleetwood.



Engine-room plans of the Boston Neptune

The main feature in this vessel is the propelling engine which is believed to be the first Diesel engine fitted with intercoolers to be installed in a trawler. Built under the White Fish Authority scheme, the *Boston Neptune* has a registered length of 128 feet b.p., a moulded breadth of 26 feet 6 inches and a depth of 13 feet. The direct reversing main engine is a Mirrlees turbocharged four-stroke unit designed to develop 938 s.h.p. continuously at 250 r.p.m. Without the intercoolers, which are placed between the turbocharger and air manifold, the normal continuous rating would be 750 s.h.p. at 250 r.p.m. The seven cylinders have a bore of 15 inches and the piston stroke is 18 inches. At the normal output and speed the b.m.e.p. is 133lb. per sq. in., the mechanical efficiency is 85 per cent and the thermal efficiency is 39·9 per cent. On acceptance trials, with a draught forward of 6 feet 6 inches and aft of 15 feet 6 inches a speed of 15 knots was attained under adverse conditions with the engine developing approximately three-quarters full load. It is claimed that this engine has a fuel consumption as low as 0·34lb. per b.h.p. hr. at full load and 0·347lb. per b.h.p. hr. at three-quarters load. The average daily fuel consumption for the main engine is 2 tons and, for all purposes, the daily consumption is 2½ tons. Sufficient fuel can be carried for a trip of thirty-two to thirty-four days. As the engine room layout shows, a relatively simple and accessible installation has been achieved. The trawl winch generator developing 145kW is of the Ward-Leonard type.—*The Motor Ship, July 1955; Vol. 36, pp. 158–161.*

German A.C. Motor Drive for Deck Machinery

During the present year, considerable interest has been evinced in Germany in the employment of the three-phase A.C. motor drive for winches (also windlasses and capstans) in merchant ships. Nearly a dozen cargo vessels have been placed in service in which such A.C. motors are employed for practically all purposes, whilst an equal number is now on order. In these, the system employed for the winch drive is that developed by the Siemens-Schuckertwerke A.G., Erlangen, the motors being of the three-phase multi-speed pole-changing type with master-switch control and switching con-

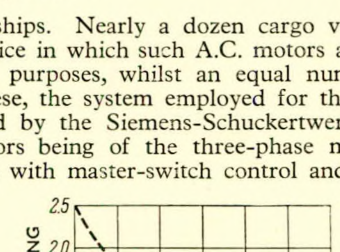


FIG. 1—*The lines 1, 2, 3 and I, II, III, show working conditions with a pole-changing a.c. squirrel cage motor (3-ton winch). Lines a, b, are for a d.c. motor*

tactors. By the choice of winch motors with 32 or 8 or 4 poles respectively, the following lifting speeds may be obtained corresponding to the curves shown in Fig. 1.

First step: About 0·15 metres per sec. or 29·15 ft. per min. for lifting and setting down.

Second step: About 0·65 metres per sec. or 128 ft. per min. for lifting heavy loads.

Third step: About 1·3 metres per sec. or 256 ft. per min. for bulk goods and heavy loads, at normal rating.

When lowering, the speed is only slightly higher than when lifting since the revolutions of the asynchronous motor changing from motor to generator operation vary very little. This has the advantage that the A.C. winch drive of this construction can also be used for a combined cargo and warping winch in which, in both directions of rotation of the winch motor, hoisting and lowering can be carried out. The dotted lines in Fig. 1 refer to a 3-ton Siemens D.C. winch with resistance control, and this graph shows that with average loading the A.C. winch operates at speeds equal to those of the D.C. winch. With heavy loads the speed is somewhat higher. The absence of a special light hook speed is not considered a disadvantage as this speed can only be fully utilized when lifting and not when lowering. On ships normally handling lifts not exceeding one ton, the use of winches with change-over gear is recommended, e.g., for 2-3-ton winches. In that case in the second stage, a speed of 2 metres per sec. (39·37 ft. per min.) can be attained with A.C. winches when lifting and lowering 2-ton loads. As a result of the shunt characteristics of the A.C. asynchronous motor the power rises approximately with the load, when hoisting. The A.C. winch motor is so designed that the rated power of 25 h.p. is absorbed at the second step with full load, and at the third step with half load. Full load can, however, also be hoisted without limiting the output by the use of overload relays or the like. It is considered an advantage by the winchmen that with the A.C. winch with a multi-speed pole-changing motor there is always constant speed for each position of the master switch, irrespective of the load.—*The Motor Ship, September 1955; Vol. 36, pp. 262-264.*

Shipbuilding in East Germany

One of the more interesting features of the recent Spring Fair at Leipzig was the exhibit of the shipbuilding industry of the German Democratic Republic (East Germany), which has latterly been occupying a place of increasing importance at that international function. The V.E.B. Schiffswerft Neptun, formerly the Neptun-werft, Rostock, well known for its pre-war handy-sized steamships, suffered considerable war damage, and has been extensively modernized in the process of reconstruction. This shipyard is still largely engaged, as it was in 1949, with repair work in connexion with the refitting of large German liners and freighters, sunk by belligerent action or scuttled in 1944-45, which have been raised by the Soviet salvage service and are claimed by the U.S.S.R. as reparations. Since 1953, however, when it became a V.E.B., it has gone in more for construction; the yard is capable of building ships of up to 6,000 tons, but those which it has built so far —two for the U.S.S.R. and one for Bulgaria, were completed in 1954—have been of 4,500 tons, with coal-fired steam propulsion, as are also those built since then and now building for sale abroad or for the new East German merchant fleet. The building time of these is between six and eight months. It is also building 475-ton luggers for the East German fishing fleet, and 600-ton parent-ships for service with them. The V.E.B. Warnow Werft is a brand-new shipyard, built since the war at the mouth of the River Warnow, a few miles north of Rostock, to compensate for the fact that the Neptun-werft could not be expanded. It can repair ships of up to 25,000 tons, and has two slips 590 feet long, on which it can build ships of 10,000 tons or more. Two more such slips are in project. Its vast shipbuilding-shed, claimed to be the largest in Europe, with floor-space of over 215,000 sq. ft., permits of extensive prefabrication, which, combined with the employment of automatic welding and other similar measures for speeding up work, and three-shift working, enable the building time for a 10,000-ton ship to be reduced to as little as eighteen months, with every prospect that before long that time will be halved, as is projected. The slips are served by a cable-crane system with a height of 210 feet and a length of 960 feet, consisting of twelve parallel cable tracks, in pairs, arranged 14 feet apart. Two 10,000-tons d.w., 450 feet by 63 feet by 27 feet, Diesel-engined, cargo-passenger ships were built and delivered last year to the People's Republic of China. Others on the slips are destined for the U.S.S.R. and for the national merchant fleet. Ten of this type are planned for completion each year. It has built and is building also, again destined mainly for the U.S.S.R., a number of 198-feet, Diesel-engined river boats, with accommodation for 200 passengers, salvage vessels, 15-ton floating cranes, etc.—*Cdr. E. P. Young, R.N. (ret.), The Marine Engineer and Naval Architect, May 1955; Vol. 78, pp. 177-181.*

German-built Trawler

The first of a group of five trawlers building for British owners by the German yard of Rickmerswerft, Bremerhaven, has been delivered. This vessel, the *Coldstreamer*, has been built for the Standard Steam Fishing Co., Ltd., of Grimsby, one of the trawler-owning companies of the Butt Brothers group. A sister ship is completing for the Great Grimsby and East Coast Steam Fishing Co., Ltd., another firm of the group. The *Coldstreamer* is a good example of a modern German-built trawler, with an all-welded hull and a totally-enclosed steam engine with exhaust turbine. Her principal particulars are as given below:

Length o.a.	203ft. 9in.
Length b.p.	181ft. 1in.
Breadth moulded	31ft. 6in.
Depth moulded	17ft. 1in.
Mean draught (excluding box keel)	14ft. 5in.
Depth of box keel, feet	1
Gross tonnage	696·61
Net tonnage	238·49

The ship has been built to Lloyd's Register of Shipping classification. As mentioned above, the hull is welded throughout, both the stern post and the soft-nose stem being fabricated. A feature of the hull is the special keel design, which incorporates an external box keel. This keel is used to house the transducers for the echo-sounding equipment. Another feature of the design is that, in common with most modern German trawlers, the vessel is arranged for fishing on the starboard side only. The main-deck erections amidships and aft are therefore extended out to the ship's side to port, giving extra accommodation space. The fish hold has a capacity of some 16,000 cu. ft. inside linings. Access to it is by means of four holds with steel covers. It is insulated at top, bottom and sides with 2 inches Onazote. A similar thickness of this material is fitted on the forward bulkhead, with 4 inches on the after bulkhead. The ceiling is of 2-inches Swedish redwood, and the bottom is covered with 2 inches of reinforced concrete. In contrast to common British practice at present, two masts are fitted, one derrick being worked from each mast. The trawl winch is by Robertsons of Fleetwood, and is of the modified Bear Island type, with 1,500 fathoms of wire on each barrel. Other deck machinery includes an electric windlass of German manufacture, and a hand docking winch. The steering gear is of the rotary vane type developed by the German firm of AEG, and is hand-electro-hydraulically operated. The main engine is a triple-expansion steam reciprocating engine of totally-enclosed type with forced lubrication, coupled to a Bauer-Wach exhaust turbine. The engine itself was supplied by Ottensener Eisenwerk A.G., of Hamburg, and the exhaust turbine by A.G. Weser, Bremen. The total output of the propelling machinery is 1,400 i.h.p. at 130 r.p.m., and this gives the ship a loaded speed of 14 knots. The engine uses superheated steam, which is supplied at a pressure of 227 lb. per sq. inch by a three-furnace cylindrical boiler equipped with forced draught and pressure oil burning.

The boiler has a diameter of just over 14 feet and a length of 11 feet 8 inches. The forced draught is on the Howden system, and an air heater is fitted.—*The Shipping World, 31st August 1955; Vol. 133, p. 210.*

The Babcock "Selectable Superheat" Marine Boiler

Modern marine steam-generating practice demands accurate control of steam temperature in order to allow for efficient operation below full power requirements, and to permit manœuvring at short notice. A boiler unit recently developed by Babcock and Wilcox, Ltd., fulfils these requirements with lower operating costs than those of the twin-furnace boiler. The boiler in question is known as the Babcock and Wilcox "selectable superheat" marine boiler, and it combines the advantages of the twin-furnace controlled superheat boiler with the simplicity of construction and small floor space of the B. and W. integral furnace boiler. With the new boiler the steam temperature required can be selected and maintained over a wide range of loads, and furthermore, large quantities of near-saturated steam can be provided for auxiliary requirements, without endangering the superheater. The selectable superheat boiler is, at the same time, operated and fired in precisely the same way as a normal single-furnace unit. The general arrangement of the unit is shown in Fig. 3, from which it will be seen that the gas leaving the furnace is divided into two flows by a stud-tube wall, one flow heating the convection tubes and a superheater, and the other heating the convection tubes only. Control of the relative gas flow in either of these two sections is by means of two sets of coupled dampers in the uptakes, one set being open when the other is closed. By simple damper operation the proportion of gases in the " superheater " and " saturated " passes can be varied to give the required final steam temperature. After passing the dampers, the gas streams combine to pass through an economizer and/or an air heater before being discharged through the uptakes to the funnel. Apart from the variable steam temperature, the control of which is a function of the damper position, the control and operation of the boiler are identical with that for a standard single-pass integral furnace boiler, and the furnace can be fitted with a simple form of combustion control. This can, if necessary, be extended to operate the dampers, and so give automatic control of the steam temperature at any predetermined figure. In its simplest form the damper arrangement comprises a set of butterfly valves mounted upon a single shaft running across the flue. The material of which the dampers are made is selected to give freedom from distortion and burning, and since the temperature under which they operate is relatively low, corrosion and fouling do not occur. The furnace stud tubes are covered with chrome ore, while the superheater tubes which are short, can easily be handled and replaced, and they are provided with finger-type supports which can be replaced if necessary without disturbing the superheater tubes. Easy access to the tubes for cleaning purposes is provided by means of doors in the boiler casings. Cyclone steam separators are fitted in the boiler steam drum to allow for positive circulation and to ensure that the water in the drum is bubble-free. The selectable superheat boiler, although new, is by no means untried; units have been in operation for some considerable time under conditions more arduous than those of normal marine boiler practice.—*Engineering and Boiler House Review, September 1955; Vol. 70, pp. 308-309.*

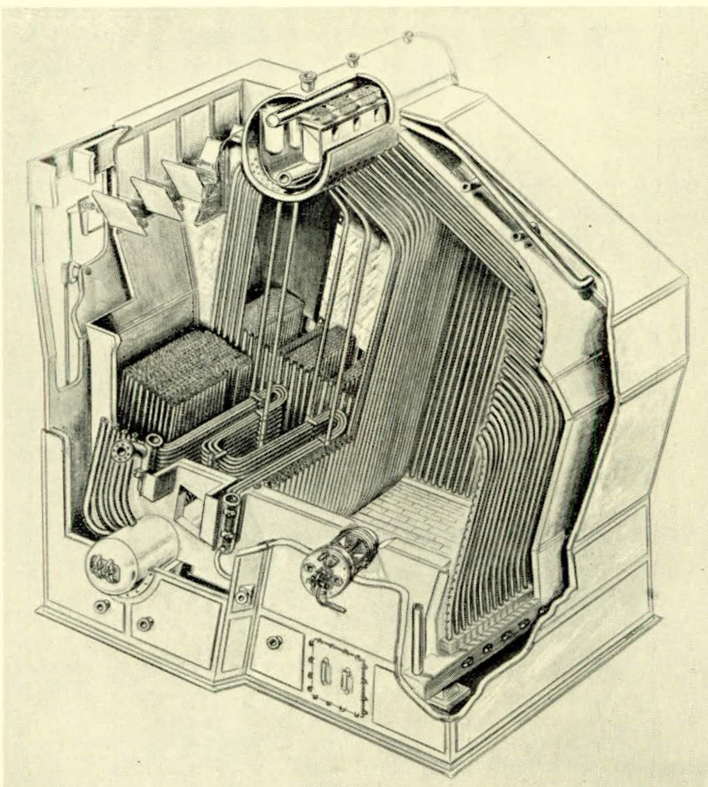


FIG. 3—*Cut-away view showing arrangement of Babcock and Wilcox "selectable superheat" marine boiler*

Automatic Tension Winch

An automatic tension winch, primarily designed for use on Canadian ore carriers which have to negotiate locks and canals without the aid of tugs, is now being produced by Laurence, Scott and Electromotors, Ltd., in collaboration with Stothert and Pitt, Ltd. It is electrically operated, and is being built in three standard sizes of 20, 35 and 50 h.p. With the ore carriers in service on the Great Lakes and St. Lawrence Seaway of Canada, frequent docking operations must be carried out in the shortest possible time and with the minimum of manpower. To do this the winch must be capable of checking the way on a vessel and, once moored, must keep a constant selected tension on the mooring line, automatically heaving in or paying out with the rise and fall of the water. The Almon Johnson automatic tension winch, from which the Pitt-Scott winch has been developed, has already been fitted to a large number of ore carriers, including the latest 715 foot long, 25,000 tons d.w., *T. R. McLagan.* These winches have materially contributed to the unusually rapid passage through the Welland locks, the time taken being only ten hours with cargo and eight hours in ballast. There are many applications where a constant tension winch is an advantage. For example, the winch is admirably suited as the haulage winch for a suction dredger where the vessel must be held up against the bar and automatically moved forward as the dredging proceeds. The design of winch is also readily adaptable for use as a towing winch for tugs. The winch is generally of cast construction designed to withstand the breaking strain of the cables recommended for the various winch sizes. Steel gearing is employed throughout and this is totally enclosed. The drum shafts are of alloy steel and both the cable drum and drum shaft run in self-lubricated roller bearings. The cable drum is driven through an epicyclic system of gearing, with a third or oscillating member moving only as the tension in the cable varies. This oscillating member is used to operate the automatic control which starts, stops and reverses the motor. A handwheel-operated clutch-brake band, compressed round this oscillating member, acts as a slipping clutch under shocks and prevents cable breakage by limiting the tension that can be applied. With the clutch brake band released, there is no positive drive to the cable drum. Alternative arrangements are provided to lock the cable drum under these conditions when the whipping drum can be used for pulling hatch covers or other purposes. The D.C. motor operates on either a constant or variable voltage system, according to the conditions of use. A Scott patent disc-type magnetically operated brake is fitted to prevent overhauling of the winch whenever the motor is de-energized. The automatic tension ranges of the larger sizes are for the 35 h.p. winch, 2,500 to 12,000 lb.; and the 50 h.p. winch, 2,500 to 15,000 lb. Intermittent line tensions very much in excess of the above can be obtained under manual control depending on winch speed. Heaving and veering characteristics for the 50 h.p. size are approximately 80 feet per min. at full load (15,000 lb.), running up to 450 feet per min. with a light hook. Again these can be readily varied to suit a particular application. An important feature of the Pitt-Scott winch is its ability to check the way of a ship preparatory to mooring. With the mooring cable secured to a bollard on the quayside, the winch will automatically impose the maximum retardation the line will stand without damage and will continue to check smoothly as the speed of the ship drops. In addition, by use of the controller the winch can be speeded up to introduce slack into the cable whenever desired so that the cable bight may be transferred to a more forward bollard before the cable is fully unwound from the drum, and the checking process repeated.—*The Shipping World, 24th August 1955; Vol. 133, p. 187.*

New Amine Treatment, Combined with Industrial *p*H Meter, for Boiler Feedwater

The problem of scale formation in high-pressure water-tube boilers installed on board ships has been solved, to a great extent, by the use of chemical treatment. There are still experienced, however, difficulties arising from the presence of traces of iron and copper in the boiler feedwater. During 1954, trouble was met in the oil-tank vessels of the Esso fleet, and investigations carried out by the Alfloc water-treatment service of Imperial Chemical Industries, Ltd., suggested that the failure was connected with corrosion of steel cargo-heating coils and pick-up of copper in the ships' feed systems. It was recommended that the boiler feedwater should be treated with a volatile amine, which would pass over with the steam to ensure that the condensate remained slightly alkaline; by this means, corrosion in the steam, condensate and feed systems, including the cargo-heating coils, would be stifled. Cyclohexylamine was selected for application; but it was also essential that the *p*H value of the condensate should be measured at frequent intervals, and the treatment varied according to the test results obtained. The methods of determining *p*H by the use of indicators and colour standards were considered unsuitable, and it was finally decided to fit a continuously recording *p*H meter of the industrial type. The *p*H meter selected was the No. 28 model of the Electronic Instruments, Ltd., Richmond, Surrey, and this instrument, together with ancillary equipment, formed the monitoring system by which the amine treatment was controlled. This trial has been so successful that arrangements have been made to extend similar treatment to other tankers of the Esso fleet; as a fact, *p*H equipment, supplied by the Electronic Instruments, Ltd., has already been installed in the *Esso Oxford, Esso Cambridge, Esso Canterbury, Esso York, Esso Westminster* and *Esso Exeter.* An important feature of this new treatment is the considerable saving anticipated in the costs of repairs and maintenance. Combined with the efficient monitoring system outlined in this article, the new Alfloc treatment should make a major contribution towards increasing the availability of ships for cargoes, instead of lying idle in repair docks.—*The Shipbuilder and Marine Engine-Builder, October 1955; Vol. 62, p. 613.*

British-built Oil Tanker for Norway

Although the trend towards tank ships of greater tonnage is now more marked, there is still a large demand for the 18,000-ton vessel, of which the single-screw motorship *Vardefjell,* built by the Blyth Dry-docks and Shipbuilding Co., Ltd., of Blyth, for Messrs. Olsen and Ugelstad, of Oslo, is one of the latest examples. The *Vardefjell* has been built under the special survey of officers of Det norske Veritas, and has been awarded the highest classification of this society; her principal dimensions and other particulars are given below:

Length overall	556ft. 4in.
Length b.p.	528ft. 6in.
Breadth moulded	72ft. 0in.
Depth moulded	38ft. 9in.
Draught extreme, summer load water-line	29ft. 11¼in.
Corresponding deadweight, tons	18,190
Corresponding displacement, tons	24,570
Gross tonnage	11,990·6
Net tonnage	6,859·97
B.H.P.	6,300
Corresponding r.p.m.	125
Speed, knots	14

The vessel is of the single-deck type, and has twin longitudinal bulkheads extending over the range of the main cargo-oil tanks. The tank range is bounded forward and aft by cofferdams, and transverse subdivision provides eight groups of three tanks each. Forward of the main tank range there is a dry-cargo hold, beneath which are deep tanks, port and starboard. Deep fuel-oil cross-bunkers occupy the space between the after end of the tank range and the machinery space. Two main pump rooms are provided, one between Nos. 3 and 4 tanks and one between Nos. 5 and 6 tanks. A ballast-pump room is arranged to port, at the forward end of the fore deep tank. Heavy oil is carried in the cross-bunker and forward deep tank, while part of the double bottom beneath the engine-room is arranged for the carriage of Diesel fuel. Provision is made in the machinery space for service and settling tanks. The vessel is of practically all-welded construction, riveting having been confined to the midship seams of the bilge strake, the frame connexions, and the ends and the deck stringer angle to the upper deck and sheerstrake. Where the shipbuilders have found it convenient, riveting has been employed for such minor structural members as beam and stringer knees. An inclining experiment was carried out with the ship in a fitted-out condition, and ballasted for undocking. There were certain items of outfit still to go on board, and a considerable quantity of yard gear and dunnage to be removed. The draughts were taken forward amidships and aft, both port and starboard, and the density of the water was measured by a hydrometer. Eight inclining weights were used, each one being weighed prior to the experiment, and the angles of inclination were recorded by a Dobbie McInnes Stabilograph. The extreme displacement, corrected for trim, breakage and density in the inclined condition, was 8,434 tons and the L.C.B., corrected for trim, was 9·8 feet forward of amidships. The results of the weight shifting gave an angle of 0·143 degrees when a mean weight of 5·54 tons was moved through a distance of 63 feet. From these results, the GM, as inclined, works out to 16·6 feet, and the inclined KG to 22·8 feet. After making the necessary weight corrections, the light ship worked out to 6,380 tons with a V.C.G. of 24·2 feet and an L.C.G. 41 feet aft of amidships. This gave a deadweight of 18,190 tons on a load draught of 29 feet 11¼ inches. From this light-ship condition, the various conditions of loading were calculated. The *Vardefjell* is propelled by a Sulzer single-acting, two-stroke cycle, nine-cylinder airless-injection oil engine, which incorporates a lever-driven scavenging-air pump to each cylinder. The engine is designed to operate on heavy fuel oil, and, with a cylinder diameter of 720 mm. and a piston stroke of 1,250 mm., is rated to develop 6,300 b.h.p. at 125 r.p.m.—*The Shipbuilder and Marine Engine-Builder, October 1955; Vol. 62, pp. 600-610.*

Aerothermodynamic Considerations of Turbocharging Diesel Engines

The turbocharged engine is, in effect, a compound engine in which the engine itself handles the high-pressure end of both compression and expansion, while the exhaust-turbine-driven compressor takes care of the low-pressure end. The turbocharger pressure ratio determines the division of work between high-pressure and low-pressure components, and the value of this pressure ratio governs, to a large extent, the values of all engine-performance variables. In this paper the interrelationships between all of these variables are discussed. Curves are presented giving numerically the interdependence, one on the other, of turbocharger pressure ratio, thermal loading, specific fuel consumption, and turbocharger combined efficiency, with and without intercooling. The aerothermodynamic situation of the two-cycle engine is treated separately, with emphasis on the all-important flow-handling ability of the engine. This ability is defined by the concept of the "gas change process merit ratio," and, by means of a series of curves, the specific engine air flow is given for different merit ratios and different turbocharger combined efficiencies for a range of turbocharger pressure ratios. Finally, for both two-cycle and four-cycle engines, the importance of good matching between engine air-consumption characteristics is discussed, and as a criterion for this matching the engine operating line, as it appears superimposed on the compressor characteristics curve, is used.—*Paper by R. Birmann, 1955 ASME Oil and Gas Power Conference; Paper No. 55-OGP-10.*

Belgian-built Double-acting Two-stroke Engine

The first double-acting two-stroke supercharged engine to be built is installed in the cargo liner m.s. *Lufira* recently completed by John Cockerill S.A., Seraing (Belgium) for the Cie. Maritime Belge S/A. The engine was constructed under licence from Burmeister and Wain by the shipbuilders and is of the exhaust piston type with six cylinders, 590 mm. in diameter, the combined stroke being 1,700 mm. (working piston 1,250 mm., exhaust piston 450 mm.). On test the power developed was 8,150 b.h.p. (1,360 b.h.p. per cylinder) at 115 r.p.m. (the mean of the indicated pressures at the top and bottom being 7·75 kg. per cm.^{2} or 110 lb. per sq. in. but in service the engine will be run at a continuous output of 7,100 b.h.p. or slightly under 1,200 b.h.p. per cylinder. In supercharging this double-acting engine the owners' intention was not to create a new type having an exceptional efficiency. The aim was essentially to gain some practical experience concerning the possibility of increasing the continuous output of eight-cylinder engines of the same type installed in several of the company's ships, the speed of which is considered to be insufficient. Some of these are passenger liners of the "Albertville" class and it is intended that the power increase after supercharging will be about 25 per cent. The supercharging system is based on the constant-pressure principle and the arrangement may be noted from the diagrammatic illustration. Two Brown, Boveri VTR 630 exhaust-gas turbo blowers deliver the air (drawn from the engine room) to the suction side of the two Roots attached blowers. Salt water-cooled coolers are fitted between the Brown, Boveri and the Roots blowers to reduce the temperature of the air charge. The exhaust belts from the top and bottom cylinders are connected through a large pipe in order to equalize the load on the two turboblowers and to damp down the pressure fluctuations caused by the exhaust pulses. These were the only alterations made to the normal engine before being tested in the shops, but the combustion chamber volumes were

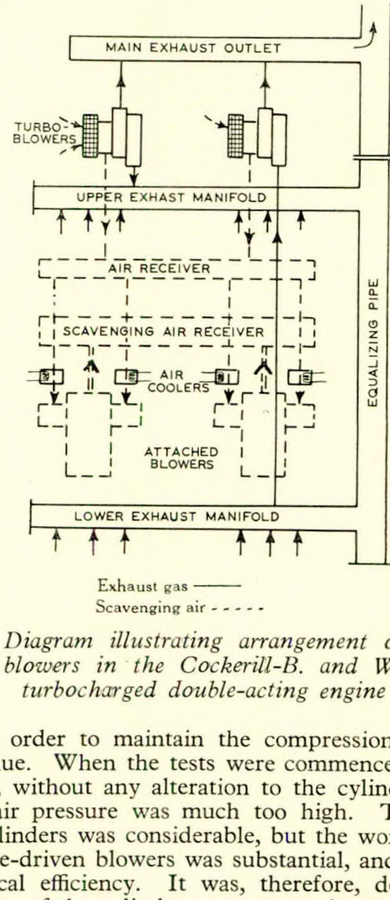


Diagram illustrating arrangement of blowers in the Cockerill-B. and W. turbocharged double-acting engine

increased in order to maintain the compression pressures at a normal value. When the tests were commenced it appeared at once that, without any alteration to the cylinder ports, the scavenging air pressure was much too high. The excess of air in the cylinders was considerable, but the work carried out by the engine-driven blowers was substantial, and this lowered the mechanical efficiency. It was, therefore, decided to increase the area of the cylinder ports as much as possible. The opening and closing of the exhaust remained unaltered, but the scavenging period was slightly increased. Moreover, the speed of the attached blowers was reduced by about 10 per cent. As time was short it was not possible to test the engine once more and it was despatched for installation in the ship. The first results obtained during the trial trip proved that the alterations had effected their purpose. It was found that the specific fuel consumption was reduced by about 10 gr. per b.h.p. per hour as compared with that on the test bed trials. During the first voyage to the Belgian Congo and back, the performance of the engine was considered by the owners to be satisfactory. Heavy fuel oil of 3,500 seconds Redwood No. 1 was utilized throughout and the output of the engine was 7,100 b.h.p. at 115 r.p.m. The turbocharged engine operates with a considerable excess of air. It is more than should normally be the case with a single-acting engine, namely, about

8·2 kg. per b.h.p. This was deemed necessary in order to provide intense cooling of the cylinders and piston heads and to obtain perfect combustion on the heaviest grades of fuel (3,500 seconds Redwood No. 1), especially on the bottom sides where the conditions are not favourable. The following readings were taken after eight days' running of the engine at full power on heavy oil and under tropical conditions, namely, with a sea water temperature of 28 deg. C. and air 45 deg. C.

M.I.P., top, kg. per cm.^{2}	7·26
M.I.P., bottom, kg. per cm.^{2}	6·23
B.H.P.	7,210
Speed, r.p.m.	114
Compression pressures, top, kg. per cm.^{2}	35·5
Compression pressures, bottom, kg. per cm.^{2}	35·4
Firing pressures, top, kg. per cm.^{2}	50
Firing pressures, bottom, kg. per cm.^{2}	49·5
Gases—	
Exhaust temperature at cylinders, top, deg. C.	323
Exhaust temperature at cylinders, bottom, deg. C.	290
Inlet temperature at turbines, top, deg. C.	410
Inlet temperatures at turbines, bottom, deg. C.	355
Outlet temperature at turbines, top, deg. C.	350
Outlet temperature at turbines, bottom, deg. C.	295
Inlet pressures at turbines, top, mm. Hg.	270
Inlet pressures at turbines, bottom, mm. Hg.	265
Air—	
After turboblowers before coolers, temperature, deg. C.	74
Pressure, mm. Hg.	217
After turboblowers and after coolers, temperature, deg. C.	39
Pressure, mm. Hg.	203
Scavenging belt, temperature, deg. C.	51·5
Pressure, mm. Hg.	364

—*The Motor Ship, September 1955; Vol. 36, pp. 238-240.*

Preparation of Residual Fuel for Motive Power

Residual fuel is the by-product which remains after very careful control of the process for extracting specification products from crude petroleum. Since crude oils vary quite widely in composition, it follows that the residue which remains after extracting benzene, gasoline, kerosene, and distillate fuels, all of which are standard in analysis, must in itself be of non-uniform analysis. In fact, this variation will be much greater than in the larger volume of crude petroleum oil. Specific analyses of residual fuel from many companies have been reported in numerous papers showing its widely varying physical properties and chemical composition. The problem, therefore, which faces the industry in the proper utilization of residual fuels for Diesel engines and gas turbines is to find a means for reducing this variable by-product down to a standard useful fuel. The final product must be capable of operating the engine or turbine at peak efficiency without significantly increasing maintenance costs and do this on the residuals which are available to the American consumer. Residual fuel must be subjected to one or more of the following purification steps, depending on source of supply and end use: (1) If the residual fuel is wet from storage or tank leakage, the water must be removed. This is particularly important in marine use, but is seldom a problem at a carefully operated land-based power plant. (2) Carboid solids, either with or without asphaltenic coatings, must be removed. This is extremely important in the case of Diesel engines where clearances are very small and long-range maintenance is important. (3) Asphaltenic agglomerates should be separated from the carboid nucleus and redispersed in the oil in a state as nearly colloidal as possible. This is important for any use where economics of operation are critical. (4) For turbine use, water-soluble minerals must be removed by water washing to reduce corrosion on the turbine blades. This paper shows how these purification and preparation steps are accomplished.—*Paper by F. H. Smith and F. P. Downing, 1955 ASME Oil and Gas Power Conference; Paper No. 55-OGP-1.*

Wax Model Construction

This report gives an account of the development of a satisfactory wax blend for the manufacture of ship models at the David Taylor Model Basin. In initiating the wax development programme, the experience of the European tanks with the use of paraffin and beeswax in model construction was examined. This indicated that models manufactured of these materials would probably sag, if not specially supported, in the temperature range above 70 deg. F. As a first step, wax manufacturers and suppliers were contacted and requested to supply samples of material suitable for conducting physical and chemical laboratory tests. More than fifty different natural and synthetic waxes and plastics were tested individually and in about eighty different combinations. These tests, made on small samples, included tests for strength, melting temperature, shrinkage, distortion, saponification, hardness, workability, and smoothness of the finished surface. As a result of these tests, it was found that a composition of 35 per cent n-butyl methacrylate (Lucite 44), 27·5 per cent hydrogenated castor oil (Opalwax), and 37·5 per cent refined paraffin (Aristowax, 140 M.P.) met most of the characteristics of the desired wax compound.—*J. B. Hadler and W. B. Hinterthan, David W. Taylor Model Basin Report No. 930, 1955.*

Inert Arc Welding of Pressure Piping

The application of the inert-gas-shielded arc-welding process for the purpose of eliminating metallic backing rings or inserts in the welding of circumferential butt joints in pressure piping systems has stimulated considerable interest in the past few years. The major problem confronting those engaged in applying this process to pressure piping work is that of producing a uniform inside bead condition consistently in all positions. The major feature of this technique is the novel manner of preparing the root edges of the joint. Fig. 1 illustrates the welded joint detail employed in the development of this welding procedure. This method of preparing the joint

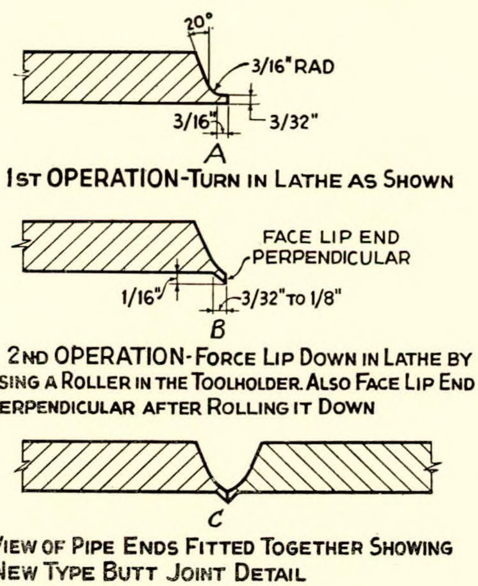


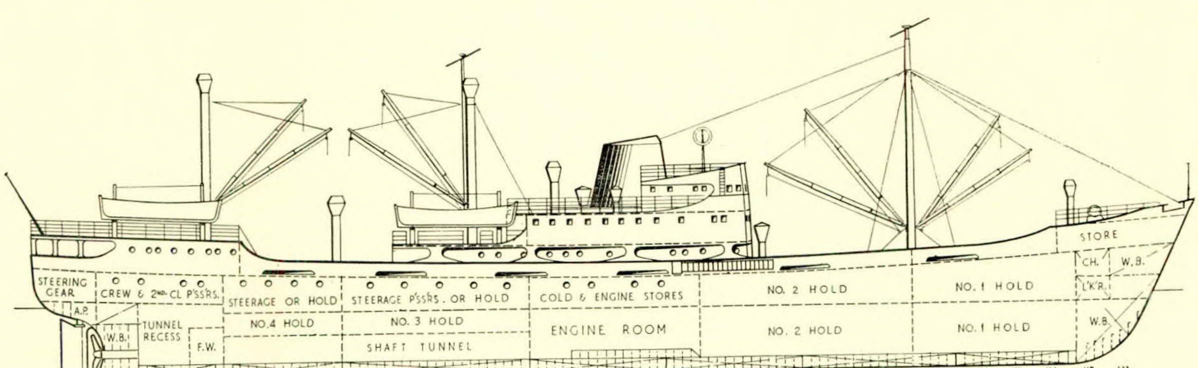
FIG. 1—*Novel manner of preparing the root edges of the joint for this welding procedure*

produces an internal circumferential lip, similar to an insert or backing ring. When the root edges of this type of joint are fused together in an inert gas atmosphere, the inevitable concave inside condition, generally prevalent when welding in the overhead position, is eliminated. The 3/32 inch thickness of the lip affords the necessary extra material during fusion to produce uniform inside conditions, and it also reduces the tendency of burning through during the initial fusion of the root edges of the joint. Therefore, a desirable, uniform, internal root bead can be consistently obtained in any position.—*R. T. Pursell, The Welding Journal, August 1955; Vol. 34, pp. 747-751.*

German-built Cargo Motor Ship for Mauritius

A passenger and cargo vessel of 2,427 tons deadweight has been built by Jos. L. Meyer, Papenburg/Ems, Germany, for the Colonial Steamships Co., Ltd., Mauritius. The *Mauritius,* which is built on Maierform lines, is fitted with a Costa bulb rudder and is propelled by a Deutz Diesel engine developing 1,650 b.h.p. at 250 r.p.m. The principal particulars of the *Mauritius* are as follows: —

Length o.a.	277ft. 11in.
Length b.p.	255ft. 11in.
Breadth o.a.	41ft. 2in.
Breadth moulded, feet	41
Depth moulded to upper deck	22ft. 8in.
Depth moulded to tweendeck	15ft. 1in.
Draught, feet	17
Tonnage—	
Deadweight	2,427
Gross	2,092
Net	1,165
Block coefficient	0·725
Service speed, knots	12
Fuel consumption, mean, tons per day	5·5
Cargo capacity—	
Grain, cu. ft.	124,800
Bale, cu. ft.	115,650
Passengers—	
First class	24
Second class	20
Steerage	104



The *Mauritius* has been built to Lloyd's Register of Shipping ✠ 100 A1 specification and the requirements of the Ministry of Transport in order to obtain the passenger certifying letter, and has a main deck and tweendecks, raked soft-nosed stem and cruiser stern. The frames are of riveted construction with welded butts. All the side plating, including the sheerstrake, is lapped wherever possible and riveted. The bottom plating is welded, and all the seams and butts in the main deck and tweendeck plating are welded. Cellular double bottoms are fitted fore and aft, divided into separate tanks for oil, water ballast or freshwater, enabling 640 tons in all to be carried. The bunker capacity is 250 tons in double bottom and deep tanks. The propelling machinery in the *Mauritius* consists of an 8-cylinder Deutz four-stroke direct-reversible supercharged Diesel engine, having a rated output of 1,650 b.h.p. at 250 r.p.m. The engine is equipped with a Brown Boveri exhaust gas turbocharger and intercooler, the latter being fitted in order to improve the efficiency of the engine when running in the tropics. It will be appreciated that without an inter-cooler between the turbocharger manifold and the turbocharger, the drop in horsepower with a high ambient temperature would be about 70 b.h.p. The Deutz engine has a fuel consumption of about 0·359 lb. per b.h.p. per hr., and is arranged for fresh water cooling. The fuel system is arranged so that gas oil, marine Diesel oil, or a mixture of both, can be burned. A Westfalia separator is fitted for purifying the fuel oil before it is pumped into the daily service tanks.—*The Shipping World, 17th August 1955; Vol. 133, pp. 159-161.*

Systematic Propeller Profiles

A problem that is frequently encountered when designing propellers is that of determining a profile which, with a given aspect ratio and a fixed angle of attack, will give a certain lift coefficient in two-dimensional flow. In practice, this is achieved by curving the centre-line of a suitable symmetrical aerofoil section. The velocity distribution over this aerofoil must be comparatively uniform, and to prevent cavitation there must be shock-free entry over as wide a range of angles of attack as possible. These conditions were not met in full by the existing profiles, and so a new profile is described in this report, and details of the profile obtained are given. The derivations of certain of the formulæ employed are given in appendices.—*W. Alef, Hamburg Shipbuilding Experimental Station, Report No. 1041. Journal, The British Shipbuilding Research Association, August 1955; Vol. 10, Abstract No. 10,493.*

Fuels for U.S. Navy Gas Turbines

Any plan of gas turbine employment in the U.S. Navy would naturally include consideration of the type of fuel to be burned. Up to the present time, Naval consideration of gas turbines has been on the basis of using either Diesel fuel or Navy special fuel. Basically, all turbines under development are intended for the use of Diesel fuel in the event of no other fuel being suitable. Small high-speed gas turbines of the auxiliary type are applied in locations and operated in a manner which precludes the use of anything except a relatively volatile, non-viscous, easily burned fuel of the distillate type, similar to Diesel fuel. This is also true of turbines for small-craft propulsion. But in booster turbines used with steam power plants, the possibility of using other than Diesel fuel, i.e., residual fuels and lower-grade distillates, is being explored extensively. The U.S. Navy presently requires considerable quantities of Diesel and Navy special fuels for shipboard applications. To ensure that no serious problems would be encountered in the application of Diesel fuels to auxiliary-type gas turbines, an investigational programme was initiated at the U.S. Naval Engineering Experiment Station, Annapolis, Md. In this programme, tests were made to determine whether a typical small, high-speed, open-cycle-type gas turbine would operate successfully with fuels covering the entire range of properties procurable under the Military Marine Diesel Fuel Specification MIL-F-16884 (SHIPS).—*Paper by H. F. King and H. V. Nutt, 1955 ASME Oil and Gas Power Conference; Paper No. 55-OGP-8.*

Supercharging the Nohab Polar Engine

In the autumn of 1954 supercharging trials were commenced with the new Nohab-Polar engine having six cylinders with a diameter of 340 mm., a piston stroke of 570 mm. and a speed of 300-375 r.p.m. This unit has been developed from the Nohab-Polar M-type engine and has the same cylinder dimensions. The distance between the cylinder centres has been reduced and the dimensions of the crankshaft increased. It is provided with pistons of a new design and it is claimed that the already high scavenging efficiency of the Polar engine has been further improved. The valves in the scavenging pipe have been removed. In the first place, tests with the constant-pressure system were made and the exhaust-gas supercharger, a TS 400 Napier-type unit, was connected in series with the engine-driven scavenge pump. The engine was run on various loads at 300, 335 and 375 r.p.m., the results when operating up to 300 r.p.m. being seen in Fig. 3. The maximum output so far achieved corresponds to a b.m.e.p. of 8·8 kg. per cm.^{2} (124·9 lb. per sq. in.), 8·4 kg. per cm.^{2} (119·3 lb. per sq. in.) and 7 kg. (99·4 lb. per sq. in) at 300, 335 and 375 r.p.m. respectively. At 335 and 375 r.p.m. the power was limited by the maximum permissible exhaust-gas turbine speed, namely, 10,500 r.p.m. Up to a mean pressure of 8·2 kg. per cm.^{2} the exhaust gas was invisible. Standard injection equipment was employed, also the normal direct-driven lubricating pumps (two) and standard direct-driven engine-cooling water and bilge pumps. The lubricating oil cooler was of the same dimensions as that used with the non-supercharged N-type engine. After a period of operation of 100 hours at a b.m.e.p. of 8·4 kg. per cm.^{2}, the pistons, cylinders, bearings and crankpins were examined, and no indications of overstraining of these parts by thermal or mechanical stresses were noted. After the trials with the engine working on the constant-pressure system were concluded, tests with the exhaust-pulse system, without the scavenging pump were made. In carrying out this arrangement, the experience which had already been gained from the trials with the pulse system of the smaller K53E engine was utilized. Separate exhaust pipes

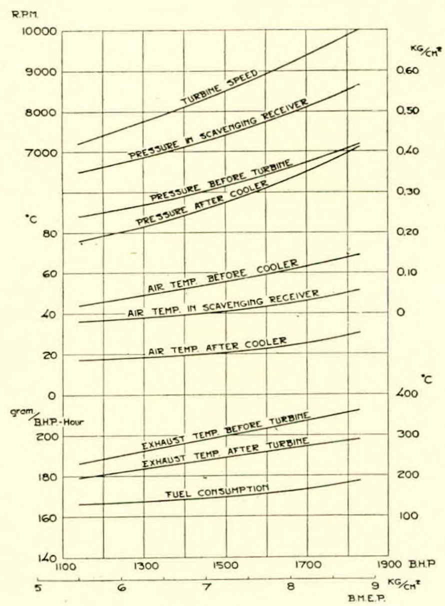


FIG. 3—*Constant-pressure system of pressure-charging*

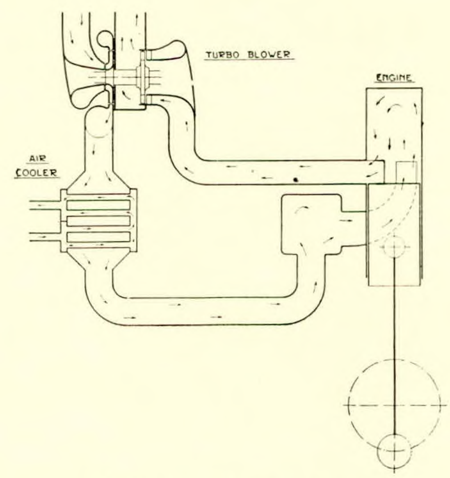


FIG. 4—*Arrangement of pressure charging system without scavenge pumps*

were connected between the engine cylinders and the exhaust turbine. The area of the cylinder ports was enlarged. The principle of supercharging is shown in Fig. 4. When starting cold, an electrically driven auxiliary scavenging blower was used, the power needed being from 6 to 8 h.p. The engine could, however, without difficulty, be started cold at a room temperature of 20 deg. C. and then run at all loads, also at idling speed, without bringing the auxiliary scavenging blower into service. The manœuvring capacity was equally as good as that on the engine without supercharging. A series of trials was run at 300 and 335 r.p.m., the test data at 300 r.p.m. being grouped in Fig. 7. As indicated on this diagram, the fuel consumption is considerably lower than with the constant-pressure system and the scavenging pump in series with the supercharger. The lowest fuel consumption was 156 gr. per b.h.p. per hr. and 158 gr. per b.h.p. per hr. at 300 and 335 r.p.m. respectively. The exhaust was invisible up to a mean pressure of 7·5 kg. per cm.^{2} Owing to the removal of the scavenging pump with its transmission, the engine operated more silently than before. The ignition sound is already low

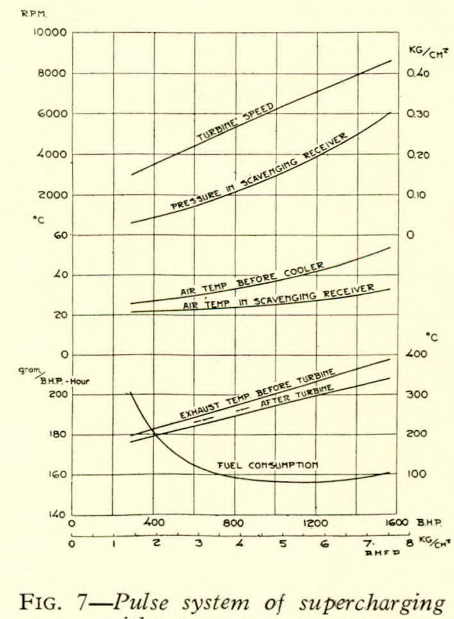


FIG. 7—*Pulse system of supercharging without scavenge pump*

on the Nohab-Polar engines owing to the special pilot injection used. The noise from the air intake was not disturbing.—*The Motor Ship, October 1955; Vol. 36, pp. 298-299.*

Cavitation Research

Although the phenomenon of cavitation has been of interest to hydraulic engineers for some time, it is only in recent years that this subject has gained the attention of physicists to any great extent. The approach has been mainly empirical, involving the close observation of the phenomena and study of the character of the destructive action. Various theories have been advanced to account for the extraordinary severity of cavitation damage. It is now generally accepted that this destructive action is of a mechanical nature, due either to the direct impact of water or the occurrence of high pressures in the neighbourhood of collapsing cavities. There is, however, at present no theory which adequately describes the mechanism. Indeed, the fundamental laws governing some of the factors involved are not yet fully understood. The properties of inertia, compressibility, and viscosity of water are involved; also, vaporization and condensation of water, expansion and contraction of the gas-filled cavity, heat conduction, surface tension, and diffusion of air into the cavity. The inception of cavitation at low vapour tension indicates the presence of gas nuclei in the water. Experiments indicate that the noise attendant upon the pulsations of bubbles decreases with increasing air content. It also appears likely that the damage caused by the collapse of a cavitation bubble is similarly related to the air content. Therefore, although the process of diffusion of air into the cavity probably has little effect upon the motion of the boundary of the cavity, the increase in air content during the pulsation of a bubble is of interest. A theoretical investigation of this problem has been made recently and numerical results have been obtained in the case of a strongly pulsing bubble. An interesting result was that the growth per period is relatively small, unless the bubble is extremely tiny or lies in the track of an ultrasonic beam.—*The Engineers' Digest, August 1955; Vol. 16, p. 351.*

Ship Motion in Irregular Waves

This report deals with the heaving and pitching motions of unpropelled ship models in irregular bow or stern seas. A time record of the motions is obtained from a knowledge of the water-surface history at one station along the model, using a Fourier integral analysis, as discussed by one of the authors. Thus, time histories of heaving and pitching of the ship model can be expressed as the convolution-type integral of the recorded wave motion and a kernel function. This kernel is the Fourier transform of the ship model's response to a sinusoidal forcing function. Using the Froude-Driloff hypothesis, kernels are explicitly computed for oscillations of a rectangular block. The kernel for a model of ship form is determined independently from a single experiment using irregular waves. Predicted time histories agree quite well with recorded time histories, read from 35 mm. cinematograph records.—*R. A. Fuchs and R. C. MacCamy, University of California, Institute of Engineering Research, Waves Research Laboratory, Technical Report, Series 61. Journal, The British Shipbuilding Research Association, August 1955; Vol. 10, Abstract No. 10,500.*

Calculation of Stopping Ability of Ships

Research Bulletin No. 3-4 of the S.N.A.M.E. contains the following two reports on the stopping ability of ships: (1) *Relationship between Thrust and Torque at 100 per cent Slip,* by E. F. Hewins. A method is outlined for determining the value of the astern thrust (T) when the ship is making no way through the water, corresponding to a given value of astern torque (Q) for a particular propeller when model test results are not available. The ratio T-Q may be determined to within 10 per cent if the propeller pitch is known, and more accurately if the camber ratio is also known. The aim of the investigation was to find a value of the astern thrust which would be a fair approximation to the theoretically constant value, and which may be easily calculated. (2) *Calculation of Head Reach while Stopping,* by A. L. Ruiz. It is shown how to make use of the value of the astern thrust when the ship is not making way through the water to calculate the distance travelled by a ship (head reach) while stopping. Most head reach formulæ are based on the assumptions of an instantaneously applied propeller thrust, and of the ship's resistance varying as the square of the velocity. It is shown by the method given in this report how to calculate head reach when the astern thrust is applied gradually. Curves are also included applicable to cases where the resistance varies as a power of the velocity other than the second.—*Journal, The British Shipbuilding Research Association, July 1955; Vol. 10, Abstract No. 10,411.*

Electro-magnetic Coupling Alternators

The British Thomson-Houston Company has further developed the conventional electro-magnetic coupling so that in addition to operating as a normal coupling between the main engine and the propeller when the ship is at sea, it can also be used as an alternator (driven by the main engine) for supplying electric power when the ship is in port. The first ship to be equipped with these newly developed coupling-alternators is the 1,400-ton twin-screw bulk cargo ship m.v. *Golden Bay* built by Henry Robb, Ltd., for the Tarakohe Shipping Company, Wellington, New Zealand, in conjunction with the Golden Bay Cement Company. The vessel was designed to the special requirement of the owners for carrying

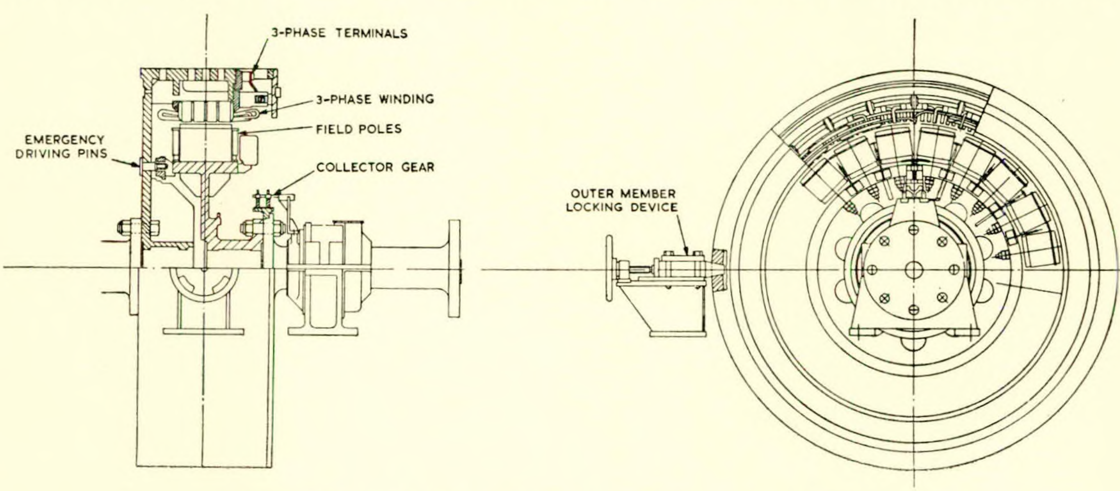


FIG. 3—*Part-sectional view of B. T.H. magnetic coupling alternator*

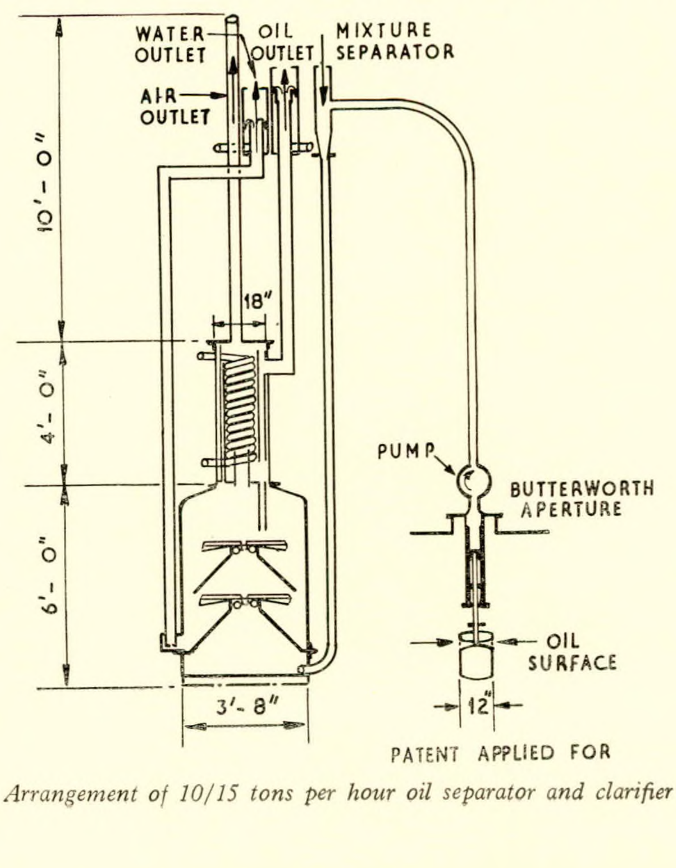
cement or coal in bulk. Each coupling alternator unit (Fig. 3) consists of an inner member and an outer member which have no mechanical connexions between them, the inner member being coupled to the engine crankshaft through an intermediate stub shaft and sleeve bearing, which ensures that the weight of the member is not wholly carried by the engine crankshaft. The outer member is coupled directly to the propeller shafting. The inner member consists of a fabricated steel rim on which are mounted twenty electromagnetic poles facing radially outwards. This rim is mounted on a fabricated steel spider with spigotted flange for bolting to the intermediate stub shaft which, in turn, is coupled to the engine crankshaft. Excitation is supplied from the ship's auxiliary 220-volt D.C. busbars through sliprings mounted on the coupling flange, the necessary brushgear being mounted on a bracket attached to the intermediate bearing pedestal. The outer member consists of a fabricated disc and a steel outer rim carrying the laminations and a three-phase winding on the inside of the rim. The winding is star-connected, and while the units are being used as couplings, the phases are connected together to form a closed circuit. Under this condition, power is transmitted from the engines to the propeller shafts with only a small reduction in speed (about $1\frac{1}{2}$ per cent) because of the slip of the coupling. When in harbour and being used as alternators, the outer members are locked stationary by means of a steel wedge which engages in a slot in the rim of the outer member. The shorting links are removed and suitable connexions are made to the three-phase windings of each outer member; the units can then be used as conventional alternators each driven by one of the main engines. Under such conditions the engines are run at 300 r.p.m., and the alternators develop 500 kW each at 440 volts, three-phase, 50 cycles—this frequency being chosen to permit standard A.C. motors to be used for driving the cargo-handling equipment. The field excitation of each coupling-alternator unit is controlled by a handwheel with starwheel location for the initial step. Moving the handwheel to this position closes mechanically-operated contactors by means of cams, and applied excitation to the coupling. Further rotation in a clockwise direction increases the excitation. As these coupling-alternators are not designed for ship manœuvring or manœuvring being carried out on the main engines, the excitation must be applied before starting up the engines, and interlocks are fitted on the engine controls to operate audible alarms should the excitation be applied with the engines running. When the machines are operating as alternators, their output voltage is maintained between pre-set limits, irrespective of the total load, by connecting or disconnecting fixed steps of resistance in series with the alternator fields. These are switched in or out of circuit by contactors operated by relays supplied from current transformers. As the load current increases, the relays operate at pre-determined current values and cut out the fixed steps of resistance to increase the excitation. Three such steps are provided and by this means the voltage is maintained between the safe operating limits, being finally adjusted to 440 volts when the load has reached a steady value.—*B.T.H. Activities, No. 3, 1955; Vol. 26, pp. 70-74.*

Jet Conveyor for Bulk Cargoes

A new jet conveyor has become available which can be used for a wide variety of jobs including loading and discharging ships, loading lorries, loading stockpiles over obstructions such as walls, loading warehouses through windows and back-filling stacks of bulk materials in a shed. The basic principle of the conveyor's operation is the collecting of material between two fast-moving rubber belts, one above the other, which give sufficient impetus to the material to cause it to be flung forwards in a close and directed jet. The distance and angle of throw can be easily adjusted as required. The capacity depends on the power unit employed, the specific gravity of the material being handled, and the height and distance of the movement required. With the jet conveyor a considerable saving in time and manpower can be effected, as the following will show: trucks can be loaded by four men in ten minutes; material can be moved a distance of 60 feet immediately and directly, without being loaded into trucks or barrows and then unloaded or tipped. There is no need to move materials from one stacking point to another by circuitous routes as the jet conveyor flings the materials over obstacles. Where a conveyor cannot be used or where its use would be too costly the jet conveyor is ideal. It is easily transported and is manœuvrable, and, being simple in practice and operation, it can be used effectively by unskilled labour. The conveyor may be obtained with petrol, electric or Diesel power. The engine is fitted with variable speed control, special filters, and is mounted on 16 inches by 14 inches heavy duty plain bearing pneumatic wheels. The jet length varies between 10 and 70 feet and the maximum jet height is approximately 35 feet. The machine's capacity is up to 60 tons an hour. The weight is 896 lb., the overall length is 7 feet 3 inches, and the overall width is 3 feet 6 inches. The floor area required is 6 feet 6 inches by 3 feet 6 inches and the horsepower required ranges from 5 to 8 h.p. The conveyor can be supplied as a trailer unit.—*Cargo Handling, June 1955; Vol 3, p. 47.*

Device for Separating Oil from Water

With the successful passage through Parliament of the Oil in Navigable Waters Bill, it was to be expected that consideration would soon be given to devising a suitable method of dealing with oil-contaminated ballast water from the cargo tanks of deep sea tankers. It is the persistent oils, such as crude oil, residual oil and lubricating oil, that cause most of the pollution round the coasts of Great Britain, as well as abroad, and anything that can be done to prevent this menace should be encouraged. Oil tankers can effect separation of most of the water by settling in a slop tank, without having to use a separator. However, some considerable amount of oil is still left to cause pollution and Mr. J. M. Binmore of Mechans, Ltd., Glasgow, has thought of a device to overcome this. The method of removing the oil from ballast water was demonstrated at the Engineering, Marine and Welding Exhibition at Olympia. A model was used to show how a skimming strum could be used to remove the oil from the



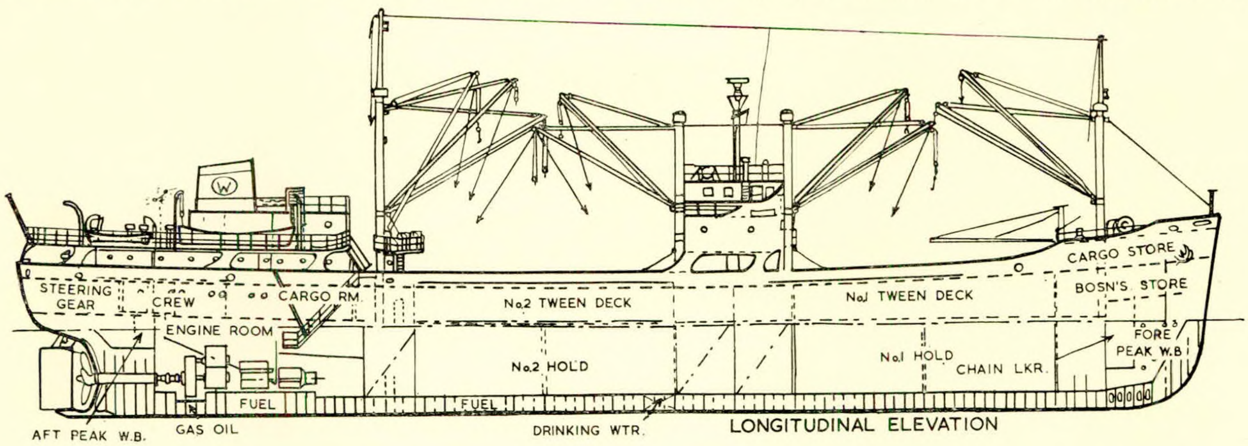
Arrangement of 10/15 tons per hour oil separator and clarifier surface and pump it to a separator. This separator removes such water and air as may be entrained with the oil in pumping and clarifies the oil so that it may be put to further use, which means that it can, if necessary, be used in boilers. In the case of whale factory vessels, which have to remain at sea for considerable periods and which fill their exhausted fuel tanks with water ballast, this is a very great asset as additional fuel oil can be recovered in this way. The experimental apparatus has been tested on whale oil and has been found to be highly satisfactory for the pumping and separation of this expensive product. An apparatus suitable for a pumping rate of 10 to 15 tons an hour is not unwieldy and is only about 20 feet in height including 10 feet of standpipe. The unit can be placed in any suitable position amidships and the skimming strum led from a main pipe line to each of the tanks in turn, only one surface strum and pump being necessary. Pumping is not affected by the rolling of the ship; inded, if anything, it is improved, as the rolling tends to break the oil film clinging to the tank sides. The separator has an arrangement of compacting cones and deflector discs which is such that the speed of flow is kept to a minimum and little or no water is passed through to the calorifier. This apparatus is suitable for use in a deep tank or double bottom, and for removing oil from bilge water.—*The Shipping World, 21st September 1955; Vol. 133, p. 285.*

German-built Diesel-electric Lakes-ships

Two ships unusual in their machinery equipment, recently completed by Kieler Howaldtswerke, A.G., Kiel, are the *Süderholm* and *Norderholm,* ordered by the Weichsel Dampfschiffahrts A.G., Kiel, for service between European ports and the Canadian Great Lakes. The first-named entered service in June this year, and the second, in July. Both ships have been built under the survey and to the requirements of Germanischer Lloyd for their class ✠ 100A4 (E) "with freeboard." It is especially interesting to note that the scantlings, and indeed the design and construction of the ship are such that, after lengthening of the Great Lakes locks by 9·90 metres, the ship can accordingly be lengthened. Each has Diesel-electric propulsion, utilizing high-speed engines and has the following principal dimensions:

Length o.a., metres	78·80
Length b.p., metres	75·00
Breadth, moulded, metres	13·03
Depth to 'tweendeck, metres ...	5·95
Depth to main deck, metres ...	8·20
Deadweight (open shelterdecker), tons	2,950
Deadweight (closed shelterdecker), tons	3,905
Draught, on Lakes, metres	4·33
Corresponding deadweight, tons ...	1,770
Gross register, tons	2,280
Net register, tons	1,512

Prefabrication and welding have featured largely in the construction of each vessel. For weight-saving and stability reasons, the bridge and the after superstructures are of light metal, as are also the shifting beams of the main deck hatch. The total capacity of the two cargo holds is 167,942 cu. ft. (grain) and 154,786 cu. ft. (bale). The two hatchways for each of the two holds can be combined to make one large hatch with a length of 17 metres. There are eight samson posts, each carrying a 3-6 ton derrick, and a 15-ton derrick serves the after hold. The SSW-Hatlapa electric winches are designed for 3-ton lifts. Electric fans installed in the holds to ensure the safe carriage of fruit cargoes, give ten air changes per hour, and can be used for either delivery or exhaust duties. The propelling installation comprises three Daimler-Benz four-stroke vee-type 12-cylinder engines each with an output of 1,100 b.h.p. at 1,500 r.p.m. and driving a 680-kW. D.C. generator supplying power to the D.C. propulsion motors. There are three propulsion motors, each delivering 600 kW. at 1,000 r.p.m. and these drive through a common reduction gearbox with an integral Michell thrust block, to the single propeller shaft.—*The Motor Ship, September 1955; Vol. 36, pp. 230-231.*



General arrangement plans of the m.s. Suderholm

New Method of Measuring Propeller Pitch

A new method of measuring propeller pitch is described in a paper read by G. Ganson at the 1955 Annual Meeting of the Association Technique, Maritime et Aéronautique at Paris. The propeller is laid flat, with its axis vertical, and a theodolite is placed on its support in the centre of the propeller in such a way that its vertical axis of rotation coincides with that of the propeller. Thus angles can be measured between any two radial lines of the propeller disc. Through the theodolite a vertical scale is viewed, the lower end of which is rigidly attached to a relatively heavy cylindrical counterweight shaped down to a point at its end. To obtain the pitch of the propeller at any desired radius, the pointed end of the counterweight is brought into contact with the surface of the propeller and at the same time the graduated scale, which must be held exactly vertical, is observed through the theodolite. Then another point on the propeller blade, at the same radial distance as the first, is touched, and the scale is again observed through the theodolite, which is turned to the corresponding angular position; as before, the scale is held strictly vertical. This procedure gives the vertical and angular distances between the two points on the blade's surface, and this information is sufficient to calculate the pitch at the chosen radius. The arrangement for maintaining the scale in a vertical position for readings is as follows: At the junction between the scale and the counterweight, the unit is held by an arm incorporating a universal joint which allows the unit to swing like a pendulum in any vertical plane. The other end of the arm has a sleeve which can be clamped at any desired height to a column fixed to a stand. This stand is placed on the propeller blade surface, and the height of the arm is adjusted so that the point of the pendulum touches the required point on the blade. The pendulum will quickly come to rest with the scale pointing vertically upwards, no matter what the angle of the stand or the supporting arm. The instrument is inexpensive, and has proved accurate and practical in use.—*Journal, The British Shipbuilding Research Association, July 1955; Vol. 10, Abstract No. 10,409.*

Measurement of Scavenging Flow in Diesel Engine Cylinders

A recent research report states that the pitot sphere appears to be the most satisfactory instrument for carrying out a static investigation of the air flow through the cylinder of a two-stroke Diesel engine. The instrument head of the pitot sphere used for this particular purpose is a brass hemisphere of 0·1 inch in diameter, supported at the rear by a gooseneck arrangement which permits it to be inserted through a 0·2 inch opening. One small hole is drilled in the centre, while four holes are drilled approximately 42 degrees from the centre hole, two in the plane of the support shaft and two at 90 degrees from this plane. These five holes lead to five brass tubes, which transmit the pressure and serve as the support for the hemisphere. Connecting tubes lead up the steel support shaft and transmit the respective pressures to the manometres. The pitot sphere is stated to have the following three advantages over other point measuring devices: Firstly, it can be calibrated in a low-turbulence wind tunnel, and then used inside a cylinder where the turbulence intensity is high, without appreciable error. Secondly, the error due to transverse flow along the support shaft is negligible; and thirdly, the error when traversing through a steep velocity gradient is not serious because of the small diameter of the instrument. This is the major error and results in an apparent increase in flow through the cylinder. Integration of the velocity profile gives a 2 to 4 per cent increase over the actual flow measured by an orifice meter. In a typical cylinder the difference in velocity across the 0·1 inch diameter sphere can amount to 8 feet per second, with the flow angle changing as much as 10 degrees.—*The Engineers' Digest, August 1955; Vol. 16, p. 354.*

Measurements on m.v. *Rijeka*

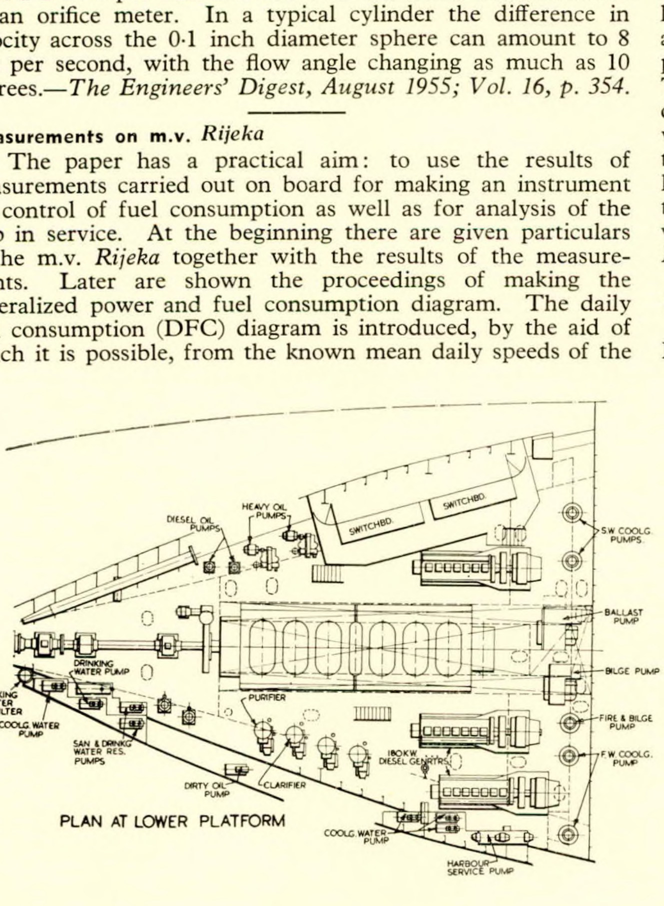
The paper has a practical aim: to use the results of measurements carried out on board for making an instrument for control of fuel consumption as well as for analysis of the ship in service. At the beginning there are given particulars of the m.v. *Rijeka* together with the results of the measurements. Later are shown the proceedings of making the generalized power and fuel consumption diagram. The daily fuel consumption (DFC) diagram is introduced, by the aid of which it is possible, from the known mean daily speeds of the ship and from known r.p.m. of the main engine, to read off directly daily fuel consumptions. For three sister ships, and for a period of two years, the fuel consumptions given in engineers' reports have been compared with those taken from the DFC-diagram—satisfactory results have been obtained. The influence of weather conditions on the speed and on r.p.m. is also shown, and the economic analysis of the ship in service is given for various speeds, weather conditions, and deadweight capacities, as well as for different fixed expenses.—*Paper by S. Silovic and M. Fancev, read at the Autumn Meeting of The Institution of Naval Architects on 20th September 1955.*

Dynamic Loading of Gear Teeth

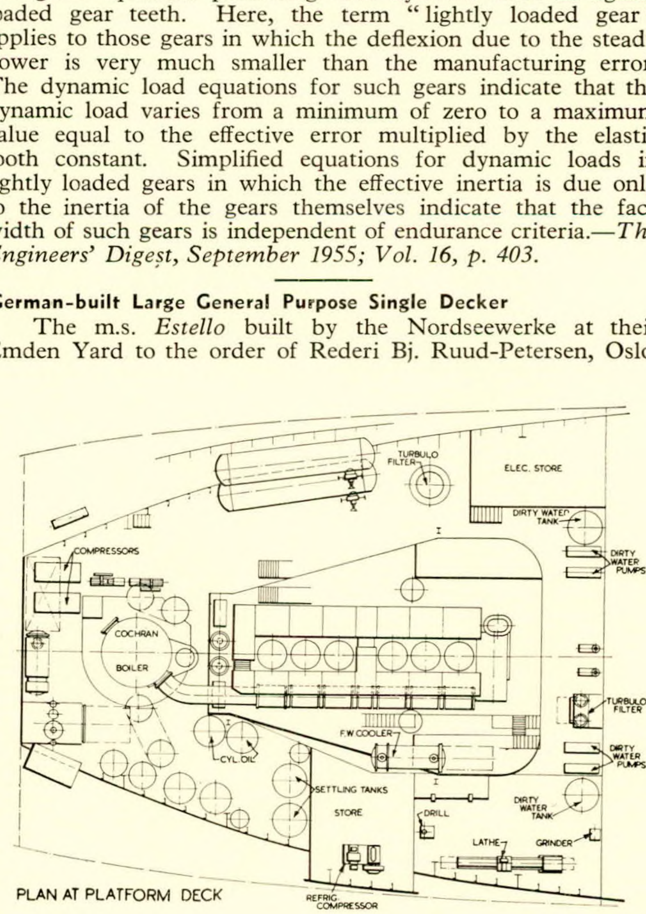
A recent research report analyses the dynamic loading of spur and helical gear teeth and presents equations which make it possible to predict total dynamic loads for both heavily loaded and lightly loaded gear teeth. The term "heavily loaded gear" is applied to those gears in which the deflexion due to the steady power is equal to or greater than the manufacturing tooth error. The dynamic load equations for such gears indicate that the dynamic load varies from a minimum of one half the effective tooth error (static deflexion plus manufacturing error) multiplied by the elastic tooth constant, to a maximum value equal to the effective error multiplied by the elastic tooth constant. In many heavily loaded gears the total dynamic load may be actually less than the static load determined from the transmitted power. The full static load must be taken by a single pair of teeth when in contact near the pitch point in gears having a contact ratio between one and two. Therefore, the static load may often be used as the maximum load in the design of heavily loaded gears. The fact that initial wear failure usually commences near the centre of the tooth surface substantiates this argument. The report also gives equations predicting total dynamic loads in lightly loaded gear teeth. Here, the term "lightly loaded gear" applies to those gears in which the deflexion due to the steady power is very much smaller than the manufacturing error. The dynamic load equations for such gears indicate that the dynamic load varies from a minimum of zero to a maximum value equal to the effective error multiplied by the elastic tooth constant. Simplified equations for dynamic loads in lightly loaded gears in which the effective inertia is due only to the inertia of the gears themselves indicate that the face width of such gears is independent of endurance criteria.—*The Engineers' Digest, September 1955; Vol. 16, p. 403.*

German-built Large General Purpose Single Decker

The m.s. *Estello* built by the Nordseewerke at their Emden Yard to the order of Rederi Bj. Ruud-Petersen, Oslo,



PLAN AT LOWER PLATFORM



PLAN AT PLATFORM DECK

is believed to be the largest general-purpose single deck ship yet built. Of 12,500 tons, she is strengthened for and designed to facilitate the carriage of ore, but is equipped for the shipment of grain or general cargo, while provision is made for deck timber cargoes. The decks have been left clear to enable cars or other deck cargoes to be carried. Designed by Knud E. Hansen of Copenhagen, and built to the requirements of the Norske Veritas class T for carrying ore, the ship has the following characteristics:

Length o.a., feet ...	475
Length b.p., feet ...	440
Breadth, moulded, feet ...	62
Depth, to upper deck ...	36ft. 3in.
Draught, summer freeboard ...	27ft. $7\frac{15}{16}$in.
Machinery, b.h.p. ...	4,000
Service speed, knots ...	$12\frac{1}{2}$

The main engine is an M.A.N. six-cylinder, single-acting, two-stroke unit, fitted to burn heavy oil and having a cylinder bore of 700 mm. with a piston stroke of 1,200 mm. At 125 r.p.m. and with a mean indicated pressure of 6·1 kg. per cm.^{2}, the engine has an output of 4,000 b.h.p., but in normal service it will operate at 110 r.p.m. to give 3,500 b.h.p. All deck and engineroom auxiliary machinery is electrically driven, power being supplied by three 180-kW, 220-volt D.C. A.E.G. generators, each driven at 500 r.p.m. by an M.A.N. 7-cylinder four-stroke engine.—*The Motor Ship, October 1955; Vol. 36, pp. 288-292.*

Frictional Drag of Smooth and Rough Ship Forms

The only method of deriving resistance formulæ for turbulent flow along flat plates more or less theoretically is by starting from theoretical formulæ for pipe flow. The latter formulæ are, therefore, subjected to a detailed consideration as is also done with the assumption that these formulæ may be adopted in the boundary layer of a flat plate. A new approximation method is developed to establish a relation between resistance coefficients of pipes and rectangular flat plates. This method proves to be in fair agreement with Schultz-Grunow's measurements of local frictional resistance. With the aid of theoretical formulæ the total frictional resistance coefficients can be determined from the local frictional resistance coefficients. Apart from this, the total frictional resistance coefficients can also be derived from resistance experiments with flat plates. The agreement between the two methods is highly satisfactory. With the aid of results obtained from experiments with model families it is shown that it is not satisfactory to apply plate-friction coefficients to ship forms. A new method is indicated for calculating frictional resistance for ship forms.—*Paper by A. J. W. Lap, read at the Autumn Meeting of The Institution of Naval Architects on 20th September 1955.*

Dutch-built Cargo Vessel for Irish Owners

To the small but growing merchant fleet of Eire there has been added the 1,300 ton d.w. cargo motor vessel *City of Dublin,* built by the N.V. Terneuzensche Scheepsbouw Maatschappij for Palgrave Murphy, Ltd., Dublin. The *City of Dublin* is of the open shelterdeck type and has her machinery placed aft. The deck erections comprise the forecastle and the poop deck house containing the accommodation of the officers and crew which is built around the engine casing. Characteristic of the appearance of the ship are the well-raked stem, the cruiser stern and the squat funnel which is built on to the navigating bridge. The *City of Dublin,* which has been constructed to Lloyd's Register of Shipping specification, has two electricly ventilated cargo holds. A double bottom is fitted to the hull and is arranged for the carriage of water ballast and fresh water. The forepeak and afterpeak are also arranged for the carriage of water ballast. Fuel oil is carried in two tanks arranged in the forward portion of the engine room. The two cargo holds are served by two hatchways of which No. 2 hatch is about twice as large as No. 1 hatch. The cargo-handling equipment serving these hatches is attached to a single electrically-welded mast and one pair of seamless steel samson posts; these latter are fitted just forward of the bridge deckhouse and are connected to form a mast of the goal post type. The main propelling of the *City of Dublin* consists of a 7-cylinder, four-stroke, direct reversible supercharged M.A.N. Diesel engine, driving a single four-bladed manganese bronze "Vordap" screw with a diameter of 2,600 mm. The reserve propeller, of the same characteristics, is of cast iron. The engine is fresh water cooled. Starting air is contained in two starting air bottles, each having a capacity of 1,000 litres. Also installed in the machinery space are two generating sets consisting of one air-starting 4-cylinder, four-stroke M.A.N. Diesel engine of 100 h.p. at 75 r.p.m., and one 60 kW generator. The engines also drive an air compressor with a capacity of 60 cu.m. an hour.—*Holland Shipbuilding, June 1955; Vol. 4, pp. 32-34.*

The Pitching and Heaving of Ships

The theory of pitching and heaving has been re-examined with a view to a clearer understanding of model experiment results and seagoing behaviour. New parameters are evolved, and a method is proposed for plotting experimental model data in a form compatible with oscillations theory and suitable for the more critical examination of data obtained. The results of treating some model data are described and discussed. The recommendation is made that model results be presented both in the proposed and in the conventional manner as complementary forms.—*Paper by H. J. Sims and A. J. Williams read at the Autumn Meeting of The Institution of Naval Architects on 20th September 1955.*

Automatic Pilot

The White Automatic Pilot consists of four principal components. First is the binnacle unit which houses the special compass; a new type of photocell is employed in relaying compass course information. This unit also has an automatic course selector, by which the vessel can be placed on any new heading simply by rotation of a small control knob. The binnacle unit is generally mounted near the boat's regular steering wheel so as to be most convenient for the helmsman. Second is the amplifier and relay box which feeds the signal from the compass to the power unit. This features a new transistorized circuit. No radio tubes, vibrators, transformers or tachometer cables are involved. The relays in this unit are extremely rugged and to the highest specifications so as to provide trouble-free life. Third is the steering motor unit. This contains a heavy duty motor and gear system which transmits the power through chain and sprockets to the boat's steering wheel shaft. This is a non-hunting system which means that the motor does not have to keep working all the time, as is the case with "hunting" types of automatic pilots. Fourth is the remote control with 25 feet of cable by which the operator can from any position on the boat take over the control for dodging obstacles, for circling or for other manœuvring. Then, with the flick of a switch, the pilot goes back to its initial automatic course. When the White Automatic Pilot is not turned on, there is no drag from it during manual steering. No warm-up time is necessary to put the automatic pilot into operation. There is no radiated signal to interfere with radios, sounders or other electric or electronic equipment. Limit switches prevent over-travel of the rudder under any conditions. The pilot can be put into operation regardless of speed, direction or rudder position and is independent of normal voltage variations from the boat's electrical system. Current consumption is approximately 40 watts during the period when the steering motor is working, but since this is only intermittent, the average power consumption is perhaps only half of that amount over any given period.—*Marine News, August 1955; Vol. 42, p. 60.*

Patent Specifications

Gravity Davit

This invention relates to gravity davit assemblies for ships in which davit arms from which the boat is suspended, are mounted for swinging movement, in outboard and inboard directions, in deck fittings and are controlled by falls passing from winch drums to head sheaves at the upper or suspension

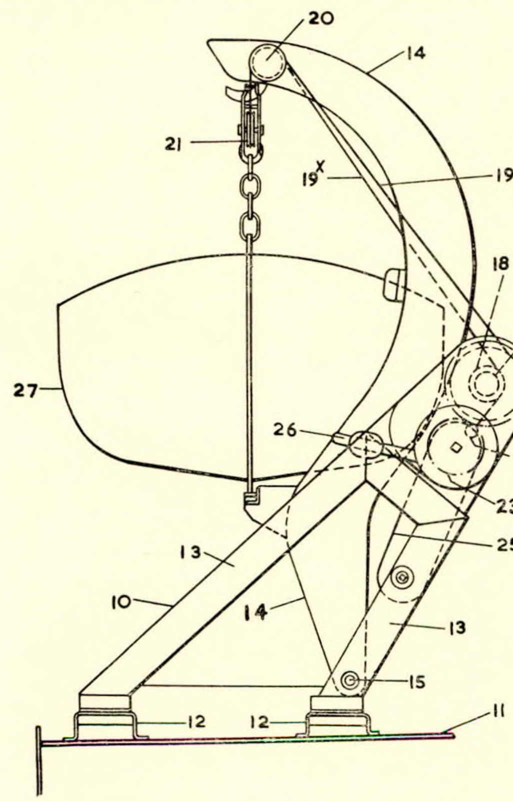
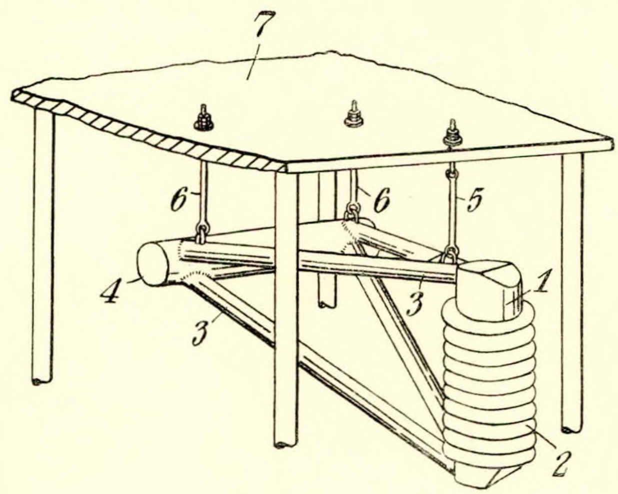


FIG. 1

ends of the arms. In a gravity davit assembly of this kind, shown in the accompanying drawing, two winch drums (16), one for each davit arm (14), are directly or indirectly interconnected by a shaft (17) for simultaneous and positive operation. The shaft is mounted for rotation in bearings (18) located on the upper parts of the deck fittings, so that the shaft is distanced away from the deck and the falls (19) pass directly from the winch drums to the head sheaves (20) without intermediate guide pulleys.—*British Patent No. 739,318, issued to H. G. Taylor. Complete specification published 26th October 1955.*

Suspended Fender

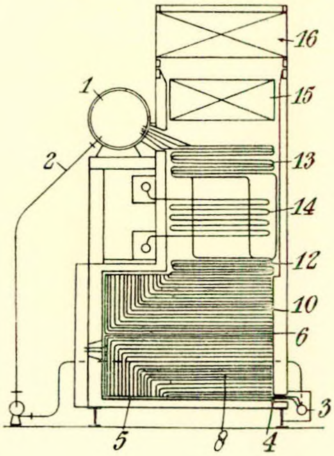
An object of the invention is the provision of an improved arrangement and construction of suspended fenders, which will avoid any need for suspension members below the low water level, enabling working parts to be located close to the deck of the berthing place, thus facilitating maintenance and inspection, without giving rise to the danger of undue compression, in use of the fender, in suspension links. A further object is the provision of a suspended fender arrangement which avoids the projection of any rigid structural members beyond the face of the jetty whilst at the same time avoiding large surface areas exposed to wave slap within the tidal range. An envisaged arrangement is shown in the accompanying drawing which

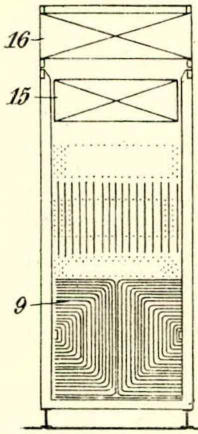


shows a front fender member (1) encircled by tyres (2) and connected by struts (3) to a weight (4) in the form of a longitudinally disposed horizontal bar, the fender being susended by front link (5) and rear links (6) from decking (7) comprized by the berthing place.—*British Patent No. 739,309, issued to A. L. L. Baker. Complete specification published 26th October 1955.*

Forced Circulation Steam Generator

In forced-circulation steam generators the evaporating tubes have hitherto been arranged in several separate circuits in parallel. Each circuit has an inlet or distributor header to which a number of tubes forming the heating surfaces are connected. The tubes of the various circuits are connected at their outlet ends, either through collector headers or directly to the boiler drum. The steam produced is discharged, together with the remaining water, into the drum in which the steam is separated from the water. The water is withdrawn by the circulating pump which feeds it to the different inlet headers and evaporating tubes, thus completing the flow circuit. In forced-circulation steam generators, the combustion chamber walls of which are fully lined with tubes, one circuit usually consists of an inlet header from which tube elements emanate which cover the floor and one side wall of the combustion chamber, forming in their continuation a tube bank arranged above the combustion chamber. The tubes of a second circuit cover the opposite side wall of the combustion chamber, and form in their continuation, a further tube bank above the combustion chamber. The rear wall of the combustion chamber is covered by a third circuit of tubes between an inlet and an outlet header. Thus, three circuits are necessary to cover the walls of the combustion chamber and to form the evaporating tube banks. The object of this invention is to reduce the number of headers, and to arrange the evaporating tube elements in such a manner that only one single circuit is obtained, thus simplifying the heating surface and reducing the cost of manufacture of the steam generator. In Figs. 1, 2 and 3 the boiler consists of a steam and water drum (1) from which a circulating pump withdraws water by way of a pipe (2) and discharges it to the distributor header (3). From this header emanate the evaporating tubes (4) covering the floor (5) of the combustion chamber (6). Near the front wall of the combustion chamber in which the burners are arranged, the tubes run upwards at (7) and cover the front part of the side wall. They are led horizontally along the side wall at (8), cover the rear wall at (9) and run back towards the front wall, covering the upper





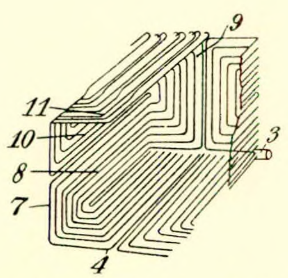


FIG. 1 *(extreme left)*, FIG. 2 *(left)* and FIG. 3 *(below left)*

part of the side wall at (10). From there they run upwards covering the roof at (11) and form in their continuation, tube banks (12, 13). A superheater (14) may be arranged between the evaporator tube banks. Above the tube bank (13) an economizer (15) and an air heater (16) may be installed. From Fig. 3 it can be seen that half the number of tubes cover one half of the combustion chamber walls and form half the convection bank and that the other half of the tubes are connected to the same distributor header (3).—*British Patent No. 739,335 issued to La Mont International Association, Ltd. Complete specification published 26th October 1955. Engineering and Boiler House Review, December 1955; Vol. 70, p. 426.*

Gas Turbine Plant of the Closed-Cycle Type

In gas turbine plants of the closed-cycle type it is known to use a turbine which has an outer housing and an inner housing where the inner housing exposed to the action of the high temperature of the working medium has to withstand substantially no stressing by the internal pressure which is taken up by the cooler external housing. According to the invention, the space between the outer housing and the inner housing of the turbine is connected to at least one point of the circuit at which the working medium is at a lower temperature and at a higher pressure than the working medium fed to the turbine; in addition the space communicates with at least one labyrinth packing of the turbine in such a manner that cooler working medium flows from the aforementioned point at higher pressure in the circuit through the space between outer and inner housing to the labyrinth packing. In this way a part of the cooler working medium is directed towards the turbine rotor for the purpose of cooling and withholding the hot working medium from the turbine shaft. The remaining part of the cooler working medium is expanded through at least a part of the labyrinth packing to a lower pressure. In Fig. 7 a gaseous working medium describes a circuit. Compressed working medium is successively brought to higher temperature in a heat exchanger (1) and in a heater (2). It then passes through a duct (3) into a turbine (4), is expanded in this turbine and thereafter cooled in the heat exchanger (1) by the compressed working medium, and in a cooler (5) by cooling water; it is finally recompressed in a compressor (6) and then returned through a duct (7) into the heat exchanger (1) so

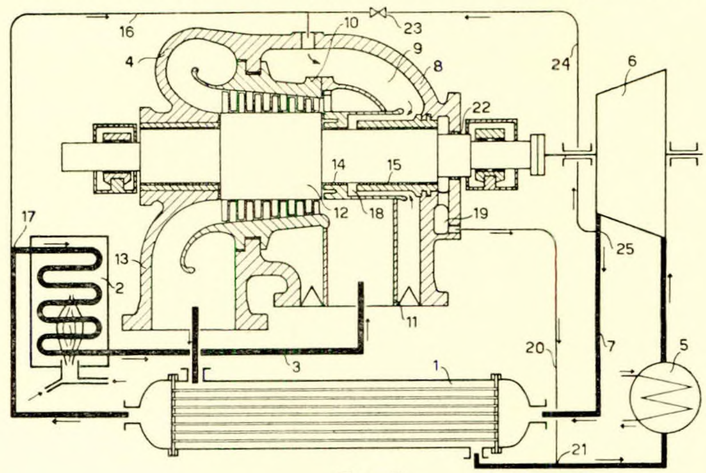


FIG. 7

that a closed circuit is formed. The turbine (4) comprizes an outer housing (8) and an inner housing (10) separated from it by an intermediate space (9). The working medium passes through an inlet branch (11), impinges upon the blading of a rotor (12), and escapes through a discharge housing (13). The two parts (14 and 15) respectively of a labyrinth packing are mounted in juxtaposition on the high pressure side on the rotor shaft. The intermediate space between the outer housing (8) and the inner housing (10) is connected on the one hand by a duct (16) to a point (17) of the circuit. This point is situated between the heat exchanger (1) and the heater (2). At this point, the working medium is at a lower temperarture and at a higher pressure than the working medium flowing to the turbine through the inlet branch (11), since it has not yet been subjected to the heating in the heater (2), and in addition it undergoes a pressure loss in flowing through the heater and the duct (3) until it enters the turbine. The space (9) between the housings is connected on the other hand to a point (18) situated between the two labyrinth packing parts (14 and 15). On the rotor side of the labyrinth packing part (14), a lower pressure obtains than at the point (17) of the circuit. From this point of higher pressure, cooler working medium can therefore flow through the space (9) between the inner and outer housings to the point (18) of the labyrinth packing. A part of the cooler working medium flows through the part (14) of the labyrinth packing and is directed towards the turbine rotor (12). In this way the rotor is cooled and at the same time the hot working medium is withheld from the shaft. The remaining part of the cooler working medium flowing to the intermediate space (9) from the point (17) is expanded through the labyrinth packing part (15) to a lower pressure.—*British Patent No. 737,648 issued to Aktiengesellschaft fuer Technische Studien. Application in Switzerland made on 13th January 1953. Complete specification published 28th September 1955. Engineering and Boiler House Review, November 1955; Vol. 70, p. 390.*

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Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 2, March 1956

On Design of Economic Tramp Ships

The paper outlines some of the background of development of the modern tramp ship and illustrates its emergence. An analysis of some economic and technical characteristics of the modern tramp ship is then given, together with a discussion of particular features which influence these and their relationship. Suggestions are made for some features which it is submitted can be included with advantage in such ships, and the final section of the paper shows design proposals for several types of ship capable of engaging economically in different categories of tramping work.—*Paper by E. C. B. Corlett read at the Autumn Meeting of The Institution of Naval Architects on 21st September 1955.*

Danish-built Oil-tank Motorship for Peru

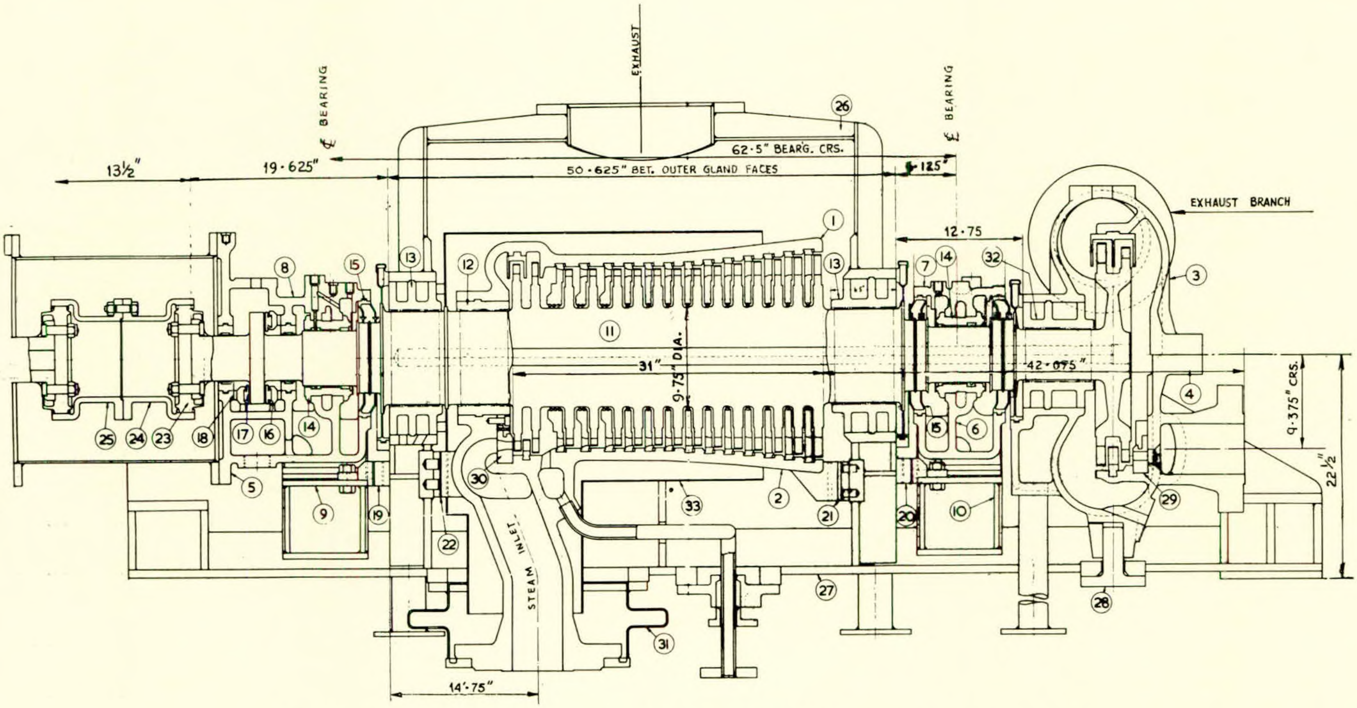
One of the latest additions to the world's oil-tank fleet is the single-screw motorship *Talara,* built by Messrs. Burmeister and Wain, Copenhagen, for Dirección General de Administración de Marine, Lima, Peru. The vessel has been built to the requirements of Lloyd's Register of Shipping for the classification ✠ 100 A.1, for carrying petroleum in bulk. The principal dimensions and other leading characteristics of the *Talara* are stated below:—

Length b.p.	336ft. 3in.
Breadth moulded	50ft. 10in.
Depth moulded to upper deck ...	22ft. 7in.
Draught to summer load-line ...	19ft. 1½in.
Deadweight, tons	4,800
Capacity of cargo tanks, cu. ft. ...	170,500
B.H.P.	2,200
Corresponding r.p.m.	115
Speed on loaded trial, knots ...	12½

The deck is without sheer for 30 per cent of its length. The tank range is subdivided into six sections and is bounded, forward and aft, by deep cofferdams. A pump room is interposed between Nos. 3 and 4 tanks, and a smaller pump room is arranged forward, outside of the main tank range. Electric welding has been used to a large extent; the shell plating, decks, bulkheads, frames and beams are of all-welded construction. Longitudinal frames are arranged in the bottom, and transverse frames at the sides. The tank bulkheads are of corrugated construction. The cargo-piping system consists of one 8-inch main line and 6-inch suctions. Located in the main pump room there are two horizontal duplex pumps, each with a capacity of 300 tons per hour, two 40-ton duplex bilge pumps, and one 40-ton special product pump. The smaller pump room, forward, contains a bilge pump and a fuel-oil transfer pump. Fuel oil is carried in deep tanks beneath the fore hold and in deep tanks immediately forward of the engine room. The double bottom is arranged for the carriage of boiler oil, lubricating oil and feed water, while fresh water is stored in the after-peak tank and a stern tank, as well as in two 20-ton tanks amidships.—*The Shipbuilder and Marine Engine-Builder, September 1955; Vol. 62, p. 555.*

Double-casing High Pressure Turbine

Development of the impulse turbine, introduced to the marine industry by Pametrada, has made it possible to design a turbine producing all its power from one cylinder. This has considerably cheapened production and eliminated cross-over pipes, and has also allowed more power to be installed in a given size of engine room and, by virtue of its double casing construction, greatly improved the habitability of the engine room. Tests are now taking place on a 4,000 h.p. high-pressure turbine eventually to form part of a two-cylinder, 7,500 s.h.p., 100 r.p.m. geared set of Pametrada design which is being built by Hawthorn Leslie (Engineers), Ltd., for a tanker building for Overseas Tankship (U.K.) Ltd. This turbine will be installed in the *Caltex Newcastle,* building at the Wallsend shipyard of Hawthorn Leslie (Shipbuilders), Ltd. The design of the turbine incorporates several novel features which allow inlet temperatures from 900 deg. F. to 1,200 deg. F. to be used; the limit being set by transfer pressures rather than by inlet temperature. The turbine consists of three main parts, a fabricated outer casing providing the main strength girder for ahead and astern turbines, a cast inner barrel housing the ahead nozzles and blading, and an astern cylinder. The inner barrel exhausts into the outer casing, which is therefore subject



Sectional view of the Pametrada double-casing high-pressure steam turbine

to exhaust steam pressure and temperature, and therefore relatively cool when compared with the inlet temperature (e.g. 400 deg. compared with 950 deg.). The barrel is of very simple design, and is therefore better able to withstand transient temperatures such as occur during manœuvring. The supports for the inner barrel take the form of brackets on the inner surfaces of the side walls. Palm extensions of the horizontal joint flange sit on these brackets, and are located in the axial direction by athwartship keys at the inlet end, directly in line with the steam inlet flange centre line. The inlet end palms are free to slide outwardly, and the exhaust end palms are free to slide outwardly and axially. As hogging depends on length between supports as well as on temperature difference between top and bottom halves, it will be seen that the short distance between the palms reduces the amount of hogging compared with a single casing construction. The athwartship alignment of the inner casing is arranged by keys or chocks on the vertical centre line at each end of the barrel bottom half. The outer casing is extended forward and aft to the turbine feet, and the side and bottom portions of the extensions have triangular openings cut in them which restrict the area for the flow of heat from the exhaust casing, and also permit differential expansion to take place without destroying the rigidity of the framework. The bearing pedestals are carried on crossbeams slung from springing plates from a point on the side walls at centre line level. Since the temperature of the springing plates is not much higher than atmospheric, they provide effective centre line support for the bearings, and again permit athwartships flexibility. Athwartships location of the beams is again provided by vertical keys on the turbine centre line locating on the end walls of the exhaust casing. All steam connexions to the inner cylinder are given radial freedom where they pass through the outer casing, either by flexible diaphragms or by piston ringed sleeves. The astern turbine casing is mounted between the forward extensions of the side walls in such a way as to provide free radial expansion, while maintaining true alignment and axial location.—*The Shipping World, 19th October 1955; Vol. 133, p. 384.*

Review of Ship Vibration Problems

The design of a new ship is an enterprise where the closest attention must be given to problems of dynamics and vibration if serious breakdowns involving costly delays and modifications are to be avoided. A great deal is now known about the various possibilities of trouble, and methods of dealing with them have been worked out. But there are still so many uncertainties, particularly with regard to physical data, and some of the essential calculations involve so much numerical computation, that it is not yet possible to be absolutely sure that all will be satisfactory on the trial trip. Nevertheless the knowledge and experience accumulated from the work of research establishments and individual investigators should enable the grosser pitfalls to be avoided. Further work on such problems as the effect of entrained water and local structural flexibilities on natural frequencies, together with mechanization of the computing processes for finding numerical solutions, will assist towards placing the subject upon an even firmer foundation. In the meantime, as Bunyan remarks in his recent paper, the sea trial of a new ship nearly always discloses some regions of the structure where additional stiffening is desirable. In many cases these are blemishes rather than real faults, troublesome because of their effect upon the comfort of passengers and crew, rather than because they are structurally dangerous. A great deal can be done with the aid of modern methods of sound-proofing and vibration insulation; the matter being one of finance rather than engineering. Occasionally, however, troubles are revealed, either on the trial trip or in service, which demand immediate attention. The task of the vibration specialist is then to diagnose the cause and prescribe the speediest possible remedy. Thanks to a vigorous and progressive electronics industry a vast array of equipment is now available to assist in this task, including the ubiquitous resistance wire strain gauge which, if skilfully used, can measure the strain in remote parts of the structure inaccessible to other means, and in the rotating and reciprocating parts of the machinery. It can also be used in rough weather and is therefore suitable for measuring the stresses and strains under the most adverse of operating conditions.—*W. Ker Wilson, The Marine Engineer and Naval Architect, November 1955; Vol. 78, pp. 427–431.*

10,000 h.p. Gas Turbine Ship

The development of the marine gas turbine for merchant-ship use has been one of the prime objects of Pametrada ever since the inception of that organization in 1944. A gas turbine of 3,500 shaft horse-power was first run on the test bed during 1950. It suffered from a number of troubles, some of which were eliminated by modification. Others, notably an inability to manœuvre rapidly owing to the mass of the turbine rotors and casings, were inherent in the original design. Nevertheless, the fact should not be overlooked that it still remains among the most efficient gas turbines yet run in this country or, indeed, anywhere else in the world, having a full power specific fuel consumption of 0·48lb. per s.h.p. per hour. It has been used as a research tool and has yielded an immense amount of valuable information, particularly as regards the problems of burning heavy fuel and also on manœuvring problems. Regarding this latter point, it should be mentioned that it incorporates a double-reduction gearbox with fluid ahead—and astern—couplings, which have been tested with the engine with satisfactory results. A stage has now been reached at which Pametrada feel that they can offer a marine gas turbine which would be a reliable and economical unit for the propulsion of a merchant vessel. Two units are proposed, each of about 5,000 s.h.p., driving through pinions on to a common gearbox. The arrangement of components is that which is now widely accepted as being among the best for marine work, namely, h.p. and l.p. turbines driving h.p. and l.p. compressors respectively, with the power taken from a free i.p. turbine. There is intercooling between the compressors, and a heat exchanger of 70 per cent effectiveness is provided. Reheating is employed between the h.p. and i.p. turbines as this reduces the air rate and increases thermal efficiency by 33 per cent and 10 per cent respectively. In the arrangement shown, the h.p. compression is divided between i.p. and h.p. compressors, the refinement of a second intercooler giving a further 4 per cent increase in thermal efficiency. The overall pressure ratio is 13·6 and a maximum turbine inlet temperature of 1,250 deg. F. is employed, this being considered the maximum at which heavy fuel oil can be used reliably. The design is based on a life of 100,000 hours at full power. This installation gives a fuel consumption (main engines only) of 0·474lb. per s.h.p.-hr., which increases very little down to 50 per cent power. One of the main problems in marine gas turbines concerns the means of going astern. Pametrada have developed fluid couplings and astern converters for this purpose and have used them on the 3,500 h.p. marine gas turbine as mentioned above. Much development work has also been carried out on a test rig, and astern converters of 65 per cent efficiency are now available. The ahead coupling gives 98 per cent efficiency, and even the 2 per cent loss can be eliminated by means of a hydraulically operated clutch which would be used during the long periods of ahead running after full away had been rung down. A cross-section of the proposed arrangement is shown in Fig. 4 and it may be mentioned that couplings of this type, designed by Pametrada, are currently being fitted in the re-engining of the *Auris*. In the design of the turbines great care has been taken to reduce thermal inertia so as to permit rapid manœuvring. This has been achieved by lightening both rotors and casings as much as possible, and the horizontal casing joint normally employed in marine steam turbines has been dispensed with. This necessitates endwise assembly and dismantling, and a scheme has been devised whereby this can be quickly and conveniently carried out aboard ship when it is desired to inspect the machinery. The small size and weight of the turbines greatly facilitate this operation.—*The Motor Ship, November 1955; Vol. 36, pp. 352–354.*

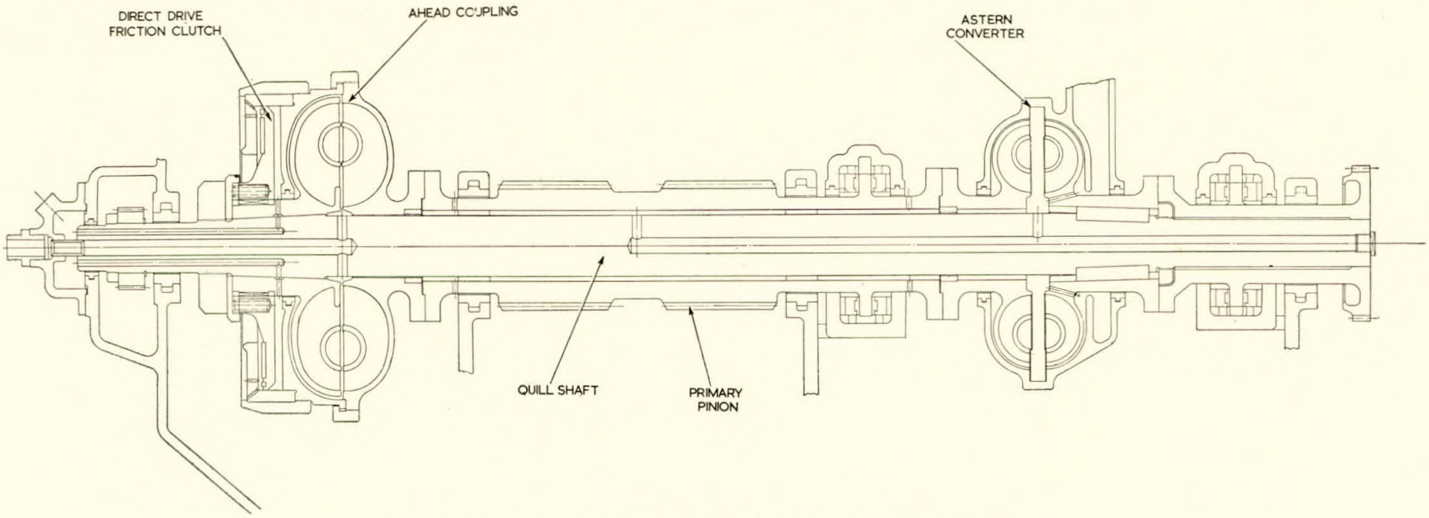


FIG. 4—*Section through coupling and astern converter*

Free-piston Propulsion Plant for Liberty Ship

The Office of Ship Construction and Repair in the U.S. Maritime Administration is conducting experimental work known as the Liberty Ship Conversion and Engine Improvement Programme. This paper covers the engine improvement phase of the programme as applied to the free-piston gas generator-turbine propulsion plant. The paper describes the installation to be made in the ship. The installation as described will be the first actual free-piston gas generator-turbine installation in the United States, and, it is believed, will also represent the largest marine application made to date anywhere in the world. The free-piston type was given consideration because of its basic advantages of combining high thermal efficiency with the flexible take-off power characteristics of a turbine drive, and at the same time its possibility of reducing costs. The Office of Ship Construction and Repair believes that a successful free-piston gas generator-turbine propulsion plant may be suitable in the horsepower range from approximately 3,000 to 10,000 shaft h.p. This will cover the range where Diesel engines are considered, and also where steam plants are presently installed, with their inherent disadvantages of reduced efficiency and higher costs for the lower horsepowers. The horsepower range for the installation of free-piston units depends to a great extent on the sizes of gas generators which are ultimately developed. The 3,000 to 10,000 shaft h.p. range is based on the GS-34 gas generator which has a shaft h.p. rating of 1,000. There are indications that the free piston will also prove to have a good reliability, low specific weight, minimum amount of maintenance, and at the same time lend itself to mass production, which in turn will result in greatly reduced costs. There is no practical reason why the same type of gas generator could not be used in a variety of applications; for example, as a marine propulsion plant, a gas pipe-line pumping unit, an electric generating plant, and a locomotive prime mover. The plant consists of a number of generators discharging through one or more gas turbines which transmit power through a reduction gear to a propeller. The operation consists of gas generators, producing moderate pressure and moderate-temperature gas which is used to drive the turbine. The gas generator has two opposed pistons in a single power cylinder. These pistons compress their own air for scavenging and charging their power cylinders. They also store the energy required to halt their outward movement and return them for their next combustion stroke. Combustion proceeds on the two-stroke Diesel cycle and the power is produced by the exhaust gases and the air driving the turbine.—*Paper by J. H. McMullen, read at the 1955 A.S.M.E. Oil and Gas Power Conference; Paper No. 55-OGP-14.*

Swedish Fast Cargo Liner

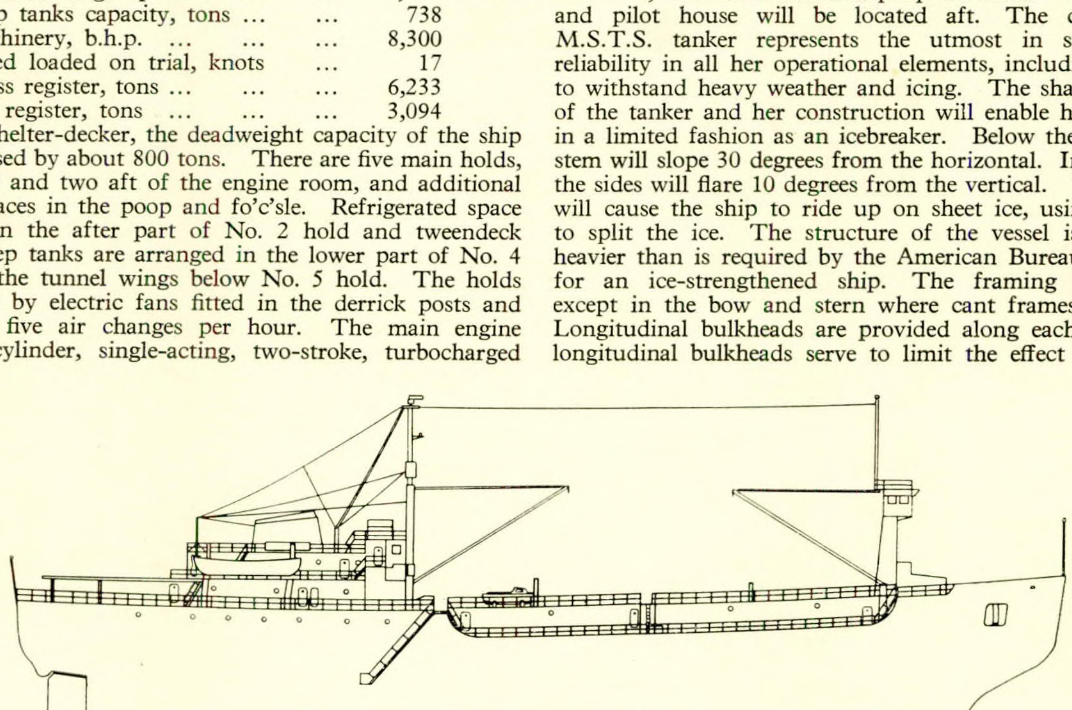
The Swedish American Line cargo motorship *Vasaholm* is the first of a new type of ship for the Broström group. She is considerably larger than the other vessels in the owners' fleets and has been specially designed to serve on both the S.A.L. routes and those of the Swedish East Asiatic Co., for whom Eriksbergs have completed two sister ships, the *Minikoi* and *Sabang,* and have one more to deliver. The *Vasaholm* is an open shelter decker type with poop and long fo'c'sle, a well-raked stem, a cruiser stern, streamlined funnel and bridge structure. She has been constructed under the special survey of Lloyd's Register of Shipping to Class ✠ 100 A.1 with scantlings required for an increased draught of 27ft. and with ice strengthening to comply with the Finnish Board of Trade's Ice Class IB. The main particulars of the *Vasaholm* are as follows: —

Length overall	482ft. 5in.
Length between perpendiculars ...	445ft.
Moulded breadth	62ft.
Moulded depth to main deck ...	29ft.
Moulded depth to shelter deck ...	38ft. 6in.
Loaded draught on summer freeboard	25ft. 9¼in.
Deadweight capacity, tons	8,575
General cargo space (bale) ...	504,000 cu. ft.
Insulated cargo spaces	37,000 cu. ft.
Deep tanks capacity, tons	738
Machinery, b.h.p.	8,300
Speed loaded on trial, knots ...	17
Gross register, tons	6,233
Net register, tons	3,094

As a closed shelter-decker, the deadweight capacity of the ship will be increased by about 800 tons. There are five main holds, three forward and two aft of the engine room, and additional tweendeck spaces in the poop and fo'c'sle. Refrigerated space is provided in the after part of No. 2 hold and tweendeck space and deep tanks are arranged in the lower part of No. 4 hold and in the tunnel wings below No. 5 hold. The holds are ventilated by electric fans fitted in the derrick posts and designed for five air changes per hour. The main engine is of seven-cylinder, single-acting, two-stroke, turbocharged Eriksberg-Burmeister and Wain cross-head type, with cylinder bore of 740 mm., piston stroke of 1,600 mm. and an output of 8,300 b.h.p. at 115 r.p.m. The designed i.h.p. of 9,360 and mean indicated pressure of about 109 lb. per sq. in. show a mechanical efficiency of 88·5 per cent. The engine is of the usual V.T.B.F. type with welded frame and integral Mitchell thrust block, and has two Rateau turbochargers. A motor-driven scavenging air blower is fitted for emergency use and a spare turbocharger rotor is carried on board. A turning gear driven by a series wound 15-h.p. electric motor acts on the flywheel. The 14-ton four-bladed solid bronze propeller is of J. Stone and Co. (Charlton), Ltd., Heliston design and make. Provision has been made for running the main engine on heavy oil with viscosities of up to 3,000 secs. Redwood I at 100 deg. F. A thermostatically-controlled steam heater and an M.A.N.-type viscosimeter are arranged between the fuel feed pump and the injection pumps and steam pipes are led beneath the lagging alongside the heavy fuel lines. The fuel injectors are cooled by circulation of Diesel oil. Heavy fuel oil treatment is carried out in twin set of de Laval purifier-clarifier equipment. The two purifiers are of the latest PX 209 F self-cleaning type and the clarifiers are of VIB 1929 type, with stainless water and one fresh water pump, each of 320 tons per hour capacity and driven by a common 55 h.p., 1,450 r.p.m. motor, a horizontal tandem pumping unit for both sea and fresh water and intended for cooling the auxiliary engines when in harbour. The main systems are tapped when at sea. Leistritz screw pumps are provided for circulating cooling oil through the main engine fuel injectors.—*The Marine Engineer and Naval Architect, November 1955; Vol. 78, pp. 431–436.*

Ice-strengthened Tanker for U.S. Navy

The U.S. Navy's shipping experience in arctic waters justifies the need for special types of ships designed and built to transport the annual replenishments of supplies to bases in the far north. Such ships need ice-strengthened hulls with equipment capable of coping with extremely low temperatures and rapid-changing weather conditions. One of the ships designed for this purpose is an ice-strengthened tanker (T-AOG-81 class) to transport Diesel oil, heavy-end aviation fuel, aviation gas, and motor gas. She will be fitted with but one deck, with forecastle and poop erections. The machinery and pilot house will be located aft. The design of the M.S.T.S. tanker represents the utmost in simplicity and reliability in all her operational elements, including the ability to withstand heavy weather and icing. The shape of the hull of the tanker and her construction will enable her to function in a limited fashion as an icebreaker. Below the waterline the stem will slope 30 degrees from the horizontal. In the forebody the sides will flare 10 degrees from the vertical. These features will cause the ship to ride up on sheet ice, using her weight to split the ice. The structure of the vessel is considerably heavier than is required by the American Bureau of Shipping for an ice-strengthened ship. The framing is transverse, except in the bow and stern where cant frames are adopted. Longitudinal bulkheads are provided along each side. These longitudinal bulkheads serve to limit the effect of liquid-free



Ice-strengthened tanker for arctic use surfaces in the tanks and give protection against flooding in case the hull is ruptured. Numerous features essential to cold weather operation will be incorporated in the tanker. Her hull will be reinforced with a ⅞-inch thick high tensile steel plating along her sides from 3 feet above the deep load waterline. The thickness of this plating will be increased to 1 inch at the bow. The stem above the first platform will be made of heavy plate. Below the first platform level this heavy plate will be reinforced by a high tensile steel bar, 6 inches in diameter, which will be welded to the shell plating. An enclosed ice pilot station will be fixed atop the mast at the after end of the forecastle. Access to it is gained by a vertical ladder inside the mast. The ice lookout station will contain complete navigation and engine room controls. It will also contain a radar scope, so that it may serve as a secondary pilot house. All the windows of the ice lookout station and the navigation bridge will be fitted with tinted glass to prevent sun and ice glare. Some of these windows will be crank operated; the remaining fixed windows will be fitted with de-icing heating elements. The boat deck will be carried sufficiently aft of the deck house to provide a landing area for a helicopter which may temporarily be assigned to the vessel to guide it through leads in ice fields. The sea chests will be fitted with steam connexions to keep them free of ice. De-icing arrangements have been provided whereby the deck machinery will operate smoothly at 20 deg. below zero F. In order to prevent the tanker from swinging at anchor while she is pumping out oil from her cargo hold through a long hose leading to the shore, she will be fitted with a complete ground tackle installation, including anchor, chain, hawse-pipe, and windlass at her stern. Thus the vessel will be able to anchor at both bow and stern at the same time. The boilers of the tanker will be large enough to supply adequate steam heat to all living and working spaces; to lubricating oil and fresh water tanks and galley; and for all de-icing needs even under the most severe climatic conditions in arctic areas. The propeller shafts will be of solid forged steel with a diameter greater than the minimum stipulated by the American Bureau of Shipping for navigation in ice. The two 4-bladed ni-aluminium bronze propellers will be ice-strengthened in accordance with A.B.S. rules. The rudder will be made 10 per cent stronger than is required by A.B.S.—*Bureau of Ships Journal, August 1955; Vol. 4, pp. 8–9.*

Glass-reinforced Plastic Lifeboat

Claimed to be the first of its type to be built in this country, a glass-reinforced plastic ship's lifeboat has recently been completed by Mechans, Ltd., of Scotstoun, Glasgow. The craft is a Class-"B" motor-propelled lifeboat, 24 feet in length, and is moulded in one piece, complete with built-in buoyancy tanks, thwarts and peak lockers. Although the initial cost of using glass-reinforced plastic for boats is higher than using steel or aluminium, it is claimed to have certain advantages over these materials. Glass-reinforced plastic has a high resistance to corrosion, while the colour is impregnated into the hull and eliminates painting, and it is unaffected by marine life. In addition, there is a saving in weight, as the glass-reinforced plastic lifeboat is lighter than an equivalent aluminium boat. The craft was constructed in about two weeks, and the work was largely performed by unskilled labour, there being no elaborate equipment required. In order to obtain the approval of the Ministry of Transport, unusually severe tests were successfully completed. These included the suspension of the boat from the lifting-hooks, loading to double the maximum capacity, and dropping the unladen boat 5 feet into the water.—*The Shipbuilder and Marine Engine-Builder, November 1955; Vol 62, p. 667.*

Cargo Liner for New Zealand

Trials were run recently from the yard of John Brown and Co. (Clydebank), Ltd., of the motor cargo liner *Whangaroa,* built to the order of the New Zealand Shipping Company. The six-cylinder 7,200-b.h.p. Brown-Doxford main engine is the first to be completely equipped with the new fuel pump and timing valves and C.A.V. fuel valves for fuel injection and, furthermore, the simplified control gear and rotary air distributor starting system, developed by William Doxford and Sons, Ltd. Briefly the system comprizes a main engine fuel pump driven by eccentrics at the after end of the engine with, in this case, three deliveries to port and three to starboard. These deliver at about 6,000lb. per sq. in. to a fuel bottle for each cylinder, the fuel then passing through the camshaft-operated timing valve to the two C.A.V. fuel injectors for each cylinder. The main advantages can be considered briefly as follows:—(a) the danger is obviated of a cylinder being flooded in the event of a fuel valve sticking in the open position; (b) there is no back camshaft, which is a simplification; (c) the reversing gear shaft and levers have been eliminated since movement of the air starting lever determines the direction of rotation of the engine; (d) the front camshaft may be of lighter proportions as it is used only to drive the timing valves, air starting valves and mechanical lubricators; (e) the fuel pump is simplified and more compact, again ensuring easier adjustment and a saving in weight; (f) the C.A.V. fuel valves are easily changed, about 10-15 minutes being required for a changeover. It is not yet possible to give the results of the effect of the new injection system on the fuel consumption, but the indications are that it should lead to better combustion and fuel economy by reason of the closer control given to the injection period. The fuel valves—or injectors—are cooled by distilled water from a system independent of that for piston and jacket cooling, the water being passed through the hollow holding-down bolts around the injector and right to the nozzle tip. The *Whangaroa* has an overall length of 471ft. 9½in., a length b.p. of 439ft. 4in., and a moulded breadth of 62ft. 9in., the depth being 39ft. 6in. The deadweight carrying capacity is 10,288 tons on a draught of 30ft. 5in.; the gross register is 8,701·15 tons and the net register tonnage, 4,907·17.—*The Motor Ship, November 1955; Vol. 36, pp. 322–324.*

Research on High Speed Journal Lubrication

Journal bearings in gas turbines have to run at higher speeds than is current practice: design data are required for marine gas turbines running at surface speeds up to 450ft. per sec. At these high speeds, frictional loss is more important than load-carrying capacity and means of minimizing it are being investigated. Preliminary work on oil-flow and temperature distribution in the bearing has been carried out on a model scale, using bearings of 1- and 2-inch diameter, at speeds up to 4,000 r.p.m. It was found in earlier work that frictional torque fell increasingly below the theoretical value as speed increased. This has led to consideration of the extent to which an oil film develops in a bearing. A new technique for visual inspection of the oil film has been developed, using a 1-inch bore Perspex or glass bearing. The film is made to fluoresce by irradiation with ultra-violet light, so that it may be photographed or observed directly. Some general conclusions can be drawn from preliminary experiments with transparent bearings with a single-hole oil entry. Although the general shape of the flow pattern under constant applied conditions did not vary with time, minor fluctuations were always visible. It was found that the outlet film broke into streaks under any appreciable eccentricity while the inlet film was also incomplete even with high inlet pressures. In theoretical analyses of the complete journal bearing it is usually assumed that the inlet film is continuous from the point of maximum film thickness, and these observations indicate the need for a re-examination of the boundary conditions. The persistence of air bubbles trapped in the film suggests that surface tension may be important. It has been observed that bearing whirl in which the thin-film region rotates around the shaft at one-half of its rotational frequency occurs only when the oil film is complete. Experiments have been carried out to determine the oil-flow requirements of journal bearings. It has been found that even with the oil supply shut off, a lightly-loaded bearing can maintain a load-carrying film for an appreciable time. At high speeds one of the main functions of the lubricant is to carry away the heat generated by friction, and the most efficient way of getting oil into the bearing is being investigated. A single-hole entry does not permit a sufficiently large rate of flow for high-speed operation, and oil-flow with other types of entry, including grooves, is being studied. A method has been developed for automatically recording temperature readings from 100 thermocouples inserted in a radial and circumferential array of holes in a bush of 2-inch bore; this enables temperature distribution in the bush to be measured under equilibrium conditions.—Abstract from the report of the Director of Mechanical Engineering Research, D.S.I.R., for the year 1954.—*The Marine Engineer and Naval Architect, October 1955; Vol. 78, pp. 393–394.*

First Henschel-Pielstick Marine Engines

Henschel Maschinenbau A.G. have acquired extensive rights for the manufacture and sale of the Pielstick 175 mm. by 210 mm. high-performance, four-stroke engine. The first examples built in the Hamburg works are three Vee-12 PA type units, developing 600/750 b.h.p. at 1,000/1,250 r.p.m. These are being installed in the Diesel-electric Great Lakes ship *Christian Sartori,* now completing at the Stülcken yard. This ship will be in general similar to the earlier ones which have Mercedes-Benz pressure-charged engines. The Henschel works are also building the PC type engine, a medium-speed unit of very similar design with 400 mm. bore by 460 mm. stroke.—*The Marine Engineer and Naval Architect, October 1955; vol. 78, p. 402.*

New British Cable Ship

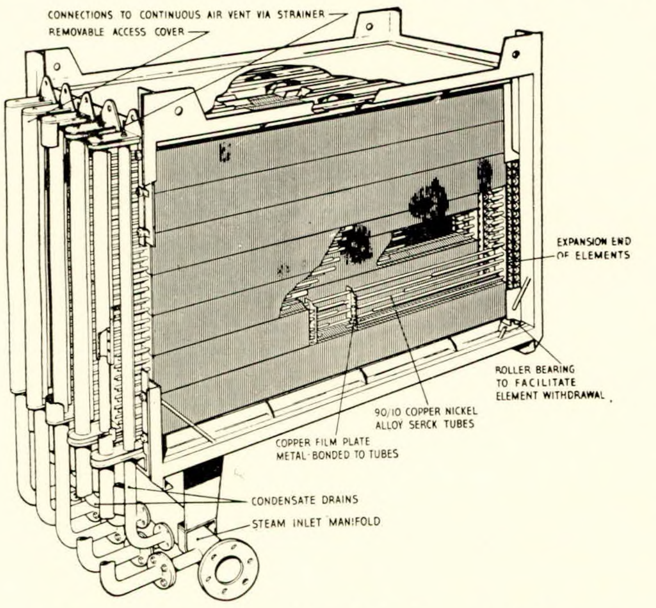
The conversion of a dry-cargo vessel of 5,360 tons deadweight into a cable laying and repair ship for Submarine Cables, Ltd., London, has now been completed. This vessel, now named *Ocean Layer,* was formerly the *Empire Frome,* completed in Germany in 1948 as a dry-cargo vessel to the account of the Ministry of Transport, and purchased by Submarine Cables, Ltd., in 1953. The *Ocean Layer* is equipped with the original engines and boilers from the *Empire Frome,* which have, of course, been extensively overhauled. The main engine is of Lentz type, coupled to a Bauer-Wach exhaust turbine. An electrically-operated reversing gear has been fitted to the Lentz engine on account of the high rate of engine movement required in cable work. The principal particulars of the *Ocean Layer* are as follows:—

Length o.a.	378ft.
Length b.p.	333ft.
Breadth moulded	50ft. 10in.
Depth moulded to upper deck ...	30ft. 4in.
Draught	21ft. 3in.
Deadweight, tons	4,800
Cable tanks capacity	76,809 cu. ft.
Speed, knots	11
Speed with Active Rudder only, knots	2 to 5

Extensive structural modifications have been carried out by the builders. The main transverse bulkheads have undergone certain modifications. The lower hold extending between watertight bulkheads 108-132 will be used for the stowage of buoys and cable gear, served by a 13ft. by 12ft. hatch. An additional bulkhead has been introduced into this space, forming an oil fuel deep tank with a cofferdam over the extent of No. 1 cable tank where the latter pierces the original bulkhead. The cable tanks are cylindrical, No. 1 being 42 feet and No. 2 cable tank 46 feet in diameter. Both tanks are of all-welded construction, having toe-welded stiffeners fitted on the outside of the drum, and extend from the tank top to the main deck. The entire forward section of the vessel has been cut away and new frames and shell introduced, increasing the flare appreciably. The new swan bow has increased the overall length some 20 feet. Anchor pockets have also been fitted. The bow sheaves are carried on substantial longitudinal deck girders and associated structure which has, by reason of the heavy loads, been extensively increased. A new steel flat has been constructed over the vicinity of the forepeak tank, to accommodate the windless engine and vertical drive to the twin-headed capstans. On the main deck forward, in the original No. 1 hold 'tweendeck space, steam-driven submarine cable gear has been sited, the winding drums of which project through specially constructed hatchways on the weather deck. The entire machinery seatings are of fabricated all-welded construction, and special attention has been paid to the strength of this deck. A completely new superstructure has been built on the upper deck, some 156 feet long, together with modifications to the bulwark for housing ship's side ladders. There are two main alleyways to the accommodation, the deck house front being closed by a special watertight double-hinged door giving a 12-inch clear opening. The *Ocean Layer* is fitted with a Pleuger Active Rudder. This comprizes a pear-shaped streamlined housing arranged on the rudder in line with the propeller shaft, and containing an electric motor driving a propeller. The motor is wound for 400 volts, 3-phase, 50 cycles, and is rated at 400 h.p., with a consumption of 294 kW, and a load of 675 amps at the synchronous speed of 720 r.p.m., and on test gave a motor efficiency of 85 per cent when developing 400 h.p. A thrust on test was measured at 29·5lb. per electric h.p. This is the second largest Pleuger unit to be fitted to date, the largest being a unit of 500 h.p. with which the German cargo ship *Falkenstein,* 7,700 tons d.w., is equipped. The Active Rudder can be operated up to an angle of 90 degrees in both directions, enabling movement of the ship to be made in any direction with the assistance of the reversible auxiliary propeller. The name "Active Rudder" was adopted because the auxiliary propeller makes it possible to manœuvre the ship when moving very slowly, or even if stationary, whereas the normal rudder blade is completely passive unless there is a pressure due to the backwash from the main propeller, or the current due to the movement of the ship. The Pleuger motor is cooled and the bearings are lubricated by means of sea water. The windings of the motor are protected against salt water as the motor is completely filled with fresh water, the windings being specially designed to run permanently immersed in fresh water. The speed of the ship when propelled by the Active Rudder propeller only is about 2 to 5 knots.—*The Shipping World, 26th October 1955; Vol. 133, pp. 399–402.*

Bled Steam Air Heaters

The first of a new type of bled steam air heaters, manufactured by Serck Radiators, Ltd., Birmingham, has been installed in the Shell tanker *Vexilla* (31,000 tons d.w.). This vessel has steam turbines working in conjunction with two Babcock and Wilcox watertube boilers having a working pressure of 600lb. per sq. in. gauge, and a steam temperature of 850 deg. F. The air heaters have been designed to heat 79,000lb. per hour of air from 80 deg. F. to 260 deg. F., with a corresponding air pressure drop of 2·3 W.G. when supplied with steam at 35lb. per sq. in. gauge with 89 degrees of superheat. The maximum throughput is 90,000lb. per hour of air. In the *Vexilla,* steam for the heater is bled from the h.p. exhaust turbine. This type of air heater is to be fitted to the remainder of the 31,000 tons d.w. tankers now on order for Shell. The Serck marine bled steam heaters have non-ferrous primary and secondary heating surfaces giving maximum heat transfer. They can be arranged for horizontal or vertical air flow and consist of a battery of elements, each element being built up from the requisite number of standard sections. The heater, having removable elements, is capable of easy access for inspection, and thermal expansion is provided for by allowing the U-tubes to slide on bearing ferrules. The heater offers resistance to atmospheric corrosion and the effects of superheated steam up to 650 deg. F. (344 deg. C.). This is due to the non-ferrous materials forming the elements which provide a particularly high rate of heat transfer with low air pressure loss. In general design the heater consists of a number of elements mounted parallel to the airflow. The elements are arranged on runners inside the heater casing (which is of welded steel construction) so that they may be withdrawn individually by sliding horizontally, affording easy access for inspection. Elements are built up of a number of sections assembled side by side. Each section comprizes four U-tubes threaded through and bonded to the secondary surface fins. The tubes, manufactured in the new tube mills of Serck Tubes, Ltd., are ⅝ inch o.d. 18 SWG (0·048 inch) 90/10 cupro-nickel alloy. The fins are of pure copper, 0·015 inch thick, spaced seven to the inch. According to specification the bond between the tubes and fins is achieved by brazing in a reducing atmosphere or by high temperature soldering. Pipework is designed to eliminate thermal stresses on the steam supply and condensate systems, which systems are self-clearing. All steam and condensate connexions are located at the front of the heater and are arranged to avoid sliding or springing of main flanges when an element is removed. For special installations, aluminium casings may be employed to reduce still further the low weight of the heater. A continuous air vent



General arrangement of Serck bled steam air heater

with strainer is arranged so that the drain header of each element comprizing the heater may operate free of air pockets. A thermo-air vent is fitted to the top balance pipe of the float chamber, the discharge from which is led to the outlet side of the float-operated drain valve. Two steam traps are fitted in the heater drain system and one, a thermo-type, is fitted to drain the steam inlet manifold. On the outlet side of this trap a sight glass is fitted. The header drains are controlled by a Drayton direct-operated steam trap consisting of a float chamber and balanced valve, the valve being connected to the float lever through suitable links and pivots. Each of the heater elements has a separate and independent lead to a drains collecting pot in which the water level is maintained by the float-controlled drain trap at a height approximately 10 inches below the top of the pot. The drain lead from the element at the air outlet end of the heater is led to the drain pot above the water level; the other drain leads are submerged. It will be appreciated that, since each element receives identical steam supply, while the air temperature at each stage is successively higher, the pressure at the drain outlet from successive elements will rise accordingly from air inlet to outlet. Drain pressure, therefore, at the first element will be lowest, since it receives full steam but the air at its lowest temperature. The ultimate element will receive air heated by the other elements but full steam supply nevertheless, so, as it does less work than the other elements, its drain pressure will be the highest. As the drain from this ultimate element is led to the collecting pot above water level, the pressure it exerts will support columns of water of differing height in the submerged drain leads from the other elements. The drain pot is therefore sited sufficiently below the bottom of the heater to ensure that the highest column of water—that inside the first element drain—is well below the drain outlet connexions from all the elements. From this it will be seen that particular care has been exercised to ensure uninterrupted flow from the condensate drains. Valves are arranged to enable both steam traps to be bypassed, and the drains are hand-controlled so that maintenance work can be done if necessary on the traps and the strainers which are fitted upsteam of each of them.—*The Shipping World, 12th October 1955; Vol 133, p. 361.*

Japanese Liberty Ship Conversion

Conversion work is progressing in Japanese shipyards on the large group of Liberty and T2-type vessels sent there by New York Greek shipowners. The group consists of twenty Liberty-type cargo vessels and tankers and six T2 tankers, and they are owned by the National Shipping and Trading Company and the Orion Shipping and Trading Company, both of New York. The work that is being done consists in all cases of lengthening the vessel, while the tankers are also being converted to allow them to carry dry cargoes. A good deal of the work is being done at three ex-Japanese naval dockyards, at Maizuru, Sasebo and Kure, now leased to Iino Heavy Industries, Sasebo Sempaku and Harima Shipbuilding and Engineering respectively. Other firms undertaking some of the work are the Mitsubishi yards at Nagasaki and Kobe, and the Asano yard at Tsurumi, near Yokohama. An extra section 70 feet long is added, this length being the greatest that it is practicable to add. The extra length produces an increase of 1,500 tons deadweight capacity, giving a new deadweight of from 12,000 to 12,500 tons, the exact figure varying with the individual ship. Some strengthening is added to the hull, but no changes are made to the propelling machinery, so that the speed of a 10½-knots ship is reduced to 10 knots. An additional pair of derricks and winches is installed in the cargo vessels for the extra hatch. For the Liberty tankers, the conversion to dry-cargo vessels is the second that they have undergone: they were converted to tankers some years ago in Amsterdam. The extra midships portion for the T2 tankers is 41 feet long, this again being the greatest length practicable. It increases the original deadweight of 16,500 tons by a further 1,270 tons, giving a new capacity of 17,770 tons deadweight. In the conversion to bulk carriers the centre tanks are turned into cargo holds, the side tanks being left untouched so as to be available for ballast, or if required, for oil. No change is made to the machinery, and the speed remains about the same as before.—*The Shipping World, 26th October 1955; Vol. 133, p. 403.*

Great Laker with Inglis-Pametrada Single-casing Turbine

Canada Steamships Lines have recently taken delivery of the *Fort Henry* from Collingwood Shipyards, Ltd., Ontario, for service in the Great Lakes. Unlike other recent additions to the C.S.L. fleet, which are bulk grain and iron ore-carriers, this ship was specially designed for the carriage of palletized package freight on the Toronto, Hamilton and Lakehead service and is the first dry-cargo Great Lake ship to be built for over twenty-five years. In order to meet the close schedule set out for the ship, every effort was made to keep the holds and tweendecks as free from obstructions as possible, so that fork lift trucks, which are used to transport the pallets of package freight to and from the ship, would have every opportunity for fast and easy manœuvring. Four 18ft. long by 9ft. wide hydraulically-operated elevators transport the fork-lift trucks to and from the lower hold and tweendeck. The tank top and main deck are flush and level, both fore and aft and athwartships; they are covered with 1½ inch thick asphalt. The ship has also been arranged to carry grain in bulk and has, therefore, been fitted with six large flush hatches on the spar and main deck. In addition to these six hatches, the main deck has a series of flush trimming hatches fitted port and starboard to permit the grain in the lower hold to be handled properly. The hatches in the spar and freeboard deck were also made flush so that automobiles could be carried on this broad expanse of deck. When carrying grain, the openings in the bulkheads dividing the lower hold into three separate spaces are closed by means of grain boards, as are the spaces in way of the gangway. The elevator openings in the main deck are also provided with hatch covers to prevent grain in the tweendeck shifting to the lower holds. The vessel's principal dimensions are:—

Length overall	461ft. 6in.
Length between perpendiculars ...	440ft.
Moulded breadth	56ft.
Moulded depth	32ft.

The ship was built under special survey to Lloyd's requirements for Class 100 A.1 (Great Lakes Service), but in view of the forthcoming opening of the St. Lawrence Seaway, the vessel's structure has been designed so that she may engage in coastal service, once the Seaway has been completed, with a minimum of additions.—*The Marine Engineer and Naval Architect, November 1955; Vol. 78, p. 445.*

American Gas Turbine Developments

The Solar T-520-522 series gas turbine (500-horsepower drive, constant or variable speed) is an example of the functional simplicity inherent in naval gas turbine power plants. The Solar model T-520-522 series consists of a 10-stage axial flow compressor designed with a tapering rotor tip diameter supplying a single, conventional can-type combustor which parallels the compressor for efficient use of space. Hot gas from the combustor is supplied to a 3-stage axial flow turbine.

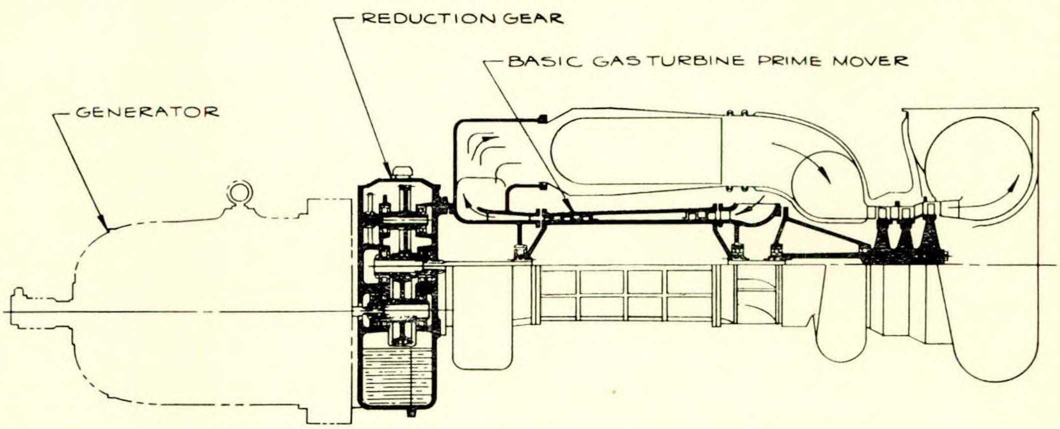


FIG. 1—*Model T-520 constant speed gas turbine*

The third stage turbine is directly connected with the first two turbine stages for the direct-drive unit (see Fig. 1). For the variable drive, the third stage is not mechanically connected with the first two stages, and output power is taken from the third stage through a suitable reduction gearbox. The performance characteristics of this engine are summarized in the accompanying table:—

Ambient air temperature, deg. F. ...	80
Turbine inlet temperature, deg. F.	1,500
Maximum rotational speed of compressor and turbine (all stages), r.p.m.	20,000
Compressor air flow rate, p.p.s. ...	8·26
Compressor pressure ratio	4·87 : 1
Rated gearbox shaft output (continuous), h.p.	521
Specific fuel consumption (continuous h.p.), lb. per h.p. per hr.	0.92

The design life of a gas turbine power plant is predicted by an analysis of such factors as stress rupture, creep, and fatigue life of the material used. However, some indication of the life expectancy of components like turbine blades, gears, and bearings can be calculated from the operational data obtained from similar gas turbine engines. Major overhaul periods for the T-520-522 engines are now set at 1,000 hours. The basic features of the 500-horsepower gas turbine are as follows:—(1) Engine weight is less than 1lb. per horsepower. (2) Dimensions are 60 inches by 32 inches by 40 inches. (3) No reciprocating parts. (4) Diesel fuel, kerosene, or jet fuel can be burned. (5) Adaptable to a 10-second-or-less starting time and requires no warm-up time for the engine. (6) Adaptable to production manufacturing. (7) Requires no engine-cooling water. (8) Torque of 3,150 ft.-lb. at zero output shaft r.p.m. (9) Low lubricating oil consumption as well as low lubricating oil capacity.—*Bureau of Ships Journal, August 1955; Vol. 4, pp. 26–27.*

Gas Turbine Starter

British Thomson-Houston Co., Ltd., have developed a new form of gas turbine starting system of the liquid fuel type which is of more simple design and is lighter in weight than any previous type. It uses the mono-fuel iso-propyl nitrate (i.p.n.) and is intended primarily for starting aircraft turbines, but can be used equally well on industrial and marine units. In the B.T.H. i.p.n. starting system the fuel is decomposed by a combination of heat and pressure only. The heart of the new system is a fuel injector which acts rather like a liquid fuel cartridge. This comprizes a cylinder containing enough fuel for one start, and a spring loaded piston. The start is initiated by a small cartridge which is mounted in an accessible position remote from the starter itself. The cartridge is fired into the starter combustion chamber, and provides heat and pressure. The pressure acts behind the piston in the injector and starts the flow of fuel to the starter chamber. Subsequent decomposition of the fuel in the chamber maintains the pressure to complete the full stroke of the injector. After the start is completed the injector recharges itself by the return of the piston. Because the cartridge pressure is low the initial engagement of the coupling mechanism between the starter and the engine is gentle, being made before the full power of the starter is developed. Moreover, since the amount of fuel available at any one start is only that required for one start, it is much easier to ensure that any form of failure in the starting system is a failure to safe conditions.—*Gas and Oil Power, October 1955; Vol. 50, p. 285.*

Portuguese Third Class Passenger Liner

The *Niassa,* which has been completed at the Hoboken Shipyard of S/A John Cockerill, may be described as a vessel designed essentially for third-class or emigrant traffic. She is to be the flagship of the owners, the Cia. Nacional de Navegaçao, Lisbon, and will run on their Lisbon-Mozambique service. Emigrants from Portugal are now very numerous and the new ship has been designed with a view to providing extremely comfortable accommodation at a reasonable cost. Accommodation is provided for about 300 in cabins for four, six or eight passengers, and the public rooms, including a dining saloon with seats for the full complement of 300, also a large lounge, are all very attractively laid out. The *Niassa* also has a cargo-carrying capacity of about 10,000 tons. The main particulars of the new vessel are:—

Length overall	495ft. $5\frac{1}{4}$in.
Length b.p.	458ft.
Breadth moulded	63ft. $7\frac{3}{4}$in.
Depth moulded to B deck ...	48ft. $0\frac{3}{4}$in.
Draught	27ft. $2\frac{3}{4}$in.
Deadweight, metric tons ...	10,000
Displacement, tons	16,225
Machinery, b.h.p.	6,800
Speed, knots	16.2

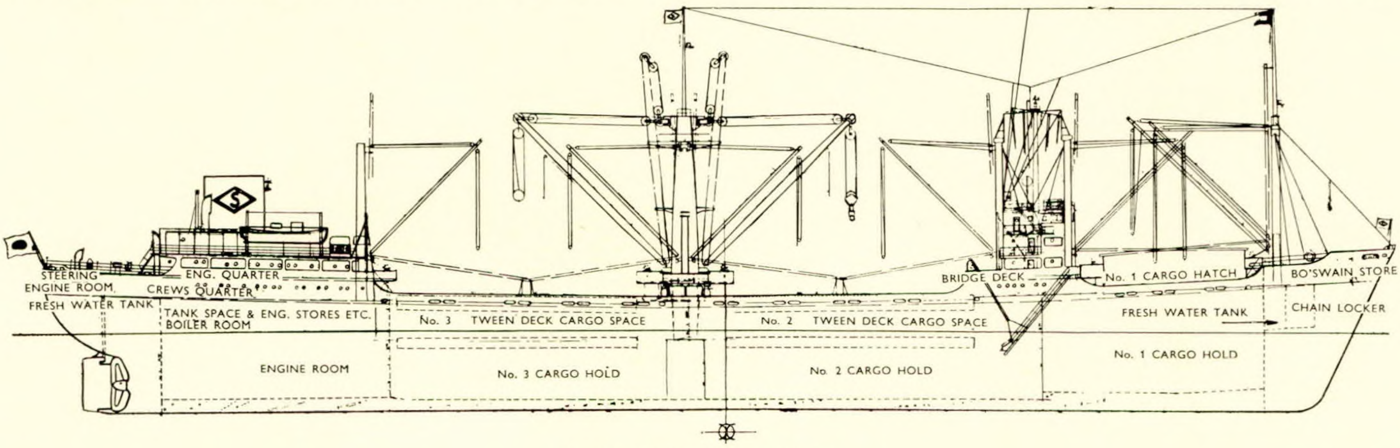
The international status of the shipbuilding industry is exemplified in the *Niassa,* which is a ship for Portuguese owners, built in Belgium and equipped with an engine constructed in Italy under licence from British designers. It is an Ansaldo-Doxford unit of standard design, developing 6,800 b.h.p. in six cylinders at 115 r.p.m., and having cylinders 670 mm. in diameter with a piston stroke of 2,320 mm. The scavenging air is provided from three reciprocating pumps, fitted at the back of the engine, lever-driven from the cross-heads of Nos. 1, 2 and 3 cylinders. For jacket and piston cooling there are two 320-ton Stork fresh water pumps, the water being circulated around two fresh water coolers by a 420-ton sea water pump, for which the ballast pump serves as a standby. The two Houtuin lubricating oil pumps are of 70 tons hourly capacity, and included in the lubricating oil circuit are two coolers and a duplex Auto-Klean strainer for each pump. A De Laval purifier and clarifier installation of four separators is provided for dealing with the boiler oil, each centrifuge being driven by a 7 h.p. motor and having a capacity of 200 litres per hr.; in addition, there is a separator for Diesel oil and two for lubricating oil, the capacity being 4,500 litres per hr. for lubricating oil or 3,000 litres per hr. for Diesel fuel.—*The Motor Ship, November 1955; Vol. 36, pp. 344–346.*

Combustion in Large Diesel Engines

In this paper the composition and physical properties of the fuel oils which are distilled from the world's crude oils are dealt with and the combustion of these fuels and the heat cycle employed to turn the heat of combustion into mechanical work are briefly examined. The development of the combustion system as applied to large marine engines is then described and the influences of the characteristics of the fuel injector—injection pressure, hole size, number of holes—are examined, as are also the influence of the shape of the combustion chamber and the effect of air turbulence on combustion. The influence of the timing and duration of injection, and the effect of pilot injection and of secondary injection, are discussed. The influences of operating conditions of the large marine engine on combustion practice are described, such as the necessity for slow running and direct reversing and the effect of the rating of the engine, compression pressure and maximum pressure, on combustion and economy. The problem of combustion in a large, slow-speed engine, operated on Diesel fuels and given orderly air turbulence, is much simpler than the problem in high-speed high-rated engines. During recent years, however, these marine engines have been required to operate on boiler fuels. The special problems of combustion with such fuels are considered, as are also the preliminary treatment of the fuels, the effect of the deposits on corrosion and wear rates, and experience of boiler-fuel operation and influence on design features.—*Paper by P. Jackson, read at the Joint Conference on Combustion arranged by the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, 1955.*

Japanese Heavy Cargo Carrier

The *Kanto Maru* was constructed at the Nagasaki yard of the Mitsubishi Zosen Kabushiki Kaisha (the Mitsubishi Shipbuilding and Engineering Co., Ltd.) for the Sawayama Steam Ship Co., Ltd. She is designed essentially for carrying heavy cargo, such as rails, locomotives and steel material, also general cargo to South Africa, India and South East Asia.



Profile of the Kanto Maru

She has one heavy derrick of 150 tons and a second of 120 tons. The main particulars of the ship are:—

Length overall, metres	146.10
Length b.p., metres	134.80
Beam, metres	19.00
Depth (moulded), metres ...	11.10
Draught, metres	8.60
Gross register, tons	8,410.36
Deadweight, tons	11,680
Cargo capacity, cu. metres, grain	17,406.7
Speed, knots	13.5
Machinery, b.h.p....	5,250

The engine is of Japanese design, the Mitsubishi Nagasaki MS type, and is a two-stroke single-acting unit, designed to develop 5,250 b.h.p. at 130 r.p.m. The machinery is installed aft, and the engine drives a five-bladed propeller. It is stated that there is very little vibration.—*The Motor Ship, October 1955; Vol. 36, p. 309.*

Fuels for U.S. Navy Gas Turbines

The two principal fuels used by the U.S. Navy are Navy special boiler fuel oil and marine Diesel fuel oil. These two fuels, one for high-pressure steam plants and one for high-duty Diesel engines, supply the energy to propel practically all Navy ships and boats. U.S. Navy Diesel fuel is essentially a straight-run fraction of petroleum. It belongs to the middle-distillate class of fuels. This type of fuel is used in all naval Diesel engines and in small auxiliary gas turbines. U.S. Navy special fuel is a premium-grade residual product. It is made from the heavy residues (bunker oil) resulting from the refining of crude petroleum which to satisfy Navy requirements is then cut back with a high percentage—up to 40 per cent—of lower viscosity distillate stocks. This fuel is known throughout the world. It is used in all naval boilers and in a large number of naval auxiliary vessels employed in military transportation. Although this fuel is residual, its properties are limited in order to guarantee ease of handling during naval operations. The carbon residue of Navy special is approximately 1,000 times the carbon residue of marine Diesel fuel. The ash content is about 100 times greater. To make sure there would be no serious problems in the use of Diesel fuels in auxiliary-type gas turbines, an exploratory programme was started at the U.S. Naval Engineering Experiment Station, Annapolis, Md. The test set-up is shown diagrammatically in Fig. 1. In this programme, tests were made to determine whether a typical small, high-speed, open-cycle type of gas turbine would operate successfully with fuels covering the entire range of properties procurable under the Military Marine Diesel Fuel Specification MIL-F-16884 (SHIPS). The fuels chosen ranged in volatility from those higher than are obtainable in Diesel fuel to those lower than are obtainable in normal Diesel fuel. During the course of the Diesel fuel study, it became evident that dry Diesel fuel would not always be available for use in auxiliary gas turbines. Therefore, a programme was initiated to determine the effect of salt water entrained in Diesel fuel on turbine deposits and corrosion. A series of short tests in which fuel containing up to 0·5 per cent of synthetic sea water was used demonstrated that sea water contamination should be avoided. A combination of salts from the sea water with sulphur from the fuel formed high melting-point compounds that adhered to the turbine casing. During operation, the temperature in the combustion chamber was high enough to maintain these deposits in a molten state. Thus, no appreciable friction between stator and rotor was noted. After shutdown, however, these molten deposits solidified, bridging over the clearance between rotor and stator and freezing the rotor in place. The clearance space is 0·025 inch; thus only a small amount of deposit is required to form the bridge. The adhesion was so rigid that it was impossible to break the rotor loose even by means of the starter fitted to the turbine. It was interesting to observe that in this series of runs—none exceeding sixty-five hours in length—notable corrosion of turbine-blade material occurred. The sodium content of the fuel due to the presence of the sea water was approximately 65 parts per million.—*H. F. King and H. V. Nutt, Bureau of Ships Journal, October 1955; Vol. 4, pp. 9–12.*

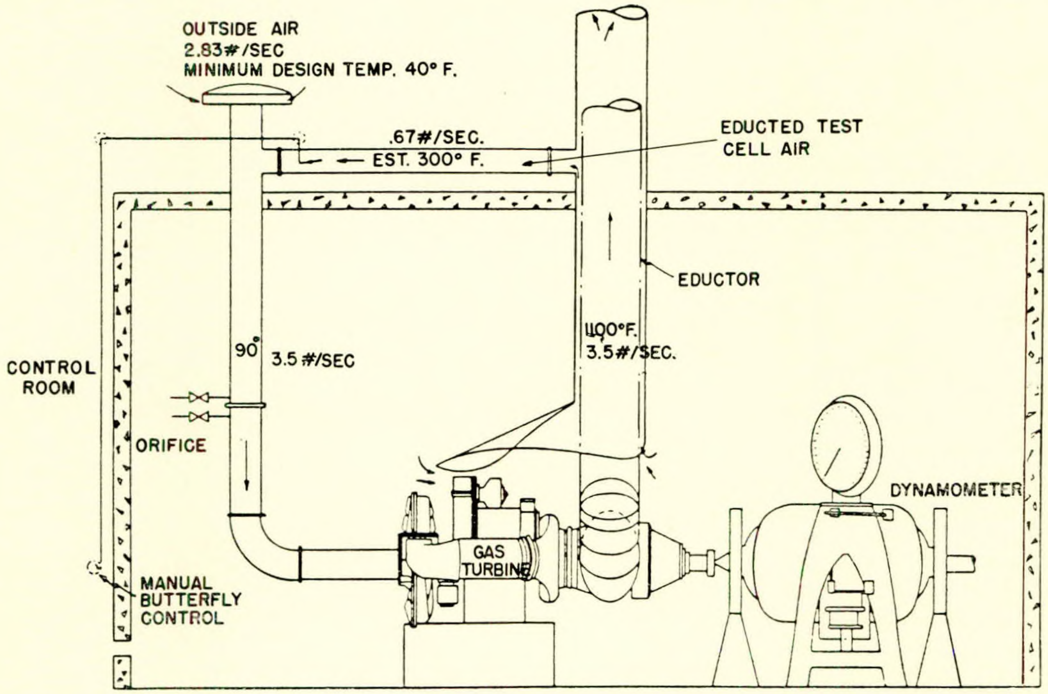


FIG. 1—*In this test cell (shown schematically), a gas turbine was coupled to a dynamometer. The high velocity of the exhaust gas was used in an eductor to ventilate the cell. The warm cell air was further heated as it passed over the outer periphery of the exhaust stack. A portion of this air was blended with outside air to regulate the temperature of the inlet air to the gas turbine. The diagram illustrates how the educted test cell air was blended with outside air*

Canadian Diesel Electric Ice Breaking Vessel

The Diesel-electric, ice-breaking, passenger, car and cargo ferry *William Carson* has been designed to operate between North Sydney, Nova Scotia, and Port-aux-Basques, Newfoundland. The *William Carson* has been designed by Canadian-Vickers, Ltd., to meet the special requirements of the service, while the construction has been supervized by officers of the Department of Transport. The principal dimensions and other leading characteristics of the *William Carson* are given in the accompanying table:—

Length overall	350ft. 10in.
Length b.p.	325ft.
Breadth	68ft.
Depth to upper deck	34ft. 9in.
Draught	19ft. 3in.
Gross tonnage	8,300
B.H.P.	12,000
Service speed, knots	15

The vessel has been designed to facilitate rapid loading and discharging of cargo, and a most modern system has been devised, which incorporates arrangements at each of the terminal ports, as well as on board the ship herself. Cargo is loaded into large containers, prior to the ship's arrival in port, and these containers are then towed into the vessel's cargo deck through large shell doors. The main propelling machinery consists of a Diesel-electric system, driving twin propellers aft and a bow propeller; the last-mentioned is employed during ice-breaking operations and while manœuvring.

Three propulsion motors are provided, and these are driven by six 1,375-kW, 925 volts d.c., generators. The after propulsion motors, each of 5,000 s.h.p., 900 volts d.c., operate at 170 r.p.m., and provide a service speed of 15 knots with the bow propeller idling. When the forward propeller is in operation, the total power available is divided equally over the three propulsion motors, and thus the forward propulsion motor is designed to produce 3,330 s.h.p. at 900 volts. The propulsion generators are driven by six 12-cylinder, opposed-piston, oil engines, each rated to develop 2,000 b.h.p. at 750 r.p.m. These generating sets are arranged in one engine room in groups of two. Each Diesel engine drives a lubricating oil pump, a sea water pump and a fresh water pump, while one motor-driven standby pump for each of these duties is also installed. The two after-propulsion motors are separately excited and are capable of absorbing full power down to 136 r.p.m., while the torque can increase gradually as the r.p.m. drops to a maximum of 200 per cent at stalling point. Cooling is effected by an enclosed circulating-air system; sea water is used to cool the air. The circulating pump, a standby for which is provided, is motor driven, and an extension of this pump shaft drives a lubricating oil pump to service the propulsion-motor bearings. This lubricating oil system is of the gravity type, and can supply the bearings with oil for some time in the event of pump failure. All the shafting is of forged steel. The propellers are of the four-blade built-up design, and are constructed of material to D.O.T. specification for ice-breaking. The thrust blocks are of the Michell type. A pneumatic brake can control the windmilling of the forward propeller. This brake is remotely operated, and can only be applied at 10 r.p.m. or less. Hand brakes are fitted on the after shafts.—*The Shipbuilder and Marine Engine-Builder, November 1955; Vol. 62, pp. 646–648.*

Combustion Products and Wear in High-speed Compression-ignition Engines

Combustion in the Diesel engine is usually studied with a view to improving engine performance. However, in many cases the study of the nature of the products of combustion is of prime importance because of their influence on engine life and maintenance. This is particularly true when attempts are made to use low-grade fuels in medium-speed and high-speed engines. Although it is generally acknowledged that the use of such fuels results in accelerated wear, particularly in the upper liner and piston assembly, the mechanism by which this is brought about is not at all clear because of the lack of positive information derived from systematic experiments. The present investigation was made in an attempt to elucidate the nature and causes of such wear and their relation to the properties of the combustion products. Commencing with a critical examination of the existing theories on the nature and causes of wear, which, not unnaturally, tend to lay emphasis on the acid formation due to sulphur content in such fuels, a series of experiments was carried out to assess the extent of corrosion in an engine cylinder. This is done by (1) the determination of dew-point, hence the sulphur trioxide content in the exhaust gases, by the British Coal Utilisation Research Association's (B.C.U.R.A.) dew-point meter, and (2) quantitative measurement of corrosion of test-pieces exposed to the combustion gases both in the combustion chamber and in the exhaust under various controlled surface temperatures. The results of these experiments indicated that, contrary to the prevailing belief, corrosion is not an important factor contributing to wear under normal full-load operating conditions. It is suggested, in the light of theoretical work at other laboratories, that the conversion of sulphur dioxide to sulphur trioxide is inversely proportional to the total sulphur present, with the result that only a constant low level of sulphur trioxide concentration could exist. Furthermore, owing to adsorption by the carbonaceous particles present, the sulphur trioxide formed is rendered inactive in raising the dew-point of the combustion gases. The findings directed the investigation from corrosion to abrasive wear caused by the large quantity of hard carbonaceous deposits commonly experienced when using certain class B fuels. A rig for wear measurement was developed by means of which the abrasive properties of the carbonaceous deposits from different fuels were compared on a quantitative basis. Some idea of the hardness of these particles was also obtained by a scratching test in which the carbonaceous particles were rubbed against a polished surface of known hardness. In another series of tests the relative amounts of the carbonaceous deposits from the class A and B fuels were compared in a quantitative manner. The results of all these tests give strong evidence that the abrasive action of the hard carbonaceous deposits is the main cause of wear under normal operating conditions. A detailed examination of the properties and fine structures of these deposits followed, use being made of micro-chemical analysis, ordinary and electron microscopy, X-ray diffraction, and spectrographic analysis. While the formation of carbonaceous deposits and their fine structures are not at all clear and require much further fundamental investigation before they can be properly understood, the present investigation enabled a theory to be developed as regards their mode of deposition in an engine cylinder. Some microscopic properties of these deposits have been examined and their relation to engine wear established.—*Paper by W. T. Lyn, read at the Joint Conference on Combustion arranged by the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, 1955.*

Corrosion Due to Flue Gas Condensation

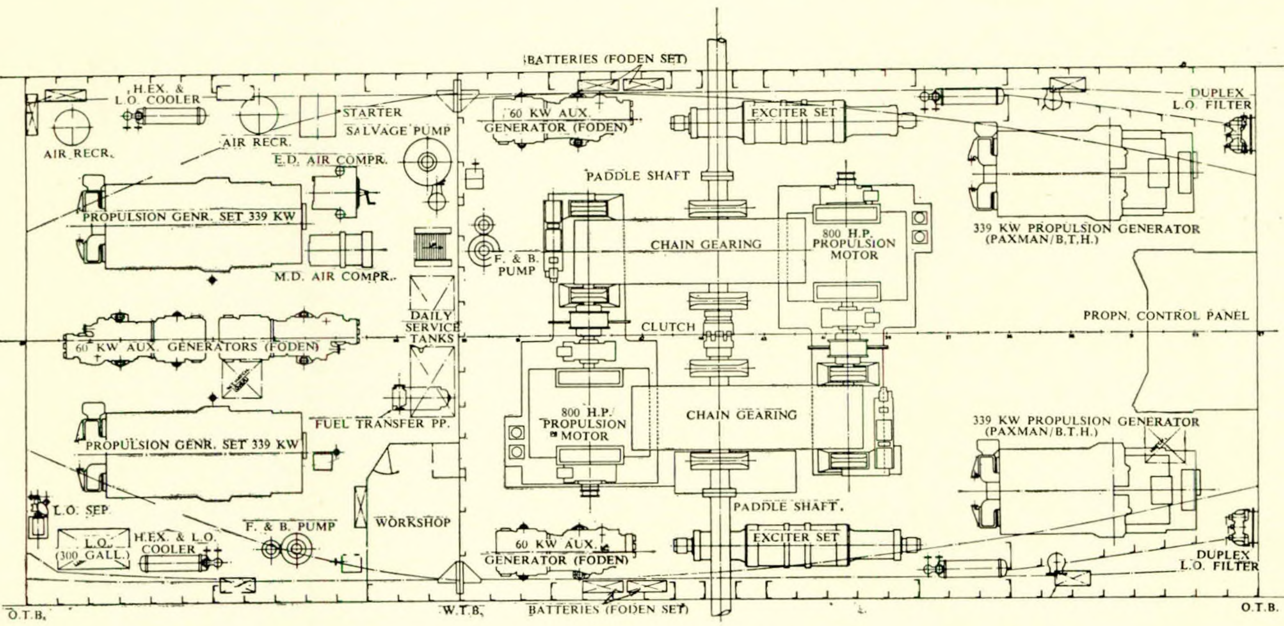
This paper deals specifically with the corrosion caused by the deposition of sulphuric acid on metal surfaces of marine boilers which are below the dew-point of the combustion gases. The products of combustion leaving the furnace consist almost entirely of nitrogen, oxygen, carbon dioxide, water vapour and sulphur dioxide. However, some of the sulphur dioxide (SO_2) can react with the excess oxygen to form sulphur trioxide (SO_3). The final conversion obtained for this reaction is controlled by the equilibrium constant and the reaction rate. The equilibrium constant determines the maximum conversion attainable after an infinite length of time. The reaction rate determines the amount of SO_2 converted to SO_3 per unit time. If the reaction rate is fast enough to attain equilibrium conditions, the equilibrium constant controls the total conversion obtainable. From measurements such as dew-points, gas and fuel analysis, it has been generally found that in boilers the conversion of SO_2 to SO_3 is usually below 10 per cent. At the furnace exit the conversion of SO_2 to SO_3 is usually below 1 per cent for normal load conditions. Any further conversion of SO_2 to SO_3 after leaving the furnace takes place probably with the aid of catalysts, since the normal reaction rates would be too low. While the conversion of SO_2 to SO_3 normally is done in the gas phase, it can also be accomplished in the liquid phase. The initial deposition of sulphuric acid would be due to SO_3 which was formed in the gas phase. This deposition would be purely a type of dew-point condensation. The acid film thus formed would attack the metal, eventually forming ferric sulphate. The methods of counteracting the corrosive effect are limited. High boiler efficiencies make low temperature flue gases a necessity, despite corrosion problems. Efforts are constantly being made to keep the temperature of the heating surfaces above the dew-point range, such as raising the feedwater temperature entering the economizer. Another promising avenue of approach is the use of coatings on air heater and economizer surfaces.—*Paper by H. Gitterman, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, July 1955; Vol. 10, p. 43.*

Paddle Tugs for H.M. Dockyards

In announcing that the order for two new dockyard tugs is to be increased by five more, the Admiralty have released a number of additional details of these craft. They will have independent Diesel-electric drive to the paddle shafts and, with their Admiralty Standard Range prime movers, will be vessels of considerable interest. There are a few Diesel-electric paddle vessels in service in this country, among which may be mentioned the Denny-built and -operated craft on the Queensferry passage and the *Farringford* running between Lymington and the Isle of Wight. As these are passenger-carrying vessels, independent drive to the paddles is not required or, indeed, allowed by regulations due to the danger of a " live " passenger load moving to one side and listing the ship sufficiently to raise one paddle out of the water. Shortly before the war Hungarian owners put a Diesel-electric paddle tug in service. This was the Danube tug *Szechenyi.* She had three 400 b.h.p. Ganz-engined generating sets which provided power for a 1,000 b.h.p., 35 r.p.m. direct-coupled propulsion motor. For dockyard work, the Admiralty has found that paddle tugs, of which they still have ten ranging from thirty-nine to fifty-six years old, are most suitable for moving large warships, particularly aircraft carriers, through narrow lock entrances and in the confined waters of the basins. To enable them to operate under the overhanging sides of aircraft carriers, the new tugs have hinged masts, squat funnels and a turned-back stem. The orders for the first of this class have been placed with Yarrow and Co., Ltd., Scotstoun, who are shortly to lay down the *Director* and *Dexterous,* and with Wm. Simons and Co., Ltd., Renfrew, who are also to build two. Details of the remaining three contracts have not been announced. Although intended primarily for harbour service, the ships are being constructed under special survey of Lloyd's Register of Shipping for " towing and salvage services ". They will have a load line assigned to them so that they can proceed to sea. The principal particulars are as follows:—

Length overall, ft.	157
Length between perpendiculars, ft. ...	145
Moulded breadth, ft.	30
Breadth over sponsons, ft.	60
Moulded depth, ft.	15
Draught, ft.	10
Speed, running free, knots	13
Bollard pull (estimated), tons ...	15
Displacement, tons	710

The propelling machinery of these tugs is to consist of four Diesel generator sets which provide power for two independent propulsion motors. In normal service, all four generators and the two propulsion motors are in the same series circuit. Each propulsion generator consists of a Paxman engine, rated to develop in this application 500 b.h.p. at 1,000 r.p.m. and directly coupled to a 339 kW 305-volt B.T.H. generator. As will be seen from the drawing, two of the propulsion generator sets are contained in one compartment and the other pair in the motor room. The propulsion motors are each 800 h.p., 600-volt, 210 r.p.m. machines and are coupled through an 8 to 1 reduction ratio Renold chain drive to the independent paddle shafts. In normal harbour service where rapid manœuvring is important, the paddles will be independently operated, but when proceeding to sea or for making passages, a dog clutch between the two half-shafts will be engaged. The motors are of two-bearing type and drive the two-bearing sprocket pinion shafts through flexible couplings. The driven sprockets are each carried in two 12½-inch Cooper heavy-series marine roller bearings of the pedestal type. Each driven sprocket is connected to its paddle shaft through a semi-flexible coupling, the paddle shaft being supported on one main paddle block. The sprocket pinions are carried in 7-inch roller bearings of similar type.—*The Marine Engineer and Naval Architect, November 1955; Vol. 78, pp. 416–418.*



General arrangement plan of the generator and motor rooms. Of particular interest are the widely-dispersed propulsion generators, the compact auxiliary sets, and the neat disposition of the propulsion motors and chain gearing

Scientific Principles of Combustion and their Application

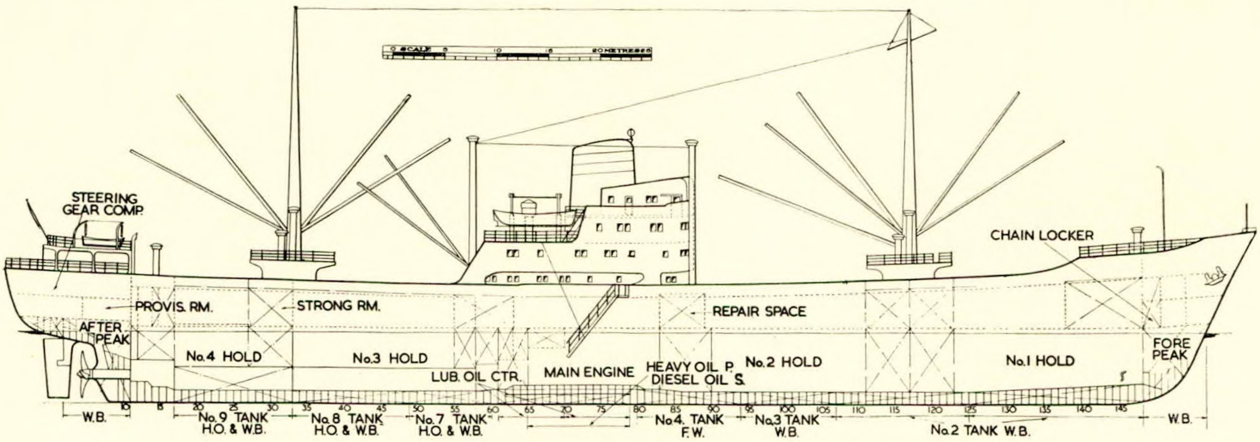
A survey is made of present knowledge of scientific principles in the field of combustion processes. This includes chemical kinetics as a means of understanding the chemical changes occurring during combustion; the propagation and structure of combustion waves as a means of understanding processes of ignition and flame stabilization; and turbulent flame propagation as a means of understanding the processes occurring in combustion chambers. The application of such principles to combustion practice is considered. It is noted that, although in general only minor applications have hitherto been made in the development of technical combustion processes, newer developments can be expected to make increasing use of the knowledge that has developed in the last decade and that is still rapidly growing.—*Paper by B. Lewis and G. von Elbe, read at the Joint Conference on Combustion arranged by the American Society of Mechanical Engineers and the Institution of Mechanical Engineers, 1955.*

New Class of German Cargo Liner

The second of four of a new class of cargo liner for the Hamburg-America Line being built by the Lübecker Flenderwerke A.G., Lübeck, has now entered service. This is the m.s. *Remscheid,* while the forerunner of the series was the *Solingen,* of 5,300 tons d.w.c., having the following dimensions:—

	metres
Length o.a.	118.94
Length b.p.	108.62
Breadth, moulded	16.20
Depth to shelterdeck	7.23
Depth to upper deck	10.15
Draught (approximate)	6.80

hours, in an oil bath maintained at about 200 deg. C. The depth of the hardened zone obtained can be from 1 to 2·5 mm. with a surface hardness of from 400 to 650 d.p.n., depending on the analysis of the steel and the required depth of hardening. The teeth are finally profile-ground. The tooth loading of the reduction gear now in service is below double the Rule value for the primary and a little in excess of this value for the secondary. Service experience which is limited to just over six months has been satisfactory.—*Paper by S. F. Dorey, C.B.E., read before the North-East Coast Institution of Engineers and Shipbuilders, 28th October 1955.*



General arrangement plans of the 5,300-ton cargo liner Solingen

Built as a shelterdecker and to the highest class of Germanischer Lloyd, each ship has a total hold capacity of about 346,000 cu. ft. Part of the tweendecks aft of No. 2 hatch have been arranged for the carriage of refrigerated cargo. These compartments have a capacity of 2,600 cu. ft. and can maintain a temperature of minus 8 deg. C. The four holds and tweendecks are served by four hatches, these being of the following sizes:—

No. 1 hatch ...	10,500 mm. × 5,600 mm.
No. 2 hatch ...	14,700 mm. × 5,600 mm.
No. 3 hatch ...	11,200 mm. × 5,600 mm.
No. 4 hatch ...	7,000 mm. × 5,600 mm.

On the after end of the foremast is a heavy lift derrick serving No. 2 hold, this being capable of taking lifts of up to 60 tons. All other derricks are designed for 5-ton lifts, except for two 10-ton derricks serving No. 3 hold and two 10-ton derricks for No. 2 hold.—*The Motor Ship, November 1955; Vol 36, p. 340.*

Ferrous Materials in Marine Engineering

In this paper, which constitutes the twenty-fourth Andrew Laing Lecture, the author makes reference to a new method of surface-hardening the teeth of marine reduction gearing. This is the tooth-by-tooth induction-hardening process developed by Messrs. Demag, Duisburg. The teeth of both pinions and gear wheels are surface-hardened, and deep-hardening steels have not been used. Both pinions and wheels are of plain carbon steels or 1 per cent Cr. steel, the C content ranging from 0·35 per cent to 0·5 per cent. The forgings are heat-treated by normalizing or oil-hardening and tempering to the specified properties, and then initial cutting of the teeth is completed. The gear is then mounted horizontally in the automatic-hardening machine. The induction-hardening head is set between adjacent tooth flanks which are heated and water-quenched as the length of the tooth is traversed. Both ahead and astern flanks and the root are therefore surface-hardened. The outside flanks of the teeth are water-cooled during this process. The head is withdrawn from the tooth space, the gear is indexed by one pitch and the next tooth space is located for the hardening head to traverse. On completion of surface hardening the gear is tempered for two

New American Towing Tank

The University of California at Berkeley has completed a new ship-model towing tank. This installation replaces the 100-ft. tank built in 1940 and which was operated on a twenty-four hours a day basis during the war. While space has been reserved at the University for a tank up to 1,500 feet long, the present one is only 200 feet long. The design features of the new tank were developed in 1952 by Prof. Laurens Troost of the Massachusetts Institute of Technology. The tank is of rectangular cross section, 8 feet wide by 6 feet deep. The maximum practical water depth is 5 feet 6 inches which, together with the width, limits the maximum length of the models which may be tested to about 6 feet. The carriage which spans the tank is driven by a d.c. motor system incorporating a General Electric electronic-amplidyne control. The carriage speed range is 0·2 to 20 feet per sec. The model resistance is measured by a combined flexure-beam balance dynamometer. The expected accuracies are approximately 0·001 of a knot for speed and about 0·001 of a pound in resistance force.—*Marine Engineering, October 1955; Vol. 60, p. 45.*

Stress Studies of Hatch Corner

Nine large welded ship hatch corner specimens containing welded doubler reinforcement of various shapes at the hatch corner were tested under tension for determining the most effective shape of doubler. The stress distributions were measured in both elastic and plastic states. The shapes of doubler were circular, eccentric circular, oval, trapezoidal, and rectangular. In addition to the above, a specimen of rectangular insert plate and a specimen without doubler were tested for comparison. For all specimens, the maximum stress concentration occurred in the deck plate at the periphery of the hatch corner. The insert plate, eccentric circular and rectangular reinforcements caused the greatest stress concentration; the circular and oval shapes resulted in intermediate values; and the trapezoidal shape yielded the least stress concentration. Local bending of the deck plate occurred near the periphery of the welded doubler for all reinforcement designs being greater in the eccentric circular shape, and least in the insert plate. It was concluded that the eccentric circular shape was inferior, and that the trapezoidal and oval shapes were best.—*H. Kihara, Y. Akita, N. Ando and K. Yoshimoto, The Welding Journal, October 1955; Vol. 34, pp. 465-s–471-s.*

Cleaning Fuel Oil Heaters

A modification of the piping arrangement on an orthodichlorobenzene system that is said to permit a more effective removal of solvent from fuel oil heaters on destroyers is suggested. The present method of blowing a bank of destroyer fuel oil heaters, after they have been cleaned by circulating orthodichlorobenzene, consists of blowing out the heaters with dock air introduced into the piping system immediately above the pump (Fig. 1) and circulated from the bottom to the top of the heaters. The suggestion is to change the dock air point of introduction from above the pump, as illustrated in Fig. 1, to the orthodichlorobenzene return line, as shown in Fig. 2, with a pump bypass valve. This arrangement will permit the air to go in at the top of the heaters, to blow down through the heaters, and to go out at the bottom. Any fluids left in the heater would be pushed down and out of the lower valve connexion, through the piping, and back to the barrel. The Boston Naval Shipyard reports that the suggested reversal of air flow greatly reduces the possibility that any residual orthodichlorobenzene will remain in the heaters.—*Bureau of Ships Journal, September 1955; Vol. 4, p. 40.*

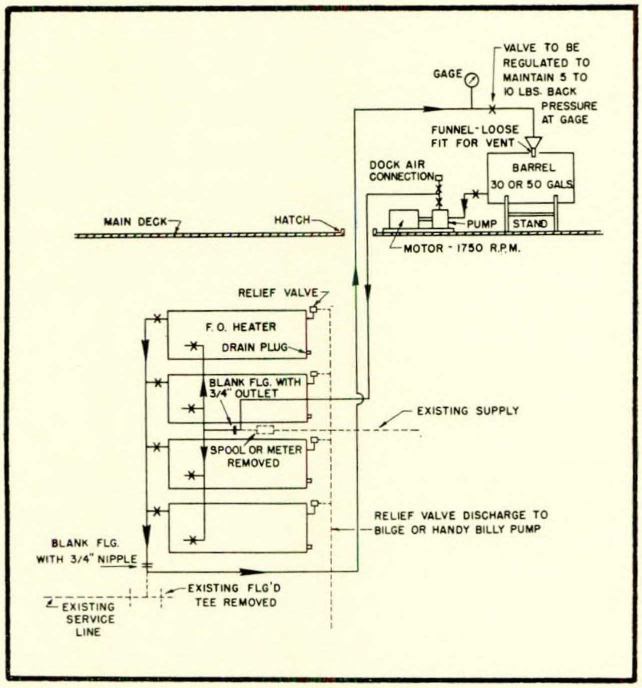


FIG. 1—*Present method of blowing a bank of heaters*

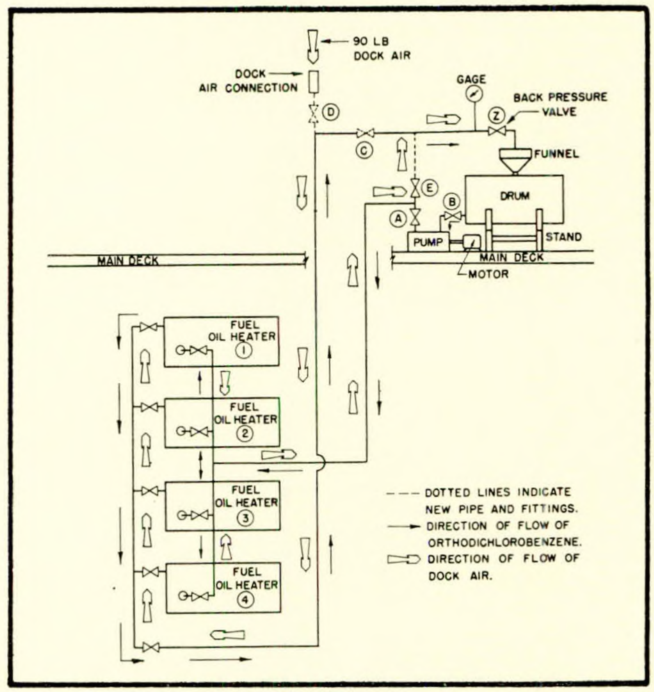


FIG. 2—*Reversal of air flow cleans tanks more thoroughly*

Measurement of Local Turbulent Skin Friction

The surface pitot tube technique for the determination of local skin friction has been extended for boundary-layer flow with adverse pressure gradients. The calibration of round tubes on flat surfaces with zero pressure gradient and with adverse pressure gradient gave results which check almost identically with those obtained in Preston's pipe experiments. It was concluded that the performance of the surface pitot tubes can be calculated by using simplified assumptions. In addition, the ratio of the inner to outer diameter of the tube was shown analytically and experimentally to have a negligible effect on the results.—*E. Y. Hsu, David W. Taylor Model Basin, Report 957, 1955.*

Aspects of Bulk Cargo Vessel Design

The paper has been written in an attempt to make available to others the experience and ideas accumulated by the writer in his capacity as naval architect to a large ship-owning and operating company. The general approach, from the shipowner's point of view, to the problem of design of ships intended wholly or partly for the bulk cargo trades, is discussed with particular reference to the following:—position of propelling machinery; general layout of hull; distribution of water ballast—deep tanks; speed and type of machinery; accommodation position. It is recognized that the problems facing different shipowners may vary to a considerable extent, and therefore a part of the paper is devoted to a description of the present services operated by the author's company. This serves as an introduction to a detailed description of a number of ships which are carrying out these operations and which it is believed are, to a varying extent, somewhat unique in certain features. Outline drawings of these vessels are supplied with the paper, which concludes with the description and drawings of a new structural design for a bulk carrier which has been evolved by the writer and his associates and which is here made public for the first time.—*Paper by J. E. Balfour, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, July 1955; Vol. 10, p. 37.*

Patent Specifications

Variable Pitch Propeller Mechanism

According to the invention, the blades of a variable pitch propeller are turned for adjustment of their pitch by movement imparted by an axial movement of the propeller shaft. Preferably the blades are turned around their pintles by means of toothed segments engaged by racks which are held against axial movement by water lubricated bearings while the shaft is moved axially. Such mechanism avoids any necessity for a long sleeve embracing the shaft, which is of advantage in some cases. For example, it may allow the existing stern tube to be used in the event of the conversion of a ship to variable pitch propeller blades. It may also be of advantage in other cases in which it is desired to save the radial space which would be occupied by a sleeve surrounding the shaft. In Fig. 2 the propeller shaft (1), having the boss (2) secured fast on its outboard end, is arranged to be axially slidable in its bearings, for example a gland and bearing at a bulkhead as well as the bearing (5) in the stern tube (6) secured at the stern (7). At its inboard end the shaft (1) is connected by a coupling permitting relative sliding movement, to the shaft of the engine or gearing by which it is driven.—*British Patent No. 738,707 issued to J. Stone and Co. (Charlton), Ltd. Complete specification published 19th October 1955.*

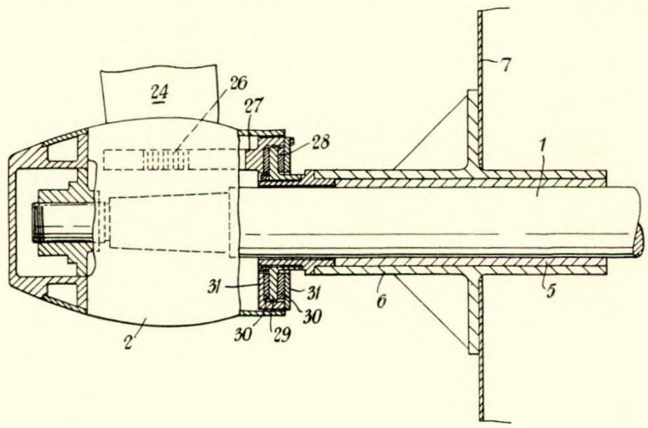


FIG. 2

Marine Power Transmission

An object of the invention is to provide a power transmission mechanism which will enable a marine vessel fitted with two engines to drive two propellers under high power conditions and to employ only one of the engines to drive both propellers when cruising. Referring to Figs. 1 and 2, when the ship is cruising, only one of the gas turbine engines (10) is in operation and the clutch (27) of the gear train (22) between the two low-speed reduction gears (15) is engaged. Thus power is transmitted from the engine (10) in operation to the input pinion (16) of one of the low-speed reduction gears (15) and through this low-speed reduction gear to its associated propeller (11). Power is also transmitted from this low-speed reduction gear (15) through the gear train (22) (since the clutch (27) is engaged) to the other low-speed reduction gear (15), and thus to its associated propeller (11). It will be appreciated that either engine can be employed to drive both propellers (11). Under these conditions it is preferred that the clutch of the high-speed reduction gear (12) of the other engine (10) be in its neutral position. When it is desired to increase the power output above that required for cruising, the second engine (10)

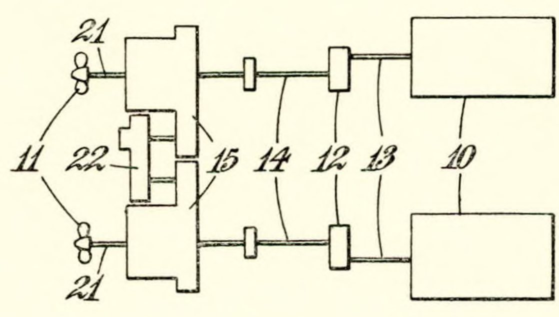


FIG. 1

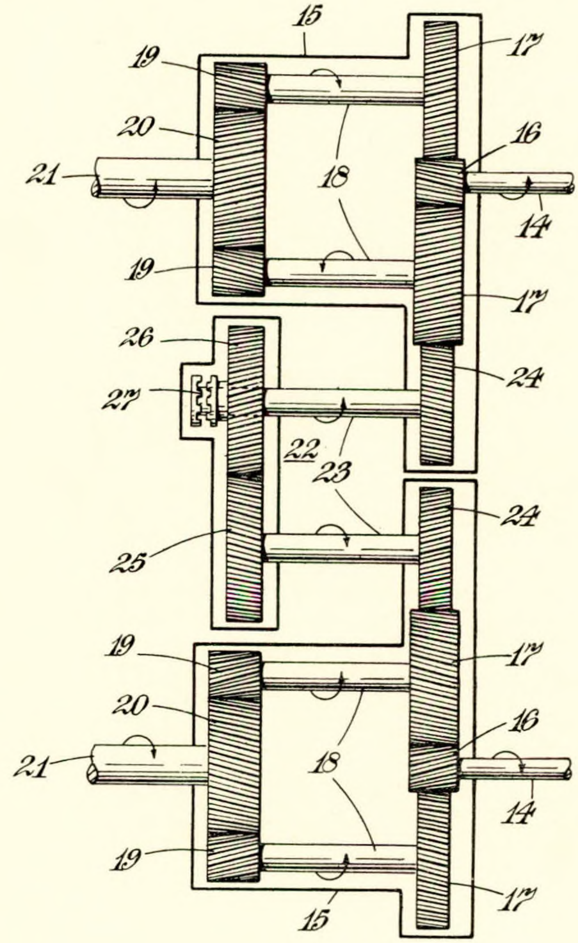


FIG. 2

is started up and the clutch (27) of the gear train (22) is disengaged. The second engine (10) is clutched in to transmit power to its associated propeller (11) and both propellers are then driven by their associated engines (10) independently of each other. The clutch (27) of the gear train (22) may be left engaged, in which case the power from the two engines will be divided between the propellers (11) when both engines (10) are operating, and the propellers (11) and engines (10) will be synchronized and will run at the same speeds assuming that the gearing in each transmission is of the same ratio.—*British Patent No. 742,794, issued to Rolls-Royce, Ltd. (Inventor E. W. Snow). Complete specification published 4th January 1956.*

Water Distillation Plant

Referring to Fig. 1, the heating steam to the evaporating plant enters by a pipe (1) under the control of valve (2), whence it passes through perforated pipes (3) arranged below the water level in the direct-contact heating vessel (4). Raw water to be supplied to the plant is stored in a tank (5) whence raw water

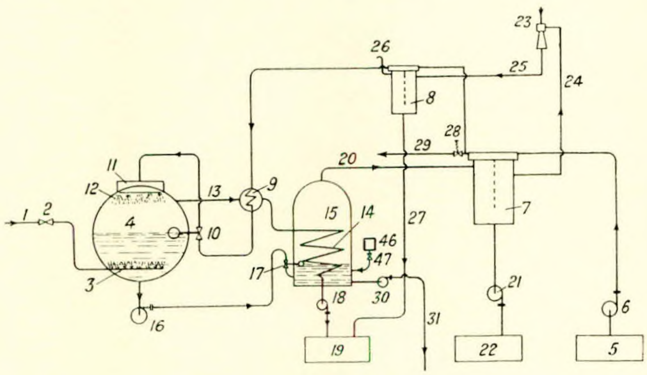


FIG. 1

is drawn by the raw water supply pump (6) and is discharged through the condenser (7) wherein the feed water is used as a cooling means, the air ejector condenser (8), the heat exchanger (9) and the float control valve (10), into the top distributing chamber (11) of the direct-contact heating vessel (4). The greater part of the steam entering the direct-contact heating vessel (4) by way of the perforated pipes (3) passes through the water contained in the bottom of the vessel (4) and leaves by the vapour pipe (13), passing through the heat exchanger (9) to the heating coil (14) in the evaporating vessel (15). The pump (16) draws water from the direct-contact heating vessel (4) and discharges through the feed regulator (17) into the evaporating vessel (15). The vapour passing into the coil (14) is passed by way of the pump (18) into the drain tank (19). The heat from the vapour passing through the coil (14) evaporates water in the base of the evaporating vessel (15), the vapour so formed passing by way of the pipe (20) into the condenser (7), through which the raw water discharged by the pump (6) passes on its way to the direct-contact heating vessel (4). The condensed vapour is withdrawn from the condenser (7) by the pump (21), which discharges into the fresh water storage tank (22). Air and other non-condensable gases are withdrawn from the condenser (7) by means of the steam-operated air ejector (23) by way of pipe (24), and discharged by way of pipe (25) to the air ejector condenser (8), the air and other non-condensable gases escaping to the atmosphere through the pipe (26). Brine from the evaporating vessel (15) is withdrawn by the brine pump (30) and discharged to waste through the pipe (31). The operating steam of the air ejector is condensed in the air ejector condenser (8) and drains by way of pipe (27) to the drain tank (19). The capacity of the pump (6) is in excess of the quantity of water required in the direct-contact heating vessel (4) and the balance which does not pass into that vessel is discharged to waste through the spring-loaded valve (28) and pipe (29). In the operation of the plant, the raw water is progressively heated on its way through the condenser (7), the air ejector condenser (8) and the heat exchanger (9) until its temperature is close to the temperature of the steam in the direct-contact heating vessel (4). The incoming steam through the pipe (1) and perforated pipes (3) passes through the water in the base of the vessel (4), thereby maintaining boiling conditions in that water, so that all the carbon dioxide is driven out, thereby facilitating the break-up of the bicarbonate and carbonate ions. The steam leaving the water is partially condensed on the incoming water from the sprays (12), but the greater part of the entering steam passes by way of the pipe (13) to the coil (14) in the evaporating vessel (15). The raw water supply to the evaporating plant is heated in the direct-contact heating vessel (4) to boiling point and thereafter scrubbed by the passage of steam through the water, so that the bicarbonate and carbonate ions are partly broken up into carbon dioxide gas, water and hydroxyl ions. After the water has been treated in the direct-contact heating vessel (4), the pump (16) discharges the water into the evaporating vessel (15) wherein the water is evaporated for the production of pure water.—*British Patent No. 741,815, issued to G. and J. Weir, Ltd., and H. Hillier. Complete specification published 14th December 1955.*

(Complete British Specifications can be obtained from the Patent Office, 25, Southampton Buildings, London, W.C.2. Price 3s. 0d. each, both inland and abroad.)

Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 3, April 1956

Miscellaneous Uses of Electricity in Ships

The following are brief references to recent developments: a method of detection of leaks in the ferrules of condenser tubes consists in the introduction of small quantities of Fluorescene into the tube and the merest " weep " is shown up in the ultra-violet light of a black-glass lamp which is portable and mains-operated. It is now standard practice to use vertical-spindle motors and pumps, thus considerably reducing the demand on floor space. Extensive telephone systems are now common, and in large passenger ships it is usual to find a telephone in each cabin. For instance, in the s.s. *Arcadia* and her sister ship *Iberia,* there is a 600-line manual and a 200-line automatic telephone system to provide service for passengers and administrative channels for officers and crew. Passengers can make service requests or can communicate with each other. Stewards' telephones have associated signal lamps which remain alight after the normal audible signal to warn the steward to call the operator on his return from other duties. Fire alarm systems and patrol systems are also normal practice. From any of the established control points, telephone communication can be established with the officer of the watch. In whale-catchers, electrocution of the catch has proved successful. The harpoon is connected to the catcher by a trailing cable, and on striking the whale causes instant paralysis, followed shortly by painless death. The weapon hitherto used consists of an explosive head harpoon. For humanitarian reasons it is hoped the electric system will be more widely adopted. Plural-start systems in which a large number of motors are coupled to one starting panel, all being started by a common starter as required by pushbutton control, continue in demand. This system economizes space on the engine room floor and has been used to control as many as forty motors ranging from the smallest sizes up to 250 h.p. Except for a limited application of panel heating, space heating, where performed electrically, continues on the basis of convector-type heaters and low-temperature enclosed radiators. Mechanical connectors in place of sweated thimbles have not yet made headway in this country, although they are now standard practice in the United States, where many excellent and reliable connectors are marketed. They usually require special tools and have to be of appropriate dimensions for each different size of conductor.—*G. O. Watson, Proceedings of the Institution of Electrical Engineers, August 1955; Vol. 102, Part A, No. 4, pp. 429–435.*

Plastic Ductwork

With the increasing use of plastics for shipboard applications, the Bureau of Ships is investigating the advantages of using plastic instead of metal in the fabrication of ductwork. Some of the advantages anticipated from the investigation are:—(1) Corrosion resistance in installations where acid fumes or other corrosive fumes are being handled. (2) Saving in weight where corrosion-resistant material is required. (3) Improved sound attenuation (noise reduction) characteristics. (4) Improved non-magnetic properties. (5) Saving in cost over metal as production increases. The two plastics which appear satisfactory for this application are rigid unplasticized polyvinyl chloride sheet (thermo-plastic) and fibrous glass mat or cloth-filled polyester resin (thermo-setting). Of the two plastics, rigid polyvinyl seems the more promising for extensive ductwork, since the fabrication and installation techniques used with this plastic are similar to those used with metal. On the other hand, fibrous glass reinforced ductwork requires forms around which the fibrous glass is wrapped before application of the polyester resin. The greatest disadvantage of using polyvinyl sheet is its loss of tensile strength at temperatures above 150 deg. F. Its use in engine rooms or other hot spaces may not be practicable. As a phase of the plastic ductwork research programme, the Bureau contracted with the B. F. Goodrich Company to develop techniques for fabricating, installing and repairing rigid vinyl ductwork. The methods will be tested by Consolidated Shipbuilding Company in the application of vinyl plastic ductwork in one of the main ventilation systems on the AMCU-43. Fabrication, cost and service experience on this vessel will form the basis of future vinyl plastic ductwork applications.—*H. J. Stark and A. E. DeSomma, Bureau of Ships Journal, August 1955; Vol. 4, pp. 20–22.*

Kort Nozzle Propulsion of Ships

The Kort nozzle is a profiled ring shrouding the blade tips of the turning screw propeller. Its profiles are similar to the profiles of an airplane wing. This ring is either fixed to the underside of the ship's stern or it takes the place of the ship's rudder, and swivels, actuated by the steering gear, to port and starboard around the turning disc of the propeller. The practical value of the nozzle is to reduce the losses between the power of the driving engine and the useful driving thrust produced by the propeller. This reduction of loss respectively this gain over the performance of an open propeller is greatest, when there is a big difference between the speed of the water arriving at the propeller at about ship's speed and the speed of the water in the jet leaving the propeller, i.e. its acceleration imparted to it by the action of the turning propeller. This explains why the nozzle is of eminent importance for tugboats or trawlers when towing, or on propellers of rather small diameter which are driven by fast-turning engines, such as are customary on the majority of motor coasters, and also on comparatively small fast boats with high power like minesweepers and other navy craft. Without any increase of fuel consumption and cost of upkeep, and without any change of the engine installation, the available towing power when handling big vessels in port will increase 40 to 50 per cent per s.h.p. and 25 to 30 per cent when towing at a speed of 4 to 5 knots. On motor coasters and motor cargo boats for inland navigation the speed will increase by between 0·4 to 0·7 knots. Another important advantage is observed when a ship is pitching in seaway. A careful investigation has shown that, under certain normal seaway conditions, the speed of an 11-knot vessel dropped to 5·6 knots without nozzle and to 7·9 knots only at somewhat less power with Kort nozzle. A tugboat in Falmouth during uniform daily towing service from harbour to sea gained during a whole winter season an average of 25 per cent in towing speed and saved in addition 13 per cent in fuel after a Kort nozzle was fitted, compared with her former winter performance without nozzle. In addition to these advantages for ships with fixed nozzles, the Kort nozzle rudder provides manœuvring capabilities which are absolutely unequalled by any boat with open propeller and normal rudder, namely: quick and reliable ahead and astern steering to any desired direction with small turning circles and at much reduced rudder angles. The swinging movement ahead and astern sets in even from dead-stop position of the ship. A powerful tug is usually stopped from the free speed at full power ahead within one or two times her length.—*E. K. Roscher, Shipbuilding, 1955; Vol 1, No. 1, p. 84.*

Dutch Motor Tug

The motor tug *Independent IV*, built by C. V. Jonker and Stans, Scheepswerf en Gashouderbouw, Hendrik Ido Ambacht, for the N.V. Verenigde Onafhankelijke Sleepdienst, Rotterdam, has been delivered to her owners. The tug has been specially designed for operation in the port of Rotterdam, and is of extra heavy construction. The vessel is arranged to carry out all types of towage in the port and, in addition, is equipped to assist medium-sized oceangoing vessels. The principal dimensions are as follows:—

	metres
Length overall	19·75
Length b.p.	17·75
Breadth	5·05
Depth	2·50
Draught	1·80

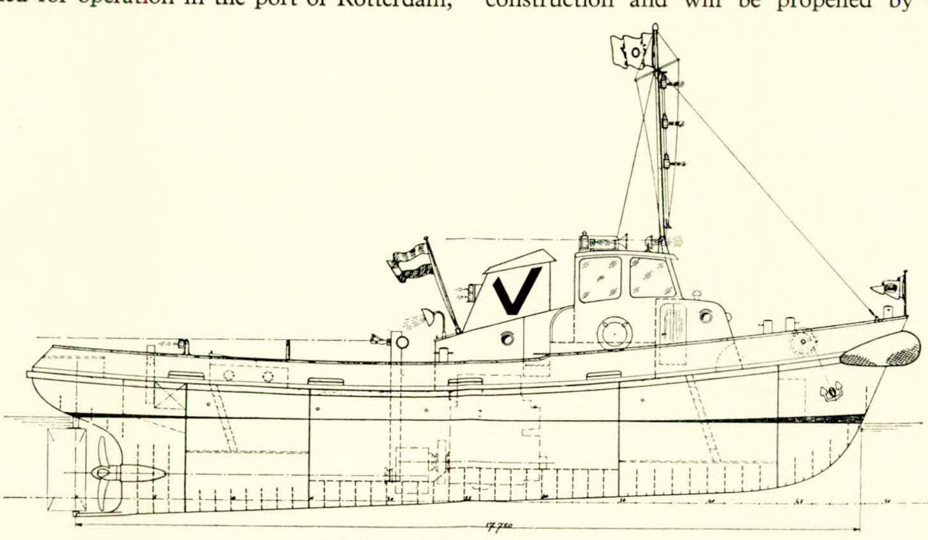
The propelling machinery of the *Independent IV* consists of a four-cylinder "Bolnes" Diesel engine of the welded type. This is a two-stroke engine with an output of 200 e.h.p. at 430 r.p.m. Via a "Brevo" hydraulic coupling with 2 : 1 reduction, the engine drives a grafista propeller delivered by Lips' Schroevengieterij, Drunen. The coupling is arranged for direct control from the bridge.—*Holland Shipbuilding, October 1955; Vol. 4, p. 46.*

Horizontal Balance Beam for Lifting Propellers

Equipment that facilitates removal and installation of propellers weighing up to 17 tons on ships in drydock is now in use at the Norfolk Naval Shipyard. The equipment is a beam attached midway of its length to cables which suspend it horizontally from a drydock crane. After the propeller is rigged to one end of the beam, a counterweight can be moved along the beam toward the other end to various points, at which the weight will balance a propeller weight of 5, 7·5, 10, 12·5, 15, or 17·5 tons. The counterweight is moved along the beam by a screw which is controlled from the drydock floor. Another advantage of the equipment is that it can be used to give an overhead crane an additional 15 feet of horizontal reach.—*Bureau of Ships Journal, August 1955; Vol 4, p. 38.*

Dutch Beertanker

After the oil-, the gas-, the ammonia-, the water- and the winetanker, a vessel believed to be the first beertanker in the world has been launchd at the N.V. Scheepsbouw Maatschappij, v.h. Fa. H. Schouten, Muiden (near Amsterdam). The vessel is to carry 120 tons of "young" beer in bulk, and for this purpose is being fitted with four enamelled tanks each arranged for the carriage of 30 tons of this liquid. Arrangements will be fitted to enable the heating of the cargo. Each of the tanks will be 10 metres in length and will have a diameter of 2·5 metres. Electrically driven cargo pumps will be used to handle the cargo. The principal dimensions of the ship are as follows:—length overall, 32·80 metres; length b.p., 31·80 metres; breadth moulded, 5·60 metres; depth 1·80 metres; draught 1·40 metres. The ship will have a displacement loaded of 200 tons. The ship is of fully welded construction and will be propelled by one M.W.M. Diesel



Motor tug Independent IV

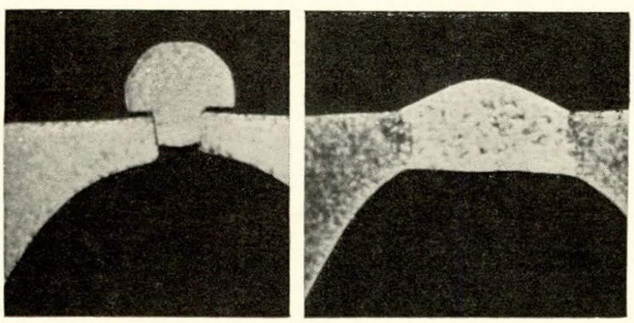
engine with an output of 150 h.p. at 1,150 r.p.m., 3 : 1 reduction gear being fitted. The height of the ship has been kept so as to enable it to negotiate the various bridges on its route. —*Holland Shipbuilding, October 1955; Vol. 4, p. 34.*

Value of Notch Tensile Test

A history of the development at Cambridge of a notch tensile test for the investigation of brittleness in structural mild-steel is described. The test procedure and the methods of assessing the temperature limit at which the material becomes brittle are outlined in Part I. Investigations of material from an oil storage tank and from ships which fractured in service show that this notch tensile test gives good correlation with these casualties whatever the nominal stress in the plates at the time of the fracture. The results of Charpy V-notch and Izod tests are given for comparison, and it is shown that the energy absorption criterion used in these tests may be misleading (Part II). In Part III, experiments are described in which the tensile test has been used to predict performance in test-pieces of more complicated geometric form. Criticisms of the notch tensile test are dealt with in Part IV. In the conclusions, attention is drawn to the fact that the designer of orthodox fabricated structures must be provided with material which is ductile at all operating temperatures and at all stress levels.—*Paper by J. F. Baker, read at a General Meeting of the Institution of Mechanical Engineers on 28th October 1955.*

Root Weld Insert

A wire of special cross section obtained by machining, cold-rolling and cold-drawing has been developed for the welding of pipes in the atomic powered submarine *Nautilus.* This wire, known as the E.B. root weld insert, is available in two sizes and in many compositions. In the left-hand illustration the insert is shown in cross section fitted between the prepared surfaces of two pipes. The internal surface of the pipe having been purged with argon gas, the insert is tack welded, using only an argon arc torch. Completion of the root pass by playing the argon arc on to the insert and joint surfaces results in a capillary movement of the insert metal into the position shown in the right-hand illustration. The capillary forces are such that in the welding of the tube the internal surface contour is independent of whether the weld is taking place in an overhead, horizontal or vertical position. This consumable E.B. root weld insert will make joints in a wide variety of alloy steels and in some non-ferrous alloys, without reliance on a very high degree of skill on the part of the welder. In the construction of a piping system for the handling of radioactive fluids, such as occurred in the automatic powered submarine *Nautilus,* corrosive attack in crevices could cause a shut down of the equipment and repairs might not be possible for months or even years, until the level of radio activity was sufficiently reduced to permit exposure to the workmen during repairs. The piping installation therefore had to have a completely reliable root pass welding technique. The composition of the weld insert requires careful metallurgical selection and in many cases the preferred composition of the weld metal differs from that of the metal being welded.—*The Shipping World, 9th November 1955; Vol. 133, p. 456.*



Left : insert shown in cross section   Right : insert metal after welding

Heat Transfer Problems of Liquid-cooled Gas-turbine Blades

In this paper a survey has been made of possible methods of cooling turbine rotor blades, of which it is suggested that the most attractive is the thermo-syphon system, in which a quantity of liquid coolant is enclosed within each blade to act as a conveyor of heat to the more easily cooled root. The effectiveness of the system was demonstrated in experiments using a rotating apparatus, from which, also, the interesting result was obtained that over a wide range the heat transferred from the heated to the cooled ends of the thermo-syphon is independent of the quantity of coolant enclosed. This result, which has great significance for turbine-cooling applications, has been confirmed in experiments with a static rig, from which, also, further details of the mechanism of the heat-transfer process have been obtained. For the system using very small quantities of coolant, an ideal theory of the heat-transfer process is postulated which is in qualitative agreement with the experimental observations, and which suggests that internal-blade-to-liquid heat-transfer coefficients will be so large compared with any others in a cooling system as to be effectively infinite, an assumption which is confirmed by comparison with results obtained from the rotating rig. The heat-transfer process in the thermo-syphon when the heated length is full of liquid is shown to depend largely on the motion of vapour bubbles within the liquid column and, on this basis, results obtained over a wide range of conditions have been correlated by dimensional analysis. In applying this system to the cooling of turbine blades, it is most important to determine at what heat flow film boiling will occur, since, at this condition, effective cooling fails. A criterion for the maximum rate of heat flow has been determined from the static-rig tests, but, like much of the data reported in the paper, it is in urgent need of confirmation by results obtained from tests on turbines or other apparatus operating under realistic conditions of speed and gas temperature.—*Paper by H. Cohen and F. J. Bailey, submitted to the Institution of Mechanical Engineers for written discussion, 1955.*

Diesel Engine Liner Wear

A special cylinder oil developed by Socony Mobil has shown marked success in retarding liner wear. It is not a cure-all; reductions of liner wear may be in the order of 35 per cent or 10 per cent, depending upon the type of engine and fuel employed. A 20 per cent reduction is average. Most important is that the advantages claimed for the new oil, named Gargoyle DTE S-250, are backed up by 50,000 hours of actual aboard-ship operating tests. These tests were made

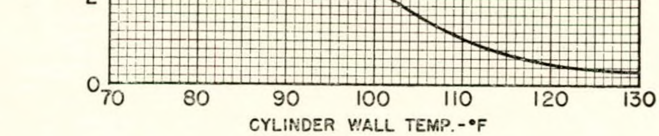


FIG. 2—*Effect of cylinder wall temperature on wear*

on eleven ships propelled by Diesels of assorted sizes and types manufactured by the Doxford, Sulzer, M.A.N. and Burmeister and Wain firms. The first step of the Socony Mobile Research and Development Laboratories was to investigate the properties of boiler fuels to determine the causes of excessive liner wear. For these investigations, a specially constructed engine was employed to permit the use of radioactive-tracer techniques. The engine's piston ring was radiated in an atomic pile. Any particles worn from the ring during the course of a test are trapped in the crankcase oil. At the conclusion of the test the degree of radioactivity of the oil charge determines the amount of wear. Fig. 2 shows the results obtained by radio-

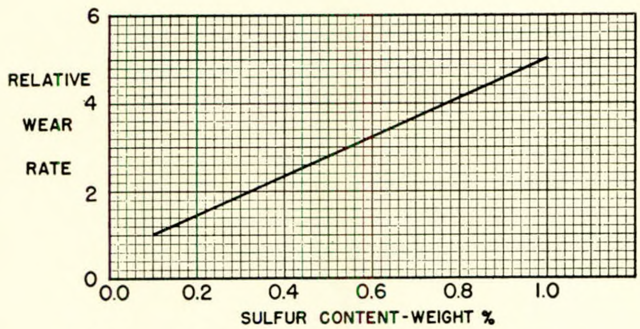


FIG. 3—*Effect of fuel sulphur content on wear*

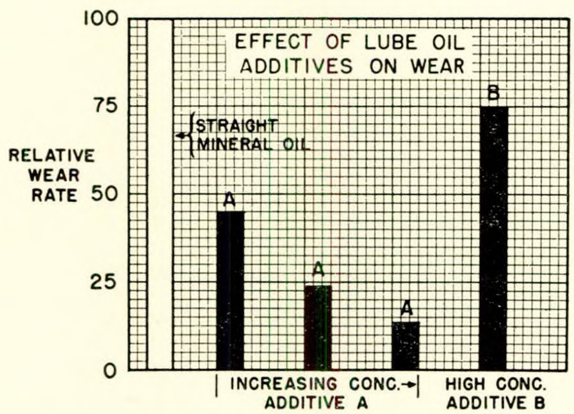


FIG. 4—*Effect of lubricating oil additives on wear*

active-tracer method of the effects of cylinder-wall temperatures. It will be noted cylinder-wall wear rates are excessive at low temperatures also the higher the sulphur content of a fuel the more pronounced is the wear rate. The sulphur-content studies were made with the cylinder-wall temperature held constant at 300 deg. F. Since cylinder-wall temperatures can be controlled,

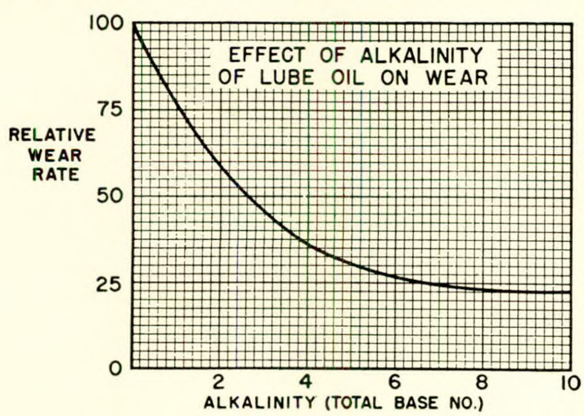


FIG. 5—*Effect of alkalinity of lubricating oil on wear*

the studies were directed at neutralizing the corrosive acids formed by combustion of heavy fuels. The laboratory tested oil additives as methods of control. Fig. 4 shows the wear rate experienced with straight mineral oil and the reduction of wear following addition of two different additives. Both had equal detergent properties, but Additive one proved far superior to the other. This demonstrates that detergency alone will not reduce wear rates. Fig. 5 shows the relationship of lubricant alkalinity to cylinder wear. Caution must be taken in interpreting the data as one high-alkalinity additive increased piston-ring deposits to a degree that under no circumstances could it be used commercially.—*Marine Engineering, October 1955; Vol. 60, pp. 64–66.*

Influence of Propeller Clearance and Rudder upon Propulsive Characteristics

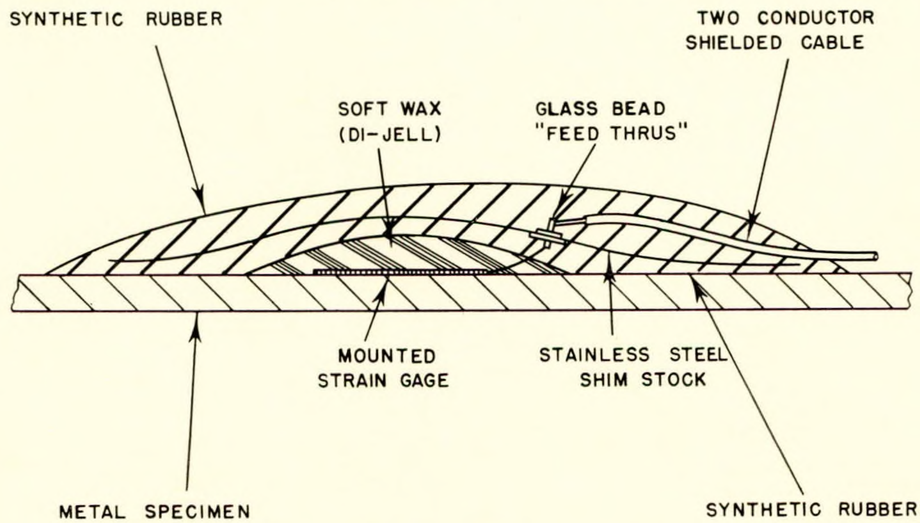
The present paper describes some special experiments which have been carried out in recent years at the Swedish State Shipbuilding Experimental Tank (SSPA). Part I deals with experiments which were carried out for the purpose of investigating the effects of propeller position and clearance (or the shape of the aperture) on the propulsive characteristics. Vibration and other practical considerations have not been taken into account in this connexion. The experiments were carried out with a 15-knot cargo ship in accordance with a scheme devised by Mr. E. Freimanis, who also was responsible for most of the analysis of the experimental results. Part II is concerned with the effects of the presence of the rudder and its thickness on the propulsive characteristics. Self-propulsion and resistance tests were carried out with a model of a tanker, both without a rudder and with rudders of different thicknesses. Open water propeller tests were also carried out, both in the normal manner (without a rudder) and, in addition, in conjunction with rudders of different thicknesses. These experiments were carried out in accordance with the recommendations of the Sixth International Conference of Ship Tank Superintendents (Washington, 1951).—*Publication of the Swedish State Shipbuilding Experimental Tank, No. 33, 1955.*

Ultrasonic Flaw-plotting Equipment

The results are presented of an evaluation of the Ultrasonic Flaw Plotting Equipment, a device which involves in combination such novel features as modulated water stream acoustic coupling, plan and cross-section view pictorial presentation of flaw images, and a manually operated search scanner capable of coping with a wide variety of specimen geometry. The principles involved in this equipment are expected to open the door to greater applicability of the ultrasonic method for the production inspection of castings, weldments, and other metallurgical products of industrial significance. As a result of the evaluation studies of the Ultrasonic Flaw Plotting Equipment, it can be concluded that: the problem of examining castings ultrasonically need no longer be frustrated by rough, as-cast surfaces. The development of the modulated water stream coupling technique has been demonstrated as a practical, economical and technically adequate solution to the surface problem. The difficulties with interpretation of ultrasonically derived flaw detection data which have heretofore existed have been diminished significantly. By employing pictorial presentation of ultrasonic results, the parameters of image size, shape and location may be employed to determine flaw type, at least for flaws larger than the size of the ultrasonic beam. Ultrasonic testing has thereby been brought within the scope of non-professional semi-skilled equipment operators. The problems involved in the ultrasonic examination of metal components too massive to permit practical immersion and involving a wide variety of shapes and sizes have been drastically reduced. The rapid economical examination of rough castings of any thickness can now be regarded as practicable for the first time in the history of non-destructive testing. Employing the Ultrasonic Flaw Plotting Equipment, gross flaws can now be detected and identified in one-twentieth the time required for radiographic examination using the most penetrating sources of radiation available. Following the engineering of a prototype model, Ultrasonic Flaw Plotting Equipment, of one-tenth the cost of competitive radiographic equipment, can be made available. In addition, there are no recognized hazards to personnel associated with the ultrasonic inspection operations. Equipment has been developed which can be moved to the casting or other product to be examined, thereby obviating in many cases the need for fixed, cumbersome, immersion tanks. For many problems, the modulated water stream can be regarded as offering the advantages of immersion without immersion. In addition to flaw detection, the modulated water stream offers the solution to many thickness measurement problems, particularly where rough surfaces and thick sections are involved.—*R. W. Buchanan and C. H. Hastings, Nondestructive Testing, 1955; No. 5, Vol. 13, pp. 17-25.*

Waterproofing Strain Gauges

A new technique for waterproofing resistance strain gauges has been developed at the David Taylor Model Basin. These strain gauges are important instrumentation aids in hydrodynamics and structural mechanics investigations, and many of the tests conducted at D.T.M.B. could not have been accomplished successfully without the new waterproofing techniques. The method used to waterproof the strain gauges is illustrated in the accompanying diagram. The gauge is first mounted and coated with wax; then a partial coating of synthetic rubber is applied. A cap of thin stainless-steel shim stock is rolled on and pressed down into the fresh waterproofing compound. Before the shim is completely placed, gauge leads are soldered to glass-bond " feed-throughs " in the centre of the circular shim cap. The external cable connexions are made next, and a final coating of synthetic rubber is applied. Before water can penetrate this installation and reach the strain gauge, the water must follow a path parallel to the specimen surface and pass through several inches of waterproofing. The stainless steel shim cap provides an impervious barrier to moisture from other directions. A gauge installation in which this waterproofing technique was used was made on the exposed surface of the outside hull plate of a destroyer. Stresses were successfully monitored in that plate for three-and-a-half months while the destroyer cruised several thousand miles.—*Bureau of Ships Journal, August 1955; Vol. 4, p. 23.*



Resistance strain gauges are waterproofed by this new technique

Survey of Atomic Power for Marine Propulsion

In dealing with the source of atomic energy, the basic physics are discussed and developed to outline the distribution of fission energy. The nuclear reactor theory and technology classifies some of the possibilities in design and outlines the major engineering difficulties to be expected. More specific treatment of such problems as reactor kinetics and control is followed by a consideration of the materials now available for use as fuels, coolants, moderators, control elements, shields and structural components. Two types of marine installations are described. First, the heterogeneous gas-cooled reactor used in conjunction with a closed cycle gas turbine. Secondly, the homogenous or " liquid fuel " reactor is considered both with and without the addition of an external, fossil fuel-fired, superheater, supplying steam turbine machinery. The basic physics, fission characteristics and system arrangements are all illustrated and the bibliography is comprised of an up-to-date list of texts, articles and speeches which cover the development of nuclear power both in the United States and Great Britain. —*Paper by D. E. Tackett, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, July 1955; Vol. 10, p. 38.*

Closed Cycle Gas Turbine Power Plant

The closed cycle gas turbine power plant has been under development by the firm of Escher Wyss, Ltd., of Zurich, Switzerland, and their licensees for the past fifteen years. During this period eleven plants have been built, ranging in size from a 500-kW plant for research purposes to a 12,500-kW plant for central station use. Fuels burned have ranged from distillate to residual oils and from peat to culm. Terminal efficiencies of these plants have ranged from 25 per cent to 30 per cent, depending upon the design conditions. The cycle of operation is the same, thermodynamically, as that encountered in the open cycle plant, but closing the cycle requires a different approach to design, due to release from some problems and acquisition of others. In operation, a gaseous working fluid is compressed, heat is added externally and the gas expands in a turbine, giving up energy to drive the compressor and produce useful power. The efficiency of the process is increased by transfer of heat from the gas after expansion to the gas after compression, in a recuperator. Unavailable energy from the process is rejected in a pre-cooler, restoring the gas to its initial temperature before recompression. The system is closed and the process is one of continuous flow. Load changes are effected by varying the pressure level of the system, bypassing the compressor, or both. Plant efficiency is substantially constant over a wide range of loads and, while it is affected by changes in sink temperature, output can be held constant by varying the pressure level. High system pressure and the fact that the working fluid is clean and uncontaminated by products of combustion results in the possibility of designing compact rotating machinery and heat transfer apparatus. Recent developments in the construction of power plants of this type have been based on the use of radial flow turbo-machinery and extended surface heat transfer apparatus, the use of which results in a major reduction in the size and weight of a given plant. Based on recent studies, the use of this type power plant results in a significant increase in the cruising range of naval combat vessels. A major problem to be solved before such an application can be successful is provision of a means of reversing. This can be accomplished by the use of a radial-inflow turbine where reversing is effected by changing the direction of flow into the wheel by means of the nozzle guide vanes. While this method is not as efficient as a reversing gear or reversing propeller, it is far more practical in accomplishment and currently presents no size limitations. In low-powered combat vessels of the destroyer and escort type the optimum power plant arrangement is a combination closed cycle gas turbine for cruising with open cycle gas turbine to provide the power for high-speed operation. Since but a fraction of the total operating time is at powers in excess of 50 per cent, these open cycle booster units can best be of modified aircraft type. For high power combat vessels, a nuclear heat source is indicated. In such a plant a common gas is used as a power plant working fluid and reactor coolant. The advantages to be accrued with such a system are savings in space and weight due to higher efficiency and elimination of intermediate heat transfer loops, with their additional bulk and weight.—*Paper by S. T. Robinson, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, July 1955; Vol 10, p. 47.*

Automatic Combustion Control

Combustion control systems automatically control the firing rate to maintain a constant steam pressure at the superheater outlet or the boiler drum, as desired. This pressure is transmitted to a bourdon tube, bellows or some other sensitive measuring device. The movement of the bellows or bourdon tube is amplified to operate an air pilot valve, or an electric contact. This air or electric signal is used to load the fuel oil valve directly or indirectly. Some types of combustion controls use the steam pressure signal to load the air volume regulator, and the combustion air flow differential is amplified, and used to control the oil pressure. This type usually is referred to as a system with the air leading the oil. Other systems use the steam pressure signal to control the oil pressure and combustion air loading simultaneously. The air flow to the burners usually is controlled by a damper near the windbox of each boiler, inlet vanes on the blower, or by varying the speed of the forced draught blower. The positioning of the dampers, inlet vanes, or the speed of the blower, is controlled by the air volume regulator and, as previously noted, the steam pressure sensing element loads the air volume regulator proportional to the steam demand. If the control is adjusted correctly, the weight of the fuel and the weight of the combustion air will be in constant ratio from minimum to maximum firing rates. The actual ratio varies with the BTU value of the fuel, but generally speaking, 17lb. of air per pound of Bunker C gives 14 per cent CO_2. From the foregoing it becomes evident that an automatic combustion control basically must be able to do the following: (1) Accurately control the steam pressure; (2) Accurately measure oil flow; (3) Accurately measure air flow; (4) Accurately proportion the air and oil flow. Most marine controls use a bellows or bourdon tube as the sensitive element for measuring steam pressure. The movement of the bellows or bourdon tube, due to the change in steam pressure, is amplified and used to operate an air pilot valve or a primary electric-contact finger. The combustion control system, which is designed so that the combustion air flow differential loads the oil valve, increases or decreases the air flow to the boiler, in response to the signal from the steam pressure sensing device, by means of an air cylinder connected to a discharge damper, inlet vanes, or a blower speed regulating device. The pressure drop across the burner arch is measured by a sensitive diaphragm element and this differential pressure is amplified by means of an air pilot valve which in turn sends out an air loading to a diaphragm operated fuel oil control valve. Since the control is adjusted to maintain a constant relation between the pounds of oil and the pounds of air, the oil pressure automatically increases or decreases due to the increase or decrease of air flow. For air operated combustion control systems designed for parallel loading, the air pilot valve on the bellows or bourdon tube of the steam pressure sensing element sends out an air loading to the diaphragm operated fuel valve and the air volume regulator simultaneously, and the oil flow and air flow increase or decrease at the same time. The electric automatic combustion control amplifies the movement of the bellows or bourdon tube to the change in steam pressure and operates a sensitive primary contact finger. The electric signal from this primary contact finger is amplified by vacuum tubes and relays, and operates a reversible motor. The motor, through a worm gear reduction operates a power arm which simultaneously loads the oil valve and air volume regulator through mechanical linkage.—*J. H. Bayard, Marine Engineering, November 1955; Vol. 60, pp. 63-67.*

High-speed Machinery for Wine-carrying Ship

The motor vessel of 5,600 tons d.w. ordered by the Compagnie Générale d'Armements Maritime from the Ateliers et Chantiers de Bretagne, is to be equipped with two eight-cylinder SEMT-Pielstick engines of 2,560 b.h.p. running at 420 r.p.m. and driving a single shaft through Vulcan couplings. The ship, which is to be 108 m. long, with a beam of 15·8 m., has a refrigerated capacity of 1,160 cu. m. and carries 20,000 hl. of wine in tanks. The speed will be in the region of 15¼ knots. —*The Motor Ship, December 1955; Vol. 36, p. 381.*

Marine Deaerators

With the increasing demand for more efficient marine steam plants, feed systems have become more and more complex. This is reflected in the tendency to use the deaerator as a convenient device for returning condensate to the feed system from any source or to use it as an evaporator condenser or as a direct receiver for make-up. While it is possible generally to adapt the deaerator to these many requirements, it is necessary that they be known to the equipment designer, and it is desirable that their effect on performance be known to the operators. The improper handling of high temperature condensate returns, at a temperature higher than the temperature of saturation in the deaerator can, in effect, produce the effect of a steam bypass around the second stage direct contact heater. Under transient conditions, it is not inconceivable that a complete bypass effect may be produced. In addition, returns coming from traps at pressures higher than the deaerator pressure also could cause a similar result if the trap leaks or becomes stuck open. When quantities of high temperature condensate returns are greater than the approximate value of ten per cent of the deaerator output, a more effective means of handling is usually required. When condensate returns are at temperatures both higher and lower than the temperature corresponding to saturation in the deaerator, which may occur with variable pressure operation, special provisions must be made to ensure consistent or acceptable deaeration performance. This is especially true when the quantities of such returns are appreciable. Another factor which is important with respect to consistently good deaeration performance is the method used for returning low temperature condensate, other than from the main condenser, to the deaerator. It it handled frequently by first collecting it from various sources in a common drain tank and pumping to the feed system ahead of the deaerator. From the standpoint of optimum deaeration performance, it should be returned at as constant a flow rate as possible. Unfortunately, the ideal method of handling requires throttling controls and a constantly operating transfer pump. Most installations employ a centrifugal pump in conjunction with an on-and-off control system. While it is necessary to have a pump of adequate size, it is both unnecessary and undesirable to have the system set for a short "on" cycle and long "off" cycle. The high rate of flow during the "on" cycle may cause a sudden drop in deaerator steam pressure and actually can cause the pressure to fall below atmospheric pressure. In order to avoid this, the "on" cycle should be made as long as possible, consistent with good operation of both the condensate return system and the deaerator. Using the deaerator as an evaporator condenser is also a common cause for reduced performance. Evaporator vapour, usually contaminated with oxygen, nitrogen, and carbon dioxide, can seriously affect the oxygen removal of a conventionally designed deaerator.—*J. F. Sebald, Marine Engineering, November 1955; Vol. 60, pp. 53-54.*

Gas Turbine Liberty Ship

A great deal of effort and money have been expended on the development of gas turbines. The Office of Ship Construction and Repair in the Maritime Administration feels that the installation of a proven commercial type gas turbine in the converted Liberty ship *John Sergeant* will properly demonstrate the advantages of the gas turbine to the marine field and result in the selection of this type of propulsion by many private operators. In order to assure the proper dissemination of this experimental work to the industry, the Maritime Administration has made arrangements for the ship to be operated by the U.S. Lines in North Atlantic service. The completed gas turbine is presently being installed by the Newport News Shipbuilding and Dry Dock Company with a scheduled completion date of early summer 1956. The present technological development indicates that the open-cycle gas turbine will find its selected application in the 7,500 to 15,000 s.h.p. range. The gas turbine incorporates a 14-stage axial-flow compressor, a combustion system, a single-stage high pressure turbine driving the compressor, and a single-stage low pressure turbine driving the propeller through a reduction gear. The regeneration used has a nominal effectiveness of 80 per cent. This unit does not incorporate an intercooler or reheat. The nominal rating of the unit is 6,000 s.h.p. This is accomplished with the compressor and high pressure turbine operating up to 6,900 r.p.m., the power turbine operating at 5,323 r.p.m., the cycle pressure ratio at 4·9 : 1, and the turbine inlet temperature at a maximum of 1,450 deg. F. Maximum rating is 6,600 s.h.p. at a propeller speed of 114 r.p.m. The gas turbine has been arranged so that compressor turbine, combustion system, accessories, accessory drive, and piping are mounted

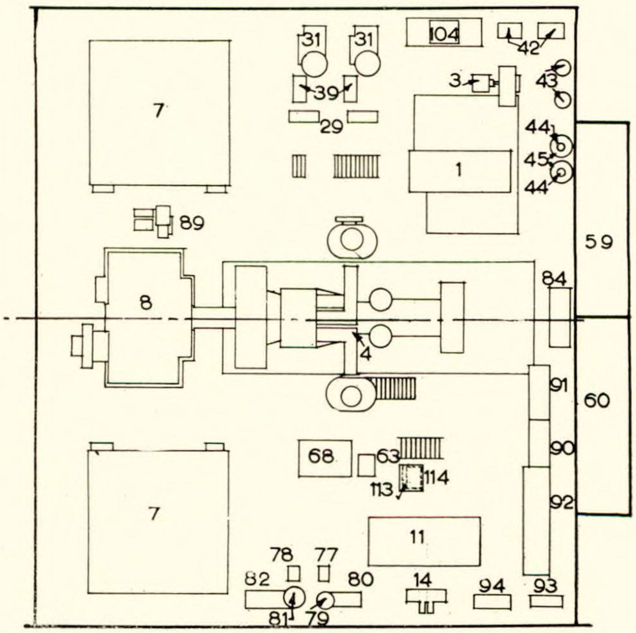


FIG. 1

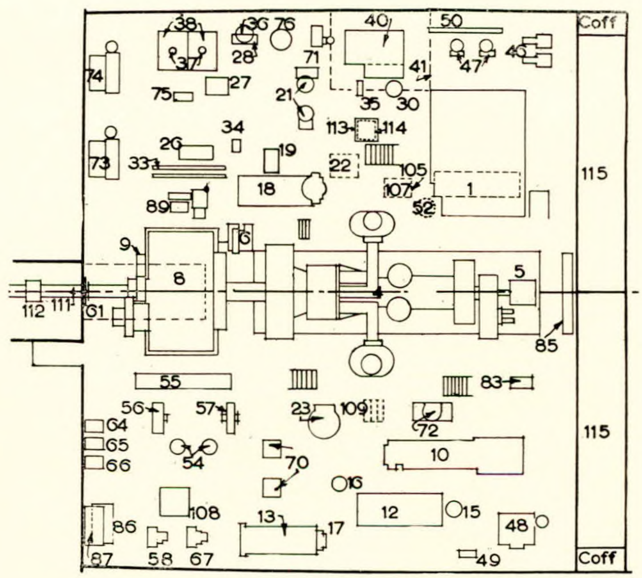


FIG. 2

Machinery arrangement in the John Sergeant. *Fig. 1—upper level Fig. 2—lower level*

1 Boiler (oil-fired); 2 Boiler (oil and waste gas-fired); 3 Forced-draught blower; 4 Gas turbine; 5 Gas turbine starting steam turbine; 6 Emergency propulsion turbine; 7 Regenerator; 8 Main reduction gear; 9 Main shaft turning gear; 10 SS Diesel generator; 11 SS turbogenerator; 12 SS turbogenerator condenser; 13 Auxiliary condenser; 14 SS turbogenerator condenser air ejector; 15 SS turbogenerator condensate pump; 16 SS turbogenerator condenser circulating pump; 17 Auxiliary air and circulating pump; 18 Feed and filter tank; 19 Grease extractor; 21 Boiler feed pump; 22 Inspection tank; 23 S.W. evaporator; 26 F.O. washing system first stage raw oil pump; 27 F.O. washing system wash water pump; 28 Tretolite pump; 29 Take-off oil pump; 30 Settling tank recirculating pump; 31 F.O. washing system raw oil clarifiers; 33 F.O. washing system raw oil heater; 34 F.O. washing system raw oil discharge strainer; 35 F.O. washing system settling tank recirculating pump discharge strainer; 36 F.O. washing system dispersator; 37 F.O. washing system water mixer; 38 F.O. washing system wash water tank; 39 F.O. washing system deaerating tank; 40 F.O. washing system settling tank; 41 F.O. washing system used wash water drain tank; 42 F.O. additive system pump; 43 F.O. additive system dispersator; 44 F.O. additive system mixer; 45 F.O. additive system tank; 46 F.O. service booster pump; 47 Boiler F.O. service pump; 48 F.O. transfer pump; 49 D.O. service pumps; 50 F.O. service heater; 52 F.O. save-all tank; 54 Main L.O. service pump; 55 L.O. cooler; 56 L.O. duplex suction strainer; 57 L.O. duplex discharge strainer; 58 L.O. purifier; 59 L.O. storage tank; 60 L.O. settling tank; 61 Reduction gear L.O. sump tank; 63 SS Diesel generator L.O. storage tank; 64 Hand oil tank; 65 Cylinder oil tank; 66 Kerosene tank; 67 D.O. purifier; 70 Propulsion S.W. circulating pump; 71 S.W. service pump; 72 Bilge pump; 73 Ballast and general service pump; 74 Fire and bilge pump; 75 F.O. treatment water pump; 76 Sanitary S.W. pressure tank; 77 Portable water pump; 78 Wash water pump; 79 Portable water pressure tank; 80 Portable water heater; 81 SS fresh wash water pressure tank; 82 SS fresh wash water heater; 83 Gas turbine cooling F.W. pump; 84 Gas turbine fresh cooling water expansion tank; 85 Gas turbine F.W. coolers; 86 SS air compressor; 87 SS air receiver; 89 Gas turbine cooling fan; 90 Propulsion control console; 91 Gas turbine starting panel; 92 Main generating and distributing switchboard; 93 Gas turbine propulsion motor generator set; 94 F.O. testing spectrographic motor generator set; 95 F.O. testing spectograph and cabinet; 99 F.O. testing laboratory work bench; 104 F.O. washing system clarifier cleaning bench; 105 Burner cleaning bench; 107 Sand box; 108 Purifier sludge tank; 111 Line shaft; 112 Line shaft bearing; 113 Telephone hood; 114 Log desk; 115 Clean F.O. tank.

on a single-fabricated base. The advantages of this arrangement for pre-assembly and installation in a ship are obvious. The present steam deck machinery requires a relatively large boiler capacity for port services, while steam required at sea is limited to such services as fuel oil heating, auxiliary generators, ship's heating, and so on, and the demand is low. This makes total steam requirements opposite to those normally found on turbine driven ships. A further design consideration was the desirability of taking advantage of the heat remaining in the gas turbine exhaust. The arrangement finally decided upon was utilization of one of the existing Liberty ship boilers modified to permit both oil firing and waste heat operation, and a new oil fired steam generator for port use. The arrangement of machinery is shown in Figs. 1 and 2. The cycle requires that the exhaust gas flows from the aft end of the turbine through the regenerator sections and up through the waste heat boiler to the stack. Since the degree of fouling of the regenerators is uncertain, it was considered essential to locate them so that they might easily be disassembled for inspection and cleaning. Although the installation of a gas turbine includes large areas of high temperature duct work which can be expected to present an unusual ventilating problem, it was calculated that one change of air per minute in the machinery space is sufficient to provide more than enough air to remove the contained heat. Ventilating air is taken in through the air intake house on the top of the deckhouse forward of the stack, and is exhausted aft of the stack. About 86,000 cu. ft. per min. are supplied to the machinery space, and about 43,000 cu. ft. per min. are exhausted mechanically.—*Abstract of paper by J. J. McMullen, read at the Annual Meeting of the Society of Naval Architects and Marine Engineers, New York, on 9th-12th November 1955. The Shipping World, 16th November 1955; Vol. 133, pp. 475-477.*

Italian-built Fast Tramp Vessel

Among the first of the new type of large, fast tramp ships to enter service is the motorship *Tideo,* an Italian-built vessel for Italian owners. The ship has been built at the Palermo (Sicily) yard of Cantieri Navali Riuniti, Genoa, while the propelling machinery, a B. and W.-type Diesel engine, has been constructed at the shipyard's engine shop at Ancona. The owners of the vessel are Societa Ligure di Armamento, of Genoa. The *Tideo* is the first post-war ship to join the fleet, and with a deadweight capacity and service speed as an open shelterdecker of 11,230 tons and 14½ knots respectively, she represents a considerable advance on the standard war types. Even so, she is neither as large nor as fast as a number of tramp ships building in Continental yards. The principal particulars of the *Tideo* are as follows: —

Length b.p.	444ft. 6½in.
Breadth moulded	62ft. 7½in.
Depth to main deck	30ft. 10in.
Depth to shelter deck... ...	39ft. 0in.
Draught at full load	26ft. 11in.
Tonnage:	
Deadweight	11,230
Gross	6,900
Service speed, knots	14½ knots

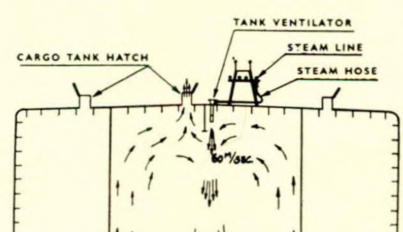
If converted to a closed shelterdecker, the draught can be increased to 29 feet, the deadweight becomes 12,500 tons and the speed goes down to 14¼ knots. The ship has been designed to the highest class of the Registro Italiano Navale. Welding has been extensively employed in the construction. A feature of the design is the introduction of the welded plate gunwale. This, although becoming common in tankers and ore carriers from Scandinavian yards, is unusual in a dry cargo vessel and in an Italian design. There are six holds, three forward of and three abaft the bridge, of which No. 4 (extending beneath the after end of the midships superstructure) is arranged as a deep tank. The propelling machinery consists of a six-cylinder C.N.R.-B. and W. Diesel engine, built in the engine shops at the shipbuilders' Ancona shipyard. It is the first of a batch of seven similar engines being constructed here, of the type B 6-74/160 N. It is a single-acting two-stroke engine, with a normal output of 5,500 b.h.p. at 115 r.p.m. and a maximum output of 6,300 b.h.p. at 120 r.p.m. Two rotary scavenge pumps are chain driven from the engine. Electrical power is generated by a group of three Diesel generators of 200 kW each, and there is also a harbour generator of 100 kW. The principal generators are driven by five-cylinder C.N.R.-B. and W. Diesel engines of four-stroke type, developing 300 b.h.p. at 500 r.p.m. All the engine room auxiliaries are electrically driven. Steam for heating the fuel oil and for ship's services is provided by two auxiliary boilers. One, exhaust fired, is of forced circulation watertube type. The other is a vertical watertube boiler, and is oil fired. On trials, at a displacement of 8,350 tons, the *Tideo* reached a speed of 17·43 knots with the engine developing about 6,000 b.h.p.—*The Shipping World, 7th December 1955; Vol. 133, pp. 531-532.*

Hydraulic Whistle Control

The Cowal Engineering, Gourock, have produced a hand-operated hydraulic whistle control designed to replace the present auxiliary system employing wire or chain linkage. This system was designed primarily for tanker installation where it is not always desirable to employ a linkage control from bridge to funnel due to the length of run and the resulting mechanical lag. The control unit consists of a hydraulic cylinder and ram actuated by a hand lever. By incorporating an accumulator in the unit, allowance can be made to counteract the expansion or contraction of the fluid under varying climatic conditions. In operation, the control is positive and the time lag negligible. The prototype unit is being installed in a Norwegian tanker, at present fitting out at Lithgow's yard, Port Glasgow.—*The Motor Ship, December 1955; Vol. 36, p. 381.*

Tank Ventilation

Götaverken A/B Gothenburg has introduced a steam-operated device which effectively solves the problem of removing the dangerous explosive gases left in a tanker's cargo tanks when oil or petroleum have been discharged. With the apparatus and methods previously in use this has been a long and costly process and the new method, which cuts down the time considerably, is already in regular use in a number of tankers. The "ventilator", as it is described, is transportable and consists of a specially designed metal trunk about 5ft. long. This trunk, which could be called an "air blower", has at its upper end a nozzle which can be coupled by a hose to the ship's steam line under the fore-and-aft gangway. It is also possible to use compressed air. The appliance is inserted in the tank cleaning hatch in the deck and the steam turned on. This passes through the nozzle at a high velocity and, by suction, draws with it a stream of fresh air down to the bottom of the tank. At the mouth of the ventilator, about three feet under the deck, a steam jet, and accompanying air, have a speed of about 200ft. per second. On reaching the bottom of the tank



Diagrammatic sketch showing circulation effected by Götaverken tank ventilator the air stream divides and swirls about, finally travelling up the sides to the open hatches where it reaches open air bringing with it the gases which were in the tank. The quantity of steam injected via the ventilator is about 600 kgs. (1,320lb.) per hour and the accompanying fresh air amounts to no less than 12,000 cu. m. (15 tons) per hour. Through the eddies set up when the stream of steam and air hits the bottom of the tank every part of the tank will be well ventilated. As is well known, tankers must have a gas-free certificate when going to a shipyard for repairs and the control and measurements made on these occasions have shown that the new system gives good results. Tests carried out using the new device, show that gas-freeing can be carried out considerably quicker than when using the old system. Gas-freeing time for one cargo tank is between thirty minutes and one hour and, using two of the new Götaverken ventilators, a 17,000-ton tanker can be gas-freed in a working day. The ventilators are portable and, due to their comparatively light weight of 35 kgs. (77lb.), one man can, without difficulty, carry the appliance from hatch to hatch and couple up the steam supply. Sparking is, of course, a great danger in the vicinity of explosive gas, but this risk is eliminated as the ventilator is made entirely of brass and there are no moving parts which can produce static electricity.—*Shipbuilding and Shipping Record, 24th November 1955; Vol. 86, p. 677.*

German Four Engined Single Screw Ship

The largest ship yet built at the yard of Heinrich Brand, Oldenburg, Germany, and one which is of particular interest in that the propelling machinery comprises four non-reversible engines driving a single shaft and a variable pitch propeller, is the cargo vessel *Admiral Bastian*, which was recently completed for Messrs. Helmut Bastian, Bremen. She is now on time-charter to the Buccaneer Line. Of 2,300 tons d.w.c. as a closed shelterdecker and 1,600 tons d.w.c. (open) this ship has a length b.p. of 73·5 metres, a moulded breadth of 12 metres, and a depth to the main deck of 7·05 metres, the depth to the 'tween-decks being 4·65 metres. There are two cargo holds with a total capacity of 112,000 cu. ft. (bale) or 121,000 cu. ft. (grain). All hatches have MacGregor steel covers and the cargo handling gear includes seven cargo winches, all electrically driven. The propelling machinery consists of four nine-cylinder 600 b.h.p. non-reversible Modag two-stroke engines running at 500 r.p.m. They drive through an A.E.G. electromagnetic coupling to the Demag reduction gearbox to give the single propeller shaft and the Escher-Wyss variable pitch propeller a speed of 250 r.p.m. A 100-kW shaft-driven generator is installed between the two forward engines to supply the ship's electrical requirements.—*Motor Ship, December 1955; Vol. 36, p. 403.*

3,780-ton Russian Refrigerated Vessel *Jana*

In September 1954, the Sudoimport in Moscow representing the Russian Government, ordered from the Orenstein-Koppel and Lübecker Maschinenbau A.G. five refrigerated vessels for carrying frozen fish. The first of these, the *Jana,* was recently delivered, while the second, the *Indigirka,* has been launched, and the third is on the stocks. The *Jana* is of 3,780 tons gross and has been registered at Vladivostock. All of the ships are being built to the regulations of Germanischer Lloyd ✠ 100 A4 strengthened for navigation in ice, with freeboard, and they also comply with the regulations of the U.S.S.R. register, ice-class "UL". The deadweight capacity is 3,240 tons and all the five cargo holds are refrigerated. The cargo carrying capacity amounts to 4,500 cu. m. The *Jana* is said to be the largest vessel built for Russian account since the war. Her main dimensions are:—

Length overall, metres	111·37
Length b.p., metres	103·00
Moulded beam, metres	14·50
Depth to main deck, metres ...	8·30
Depth to second deck, metres ...	5·60

At full load, the draught is 6·25 metres. The ten 3-ton derricks and the 25-ton heavy-lift derrick are served by eight 3-ton winches and two 5-ton electric winches. Electro-hydraulic steering gear is fitted. The main engine is a two-stroke single-acting M.A.N. unit of 3,120 b.h.p., and the ship has a service speed of 13·5 knots. There are auxiliary boilers for heating the crew's quarters and the tanks. The modern navigation instruments include a radar installation.—*The Motor Ship, December 1955; Vol. 36, p. 382.*

Observation of Propeller Cavitation Patterns

The observation of ship propellers when cavitating is clearly essential if improved propellers are to be designed, for without knowledge of what happens to the full scale propellers the results of tests with models cannot be properly assessed. But full scale observation is exceedingly difficult, and the paper by A. F. Weeks, of the Admiralty Experiment Works, Haslar, describing some trials during which "ship propeller cavitation patterns" have been observed, is only the second dealing with this thorny problem. Mr. Weeks's paper outlines the method of observing and photographing cavitation on the propellers of fast patrol boats and destroyers which has been successfully developed recently at A.E.W. The difficulties in obtaining such observations are considerable and numerous. First, it is necessary to cut holes in the hull surface plating through which the propeller can be viewed. These holes are fitted with toughened glass viewing ports, and their size, number and position are generally severely restricted by such factors as the strength and watertight integrity of the hull. The exact positioning of these ports is important if as many parts of the propeller as possible are to be viewed. Then powerful artificial lighting must be provided for viewing the propeller; a stroboscopic effect is necessary, and this is generally obtained by flashing the light at shaft frequency from a trigger on a shaft contact ring. An alternative system is to have a strobing light controlled independently so that its flashing rate can be matched to the propeller frequency by observation, and this method has the advantage that by slightly off-setting the flash frequency the propeller can be observed apparently rotating very slowly. The flashing light used in the ship trials described had a flash duration of about fifteen microseconds and its output per flash was about two joules. In order to judge the exact position and extent of various cavitation patterns, an identification grid was painted on the propeller blades. During a ship trial for cavitation observation the normal procedure was to view and photograph the propeller from cavitation inception up to full power conditions. The exact nature of the cavitation, and the order in which different forms appear, depend on the design of the particular propeller under examination.—*Shipbuilding and Shipping Record, 3rd November 1955; Vol. 86, pp. 569-570.*

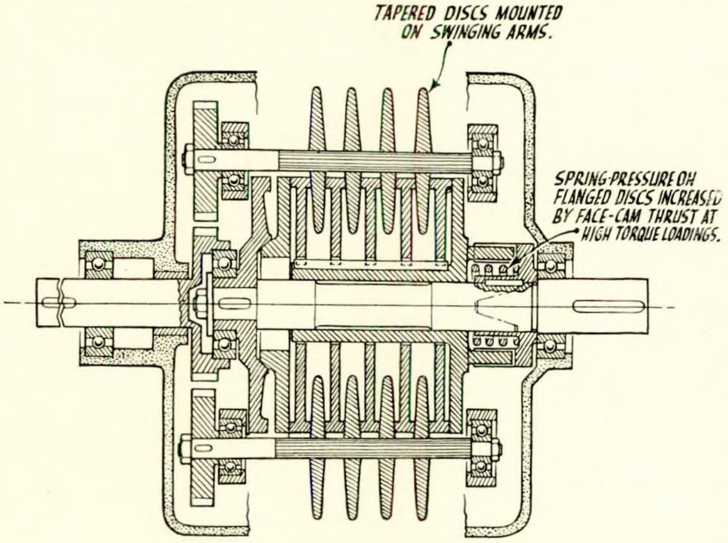
Hard Anodizing of Aluminium

One of the useful characteristics of aluminium is the manner in which it develops a thin coating of hard, corrosion-resistant oxide on the surface of the metal as soon as it is exposed to the air. The effectiveness of this natural surface can be heightened through the anodizing process which increases the thickness of the oxide coating for commercial purposes from 0·0001 inch to 0·0008 inch. In recent years, further research has been devoted to methods of increasing the thickness of this coating. At the present time, there are several processes which provide an oxide coating of from 0·001 inch to 0·005 inch. The consequences of this development have been to make the metal more competitive for parts where increased abrasion resistance, corrosion resistance, and a thick dielectric coating are desired. Such applications include pistons, valves, cams, abrasion strips, friction bearings, brake discs, coil forms, and similar machine parts. In many instances, it makes possible the use of aluminium where other, more wear-resistant or corrosion-resistant metals were formerly required. Heavy oxide coatings are cheaper than hard chromium coatings and are considered to be competitive with hard nickel-phosphorus coatings obtained from the electroless nickel plating process.

On the American continent, there are several methods of producing this type of coating. Most commonly known are the Martin Hard Coat (MHC), Alumite Hard Coating, and the Hardas (Hard Aluminium Surfaces, Ltd.) processes. Each produces an anodic coating which is a hard porous film of aluminium oxide. Rockwell hardness on these coatings measures about C40. The major difference between normal anodizing processes and the hard coating processes is that the latter are performed at a higher current density and lower temperatures in a strongly agitated bath. Intensive tests have established that these processes increase the wear resistance of the metal beyond the point of ordinary anodic coatings and equal to or better than even cyanide coatings on steel. One limitation of the hard coatings is their tendency to lower the fatigue strength of the coated metal. In some instances, this is sufficient to disqualify the metal for certain applications. However, a chromate seal on certain hard-coated alloys results in improved fatigue strength. A more recent process developed in Los Angeles by the Sanford Process Co., Inc., is similar in application to other anodizing processes except that the oxide coating can be obtained in an exceptionally short time. A 6-mil coating can be obtained by the Sanford Process in fifty-five minutes, whereas a period of four hours is required to achieve similar results by the MHC process, for instance. This process also permits the achievement of even deeper coatings with excellent hardness characteristics. In fact, the metal treated by this process is claimed to be slightly more abrasion-resistant than case hardened steel. Rockwell hardness ranges from C50 to C58 on this coating, with a Mohs scratch hardness of about eight. A process attracting attention in Europe is that developed by the Dowty Equipment, Ltd., of England. The current density in this process is maintained within a 10 per cent range and varies from 2·5 to 10 amperes per sq. cm. With normal alloys, an anodic coating of 0·002 inch is obtained in one hour. The maximum thickness of coating that can be obtained economically by this process is about 0·0035 inch. The introduction of thick anodic coatings has increased the application of aluminium alloys in machinery applications and in highly corrosive atmospheres. A further use of these processes is to build up over-machined or worn parts that are too expensive to be scrapped or replaced.—*Aluminium News, Montreal, October 1955; p. 7.*

Multiple Disc Variable Drive

A set of thin, tapered discs and a second set with flanged rims on a co-axial shaft form the driving and driven members of the Beier infinitely variable gear. Ratio variation is obtained by changing the relative position of the two axes, and this can be done while maximum torque is being transmitted. The contact area for a given size of disc is relatively large, and the discs are of low weight. Multiplication of the discs enables the capacity of the unit to be increased without undue complication. Lubrication of the simple splash type is employed. According to the official description of the gear's operational principles, the film of lubricant on the disc contact surface is temporarily subjected to a high pressure, which increases its viscosity many thousandfold to provide a powerful drag force. Up to the rated torque of the unit there is negligible slip and a high efficiency is maintained. If the discs are overloaded, slip increases, but this also raises the drag force in the film, and consequently the gear can be run in practice at considerably above its rated load. Its efficiency is then reduced and the heat generated increases, but reliability is not impaired. One set of discs, or a number of sets, is spline-mounted on a swinging arm, and the drive is transmitted to it by an idler gear on the end of the mounting pin. In the larger size of unit, three or six sets of arm-mounted discs are employed which "mesh" with the discs on the main shaft. When a constant horse-power characteristic is required the drive is taken through sets of tapered discs to a cluster of flanged discs, but for constant torque the flanged discs are arranged as the driving members. The drive, can, however, be transmitted in either direction if required. The discs on the mainshaft are spring loaded and the spring force is augmented by an axial thrust at high torque loadings to prevent slip. This is achieved by using a face arm, the displacement of which is normally limited by a stop. In the standard industrial unit the arms are commonly linked to a hand- or servo-operated control gear of the screw type. If required, an external control system could be used to provide automatic or semi-automatic operation, but various features of the gear would enable internal modifications to be introduced for this purpose without undue complication. When the arm-mounted discs are driving the centre discs an increase in torque tends to force the disc-shaft gear to travel around the idler gear and move the discs inwards. It is therefore possible to produce a gear giving an output speed which automatically increases as the load is reduced, thus providing a characteristic which is invaluable in many applications.—*The Oil Engine and Gas Turbine, November 1955; Vol. 23, pp. 248-249.*



Simplified layout of the Beier gear

Sandwich Type Rubber Fender

The Raykin Fender Buffer was developed by the Industrial Products Division of The General Tire and Rubber Company, Wabash, Indiana. The new unit is composed of a series of "sandwiches" which are cushions of rubber 3 inches thick and 15 inches square, bonded between ½in. steel plates. Mounted in an inverted V, the sandwiches have a very high rate of energy absorption permitting them to "soak up" forces that would normally snap pilings or damage hull plates when a vessel hits the dock during berthing operations. The highly adaptable system works not only as a strong safety factor but also saves a considerable amount in repair expenses. A 5,000 ton ship moving at 1·5 knots has energy of about 1,000,000ft. per. lb. Consider for the moment this object in motion approaching a pier, an object at rest. If the docking is successful, both the ship and the pier will end up at rest with no damage to either. The difference between the picture of the ship approaching the pier and the picture of the final successful docking is the disappearance of the 1,000,000ft. per lb. of energy. The energy is dissipated in the form of heat caused by the damped motion of all the objects and components that move when the ship in motion contacts the pier. Due to the contact, the ship's structural components move slightly, the pier moves almost imperceptibly, the water immediately surrounding the ship moves, and the fendering system moves quite noticeably. The energy absorption capacity of any part of the system (pier, ship or fendering) is a function of the motion (deflexion) and the force (load). The action of the ship in swinging about into a pier dissipates about half of the energy involved. Therefore the pier, ship and fendering system would have to absorb the 500,000ft. per lb. balance of energy. Assuming there were 100 feet of contact between pier and ship, that the pier could withstand 100 tons of load per running foot and the ship would take 2 tons per running foot, the pier due to impact might deflect a third of an inch and the ship might "give" about 2 inches without damage. Under these conditions the pier would absorb about 278,000ft. per lb. and the ship 33,333ft. per lb. This leaves a balance of 188,667ft. per lb. for the fendering system to absorb. By placing 20 ton Raykin fender buffers on 10ft. centres along the pier, the energy absorption capacity of the fender would be 231,000ft. per lb. With a balance of 188,667ft. per lb. the fender would deflect approximately 10¼ inches and load the side of the ship 1·9 tons per running foot. There would be about 2,000lb. of rubber used and only to about 80 per cent capacity. The Raykin system of smothering shock and shear forces can be made to meet varying problems of energy absorption. The unit, for instance, can have a deflexion of from 3 to 18 inches, with a maximum absorption of 85,000ft. per lb. By increasing or decreasing the number of "sandwiches" the unit can be adapted to many different load capacities and docking conditions. In addition, it is virtually unaffected by corrosion, rotting and ageing, and needs only a minimum of maintenance.—*R. Iredell, Motorship (U.S.A.), October 1955; Vol. 40, pp. 28-29.*

Quarter-wheel Tugs for Sudan

A group of six steel, twin-engined, motor-driven, quarter-wheel tugs have recently been built by Yarrow and Co., Ltd., of Scotstoun, Glasgow, for the Sudan Government. The tugs are for passenger, cargo and cattle barge traffic in the River Nile, and the propulsion is by means of quarter-wheels, which are driven through reduction gearing by twin Diesel engines. The principal dimensions and other leading characteristics of the craft are given below.

Length overall	125ft. 6in.
Length ex tongue	106ft. 8in.
Breadth moulded	32ft. 0in.
Depth moulded	6ft. 0in.
Draught loaded	3ft. 0in.
B.H.P.	460
Speed (towing five barges), m.p.h.	6 to 7

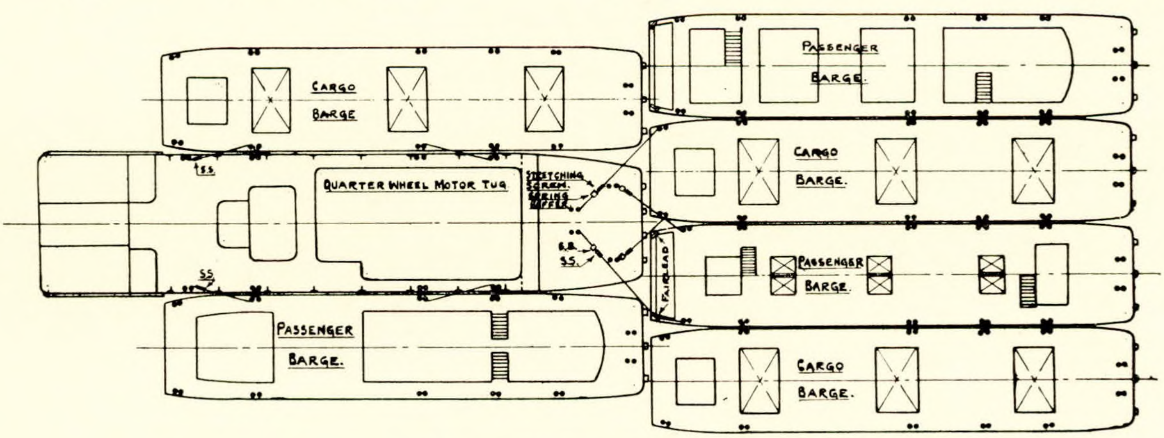


FIG. 3—*Towing arrangement*

Designed for moving a train of barges, which will be pushed or lashed alongside (see Fig. 3), the tugs will make regular trips in the White Nile, between Kosti and Juba, a distance of 920 miles. The propelling machinery, constructed by Ruston and Hornsby, Ltd., of Lincoln, consists of two Ruston type 5VEBM, vertica, four-stroke cycle, five-cylinder heavy oil engines. The engines operate through independent worm reduction gear units manufactured by Thomas Reid and Sons (Paisley), Ltd., and drive stern wheel paddles to give the ship a speed of 6 to 7 miles per hour, when towing five barges.—*The Shipbuilder and Marine Engine-Builder, December 1955; Vol. 62, pp. 705-706.*

Marine Design Problems

Perhaps the greatest disadvantage with which the marine designer has always had to contend is that of obtaining reliable observations. Only those who have been to sea in adverse weather can realize fully how difficult this matter can be. Not only are conditions very unsatisfactory for the operating staff, but the instruments themselves are often quite unable to stand up to the arduous conditions imposed on them. All engineers will agree that the absence of reliable data is a handicap of immense importance, but adverse weather is not the only difficulty in this connexion. Even in trial trips carried out under so-called "fair weather conditions" and with many experts aboard armed with apparatus specially designed to take certain observations, it frequently happens that some of the data obtained are of little or no value. In the first place this is because trial trips are usually run with the ship in the unloaded condition. The propeller is therefore not sufficiently immersed and will not absorb the s.h.p. at the designed r.p.m. Further, the ship may be trimming too much by the stern and the results obtained will bear no relation to those existing with the ship fully loaded on an even keel. Of recent years, however, under the ægis of the British Shipbuilding Research Association and with the co-operation of certain shipowners, observations have been taken on loaded ships in service operation. When sufficient data of this kind have been collected this may well be of real importance to shipbuilders. In the second place, sister ships built by the same shipyard and to the same drawings and running trials under substantially the same weather conditions, will sometimes give performances which may differ by as much as 5 per cent. This could be due to a variety of causes, but recent researches point to variations in roughness of the hull as one of the principal reasons. New ships are, of course, usually dry-docked just previous to the acceptance trials and the surface of the hull is in "good" condition, but considerable differences in roughness may still exist. In this connexion the work done by B.S.R.A. a few years ago on the ship *Lucy Ashton* is of extreme importance. The accurate measurement of s.h.p. and thrust is still difficult to ensure, and conflicting results continue to be observed which are incapable of explanation. Although welded ships have been built in large numbers for many years there is still a wide divergence in views as to the relative resistances of welded and riveted hulls. Some builders claim that the all-welded hull requires 15-20 per cent less power than a fully riveted one of the same dimensions, while others, equally experienced, put the figure at not more than 5 per cent. It is perhaps fortunate that this particular question which has also been the subject of exhaustive research in recent years may soon be a matter of academic interest only. It is probable that before long all ships will be largely welded, not indeed because welding is necessarily in every way superior to riveting, but because sufficient riveters will not be available. For this reason most shipyards are already laid out, or are in process of being reorganized, for prefabrication. Large portions of the hull, up to 40 tons in weight, are welded in shops specially designed for the purpose and lifted *en bloc* on to the building slip. It is expected that with this arrangement it will be possible to build the same number of ships with approximately half the number of slips.—*From Presidential Address by P. L. Jones, Institution of Mechanical Engineers; The Chartered Mechanical Engineer, 1955; No. 9, Vol. 1, pp. 436-443.*

New Cavitation Tunnel

Fig. 1 shows the general arrangement plan of a small cavitation tunnel which has been constructed by Messrs. Kempf and Remmers of Hamburg on behalf of the Shipbuilding Laboratory of the Delft Technological University. Since the new laboratory at Delft has not yet been completed, this tunnel was temporarily placed at the disposal of the Netherlands Ship Model Basin (N.S.M.B.) for starting their experimentation with a prototype of the flow regulator, i.e. an apparatus with which it would be possible to regulate in the axial direction any desirable velocity field in way of the propeller. Fig. 2 shows the general arrangement of the prototype of the flow regulator, which can be built-in in way of the contraction in the upper leg of the tunnel. The flow regulator divides the whole field into a large number of elements, viz. 146 in the present case, the flow being regulated for each element by a valve. The valves are adjustable from the outside and can be moved a total distance of approximately 2 inches. With the valves entirely open, the flow field in way of the propeller is fairly homogenous. By closing the valves partly or wholly any radially and/or circumferentially unequal velocity field can be obtained. The regulator is placed in the part of the tunnel where the water has the lowest velocity, while behind each valve the flow is contracted. In this way the resistance caused by the regulator is reduced to a minimum and the flow after leaving the contraction is very stable. The field in way of the propeller can be measured by a turnable Pitot-tube arrangement movable in the longitudinal direction and connected to a battery of liquid pressure gauges. On each gauge the pressure, corresponding to the velocity desired, is marked. While the flow regulator introduces no problem in mounting the driving shaft of the propeller model through it and thus simulating actual conditions, it also leaves ample space for the Pitot-tube arrangement behind the propeller. The field is regulated by means of the method of trial and error, the field being measured with the aid of the Pitot-tube arrangement and compared to the velocities required for the points concerned. This is done by turning the Pitot-tube arrangement in steps of 10 degrees and adjusting those valves which affect the velocities the tube arrangement measures. The dynamometer and propeller shaft are designed in such a way that the propeller can be moved longitudinally. In this way the optimum position of the propeller with respect to the rear end of the flow regulator can be chosen. Measurements carried out in the measuring section have shown that the pressure over the screw disc is constant. This shows clearly that the inequality of the velocity field in the tunnel is caused by friction and is therefore fully comparable to the flow behind the ship, since, in the case of the ship, the potential wake across the screw disc is practically constant as well, and the variations in wake are only due to variations in the frictional wake. It is obvious that only the axial components of the velocity field can be varied with the regulator described. The tangential and radial components are, for the time being, neglected. It has already been said that they are of secondary importance. The tangential component may, if desired, be taken into account by a correction of the number of revolutions of the propeller, while the radial component might be taken into consideration by installing guide vanes behind the regulator.—*W. P. A. van Lammeren, Schiffstechnik, November 1955; Vol. 3, pp. 34-40.*

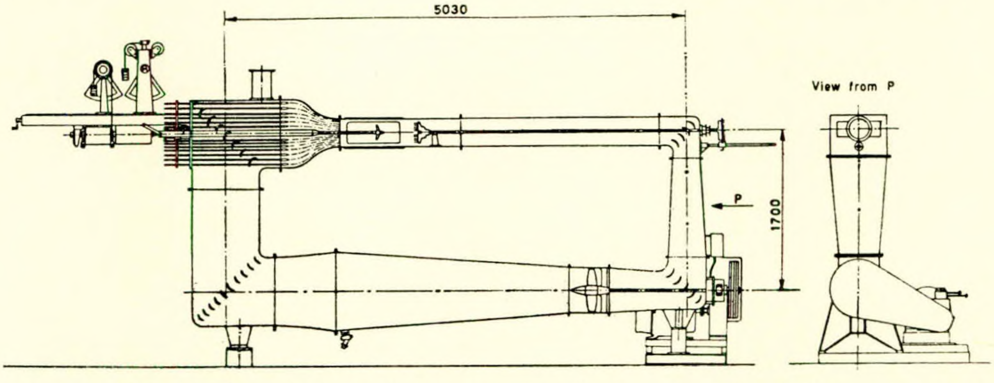


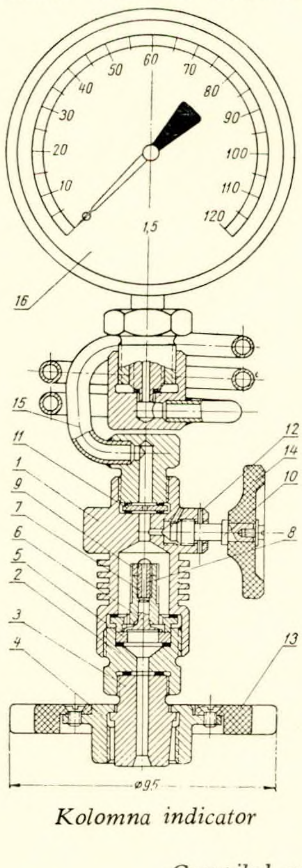
FIG. 1—*General plan of the cavitation tunnel built for the Shipbuilding Laboratory of the Delft Technological University*

British Cargo Ship with Machinery Aft

A contract was recently placed with Swan Hunter and Wigham Richardson, Ltd., by Messrs. Stephens, Sutton, on behalf of the Thomasson Shipping Co., Ltd., London, for a motor vessel with machinery aft. This vessel is to be constructed to the highest class of Lloyd's Register of Shipping and will be of the open-shelterdeck type. There will be five cargo holds, with a deep tank for water ballast between Nos. 1 and 2 holds and another between Nos. 3 and 4 holds. The length b.p. is 440 feet, the moulded breadth 61 feet and the moulded depth 39 feet 1 inch. The ship will carry a total deadweight of about 11,000 tons on a mean draught of 26 feet 3 inches. The upper deck has no sheer forward, this giving deep 'tweendecks forward for the transport of large packages. Special attention has been given to the shelterdeck to facilitate the carriage of deck cargo when required. In all holds and 'tweendecks a steel centreline bulkhead is fitted clear of the hatches, and wood shifting boards and feeders will be provided for the carriage of grain. In all cargo holds the tank tops will be sheathed. The shelterdeck hatches are to have MacGregor-type steel sliding covers while the hatches on the upper deck will be equipped with single-plank wood covers fitted with Cox's open-ended bands. In addition to the usual vertical ladders to the holds, access will also be given by separate hatch trunks. For cargo-handling purposes there will be ten derricks suitable for 10 ton lifts, but normally rigged for 5 tons. Four will be fitted at the foremast, two at the derrick posts and four at the main mast, and all will be served by ten totally-enclosed steam winches. Fuel oil will be carried in four double-bottom tanks, including one for Diesel oil, while capacity for feed water is arranged under the engineroom; fresh water is carried in tanks above the after peak and at the forward end of the crew accommodation. Water ballast is to be carried in the two deep tanks previously mentioned and in part of the double-bottom and the two peak tanks. Built by the Neptune Engine Works, the Swan Hunter-Doxford oil engine is a four-cylinder unit with a bore of 600 mm. and a combined stroke of 2,320 mm. It is fully equipped to burn heavy oil and is designed to develop 3,300 b.h.p. in service at about 108 r.p.m. It is of the latest Doxford diaphragm-chamber type in which the lower-piston skirt has been eliminated, the piston rod passing through a gland and thus preventing contamination of the crankcase by combustion products. By maintaining the lubricating oil in an acid-free condition, corrosion of the crankcase shaft, which has been known to occur with the use of boiler oil, should no longer be encountered. Scavenge air is supplied by two scavenge pumps driven by Nos. 1 and 2 cylinders. The levers on No. 1 cylinder also drive the pumps for the lubricating oil, jacket water and sea water services at sea. Exhaust gas from the main engine will be passed through a Cochran composite boiler of sufficient capacity to provide the steam required for the remaining engine room auxiliary machinery and ship's services. For port and standby duties a multitubular boiler will be provided. All the standby pumps and other engine room auxiliaries are steam driven.—*The Motor Ship, January 1956; Vol. 36, pp. 414-415.*

Russian Maximum Cylinder Pressure Indicator

When tuning internal combustion engines the maximum cylinder pressure is one of the most important parameters. This is particularly so in the case of high-speed engines working with high cylinder pressures. It is important to have available a simple and reliable device to determine the maximum pressure but the mechanical indicators used at present for the purpose, quite apart from other disadvantages, do not ensure the necessary accuracy. They are designed to take indicator diagrams of slow-speed engines and do not give direct indication of the maximum pressure but record the displacement of a spring which is proportional to the gas pressure in the cylinder. Undue clearances soon appear with the recording components of such indicators and the operating plungers must be cleaned after every six to eight determinations. Further, it should be mentioned that the results are dependent upon careful calibration of the equipment, which in turn depends on the friction in the operating mechanism and the adjustment of the recording components. Tests with a considerable number of various devices showed that the maximeter pressure gauge with a non-return valve proved to be the simplest and most reliable instrument, but the early maximeters were not entirely suitable because of inadequate design. After making a number of alterations, it was found possible to develop a reliable design and the instrument now used at the Kolomna Works is shown in the accompanying figure. This maximeter shows the maximum pressure in the cylinder directly on a dial. The pressure determines the choice of the gauge to be used. The coiled steel connecting tube (15) is provided to protect the pressure gauge from excessive heat and vibrations. The presence of combustion gases downstream of the 0·4 mm. diameter throttle orifice ensures an even motion of the indicating needle when charging and discharging the device. The needle valve (10) is provided to permit the discharge of gases from the maximeter upon completion of tests. The stroke of the non-return valve (6) is adjusted by the screw (8) to between 0·15 to 0·20 mm. The individual components are made gas-tight by copper gaskets. Only the valve seat (5), pin guide (7) and the non-return valve (6) are ground. Heat resistant steel as employed for Diesel engine exhaust valves is used for the non-return valve and the other components are made of carbon steel. The needle fluctuations do not normally exceed ± 1 per cent. The gas tightness of the instrument should be checked by removing it from the engine and timing the pressure loss, after every twenty to thirty determinations. This loss should not exceed 40 per cent of the original pressure within one minute of disconnexion. The pressure gauge, connecting tube and plastic (textolite) handwheel (12) remain cool irrespective of the number of determinations. The equipment functions satisfactorily whether dealing with pulsating gas pressures not exceeding 5lb. per sq. in. in an exhaust manifold, or when determining maximum combustion pressure of up to 1,500lb. per sq. in. If required it can be used for still higher pressures. Comparative tests of the maximeter and an electro-pneumatic indicator have proved the accuracy of the determinations. At present the maximeter has passed extensive factory tests and is being prepared for mass production.—*Y. Taliankev, Morskoy Flot, 1955. (Abstract in The Marine Engineer and Naval Architect, January 1956; Vol. 79, pp. 22-30.)*



Kolomna indicator

Aluminium in Shipbuilding

A short description is given of the various aluminium alloys and their typical properties. The choice of alloys is noted in connexion with their corrosion-resisting properties, fatigue properties, resistance to shocks and notch sensitivity; then there is a short summary of the connexions of aluminium alloys one to another and of these alloys to steel; surface treatment and protective layers; a subdivision into groups, based upon the most noteworthy properties of aluminium alloys as used on board ship is made; following this subdivision, a description is given of the principles underlying the attempt to define the scantlings of aluminium-alloy superstructures and deckhouses; the influence of such structures to the longitudinal strength of the ship is studied; a list of requirements for the scantlings of light-metal superstructures and deckhouses is given with a new proposal embracing the criticisms of the existing rules and regulations; finally there is a short summary about the direction in which research on this point is necessary and desirable.—*H. E. Jaeger, International Shipbuilding, 1955; Vol. 2, No. 11, pp. 319-350.*

Patent Specifications

Ship's Davits

According to the present invention, in a davit arrangement of the gravity type, winch drums for the falls of the two davits are mounted one on each side of one of the davit supports. Thus the winch mechanism can be incorporated in the davit stand itself and located symmetrically thereon. Advantageously the falls extend from the drums, to sheaves at the top of the davit stand, substantially in line with an upwardly sloping member, located above the drums, of the said stand. Not only are the reactions due to the loads in the falls substantially balanced with respect to their effect on the drums, but also they are taken up in compression within the said member. The drawing illustrates the application of the invention to a davit arrangement of the gravity type with davits supported well above the boat deck (1) so as to allow free promenade space below the davits and boats. Each davit stand comprises a substantially horizontal member (2) (Fig. 1) mounted at the inboard end on the ship's structure (3), as shown, or on an individual support. Grooved winch drums (9 and 10) for the two davits are supported with their common axis extending fore and aft of the ship, one on each side of the upper part of the column (4) of one of the davit stands. These drums can be supported solely from the column, for instance in bearings carried by the side plates of the box section. The falls (11 and 12) extend from the drums (9 and 10) along respective sides of the member (8) and substantially in line therewith. Over sheaves (13) mounted on the upper end of the said member, one fall (11) (Fig. 1) passes directly to the free end of the adjacent davit arm (5), while the other fall (Fig. 2) passes from the sheave (14) across to the other davit by way of a similar sheave on the other stand (not shown in the drawing) and thence to the other davit arm.—*British Patent No. 740,434, issued to J. Stone and Co. (Charlton), Ltd. (Inventor J. A. Morton). Complete specification published 9th November 1955.*

Tanker Vessel

This invention relates to ships for carrying bulk oil and is particularly, but not exclusively, applicable to sea going tanker vessels designed to carry petroleum products in bulk. One of the objects of the invention is to provide a form of vessel construction and a method of separating oil from water in such a vessel which will obviate the discharge into the sea of oil residue or drainage from vessels carrying bulk oil. Another object of the present invention is to provide a novel arrangement of cargo and ballast tanks in a tanker vessel designed for carrying bulk oil. A vessel according to the present invention for carrying bulk oil has one or more tanks

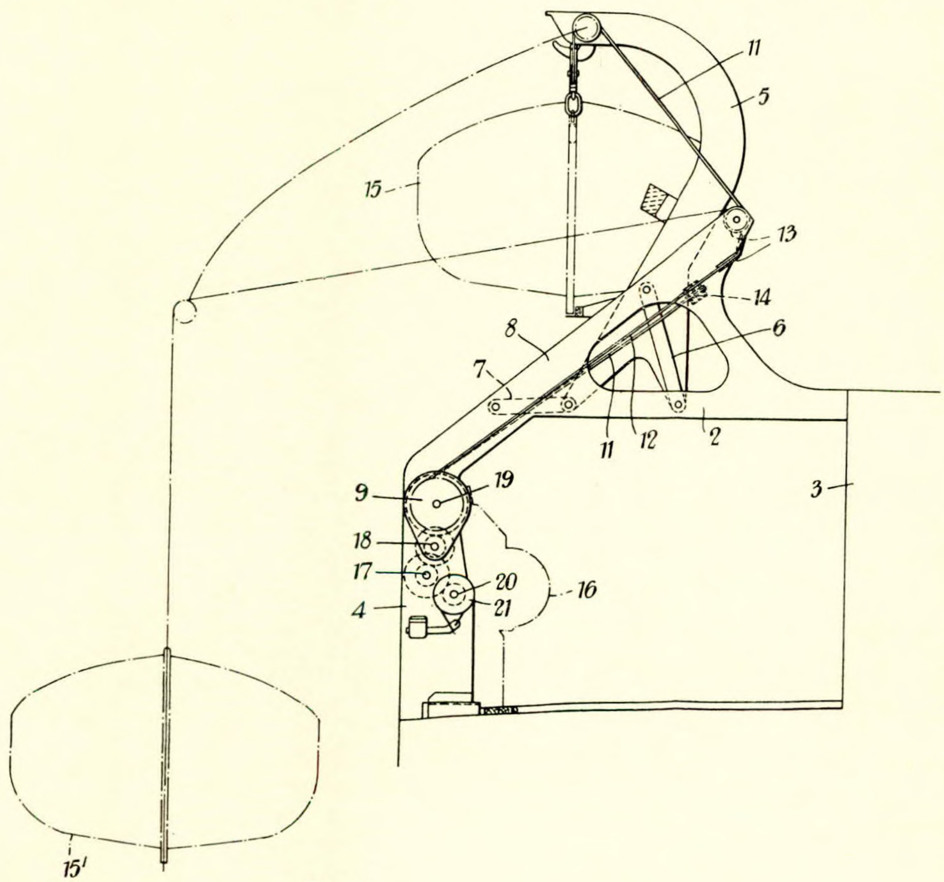


FIG. 1

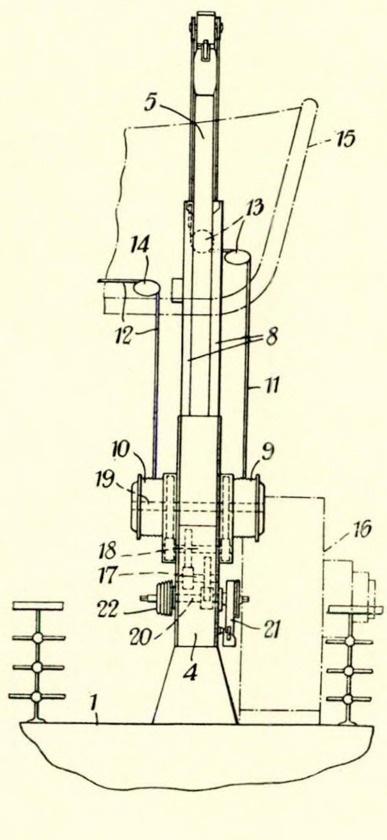


FIG. 2

for carrying bulk oil, means for washing the tank or tanks, means for passing the oil and/or sludge and water collected in a tank as a result of a washing operation into one or more separate compartments to allow the oil and/or sludge to separate from the washing water, at least one sludge compartment arranged adjacent each separation compartment so that the separated oil and/or sludge in each separation compartment can be caused to overflow into a sludge compartment by adjustment of the liquid level in the separation compartment, means for adjusting the liquid level in each separation compartment and means for discharging the oil and/or sludge from the sludge compartment. Means may also be provided for discharging the contents of ballasted oil-carrying tanks into the separation compartment or compartments together with the bilge water from the various compartments of the vessel and oily condensate from leaking cargo tank and/or bunker coils. A further feature of the present invention is the provision of a tanker vessel in which the relative capacity of the centre tanks and wing tanks is such that for all oil cargoes likely to be a source of sea pollution, a large percentage of the wing tanks will be buoyancy space during a loaded voyage and clean water ballast tanks, evenly distributed over the length of the cargo space during a ballast voyage, the aggregate capacity of these wing tanks being sufficient for fine weather ballasting.—*British Patent No. 743,713, issued to Shell Refining and Marketing Co., Ltd.*

Protective Device for Lessening or Avoiding Air Heater Corrosion

In boiler units fitted with heaters for the combustion air, corrosion of air-heater heat-exchange surfaces is not infrequently a serious problem. The corrosion leads to reduced efficiency and to damage, necessitating repair or replacement; and often considerable expense and difficulty are experienced in rectifying corrosion damage to air-heater tubes or plates. Various expedients have been proposed for avoiding corrosion in air-heaters, but the problem continues to give serious concern. An object of the invention is the provision of simple but effective means whereby such corrosion may be lessened if not avoided. A simulating element is adapted to assume a temperature substantially equal to that of the heat-exchange surfaces of the heater at the coolest region of the surfaces, and temperature-sensitive means responsive to the temperature of the simulating element are provided to effect a control affording protection or to give warning against operation of the heater within the region below a predetermined temperature. The outline arrangements, Figs. 1 and 2, show an air-heater (1) which is arranged to receive cool air from an air inlet duct (3) and to supply heated air through an air outlet duct (5) to where it is required, such as a furnace-chamber fired, for example, with oil. The heat-exchange surfaces of the air-heater are arranged to be

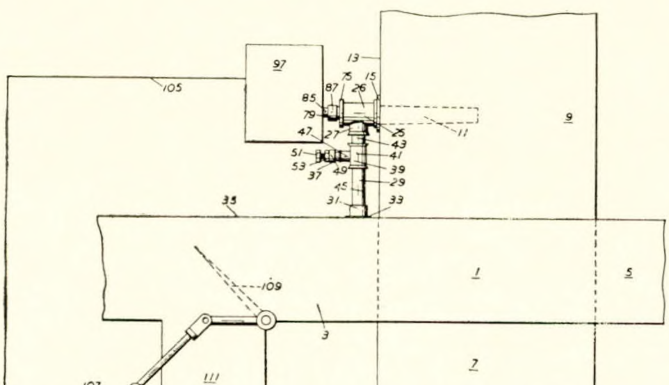


FIG. 1

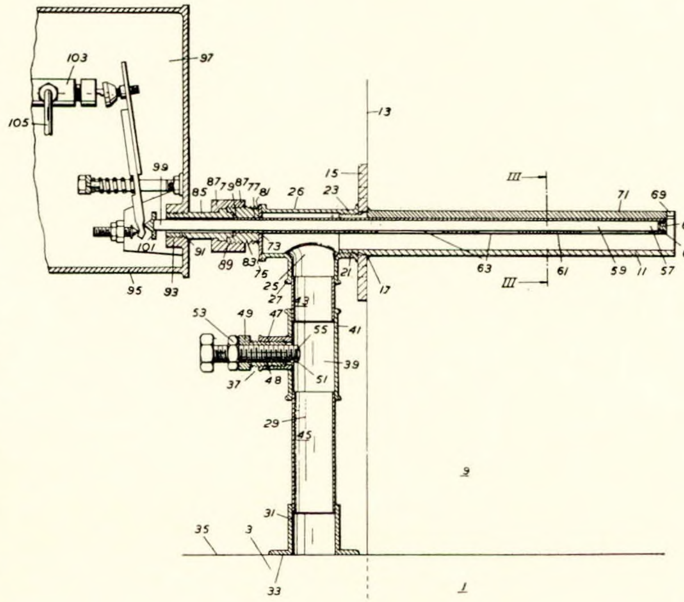
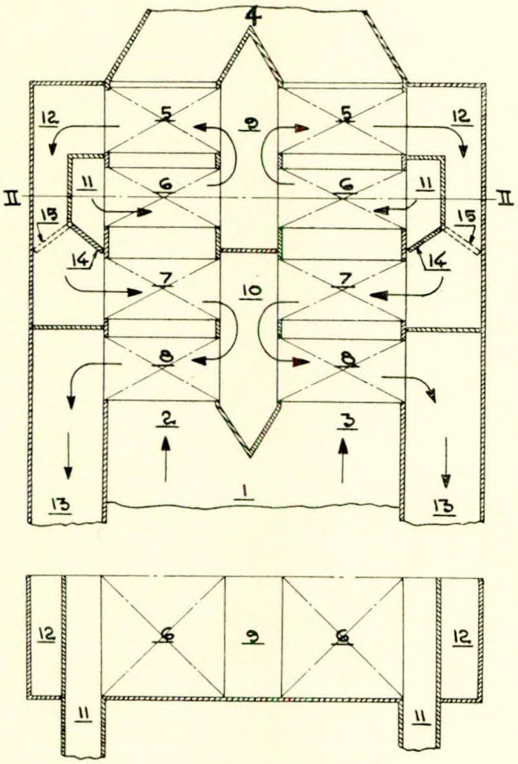


FIG. 2

traversed by heating gases supplied to the air-heater through a gas inlet duct (7) and discharged therefrom through a gas outlet duct (9). Provided in connexion with the air-heater are protective means adapted to exert a control affording protection against operation with the coolest region of the air-heater below a predetermined temperature. The protective means include an element adapted to simulate the temperature of the coolest region of the air-heater and in the form of a mild-steel tube (11), open at its ends, which extends horizontally through a side wall (13) of the duct (9). An annular flange (15) which is secured to the tube (11) by a weld (17), is provided to hold that tube in position, and is fastened to the outer surface of the wall (13) by bolts (not shown). The tube (11) is arranged to be traversed by a sample of the cool air to be heated, and which flows towards the air-heater through the duct (3). Within the tube (11) are temperature-sensitive means which comprise a differential thermostat (57) including elongated concentric elements (59 and 61) having different coefficients of thermal expansion. During operation, upon the temperature of the tube (11) and therefore of the heat-exchange surfaces at the coolest region of the air-heater (1) falling to a predetermined value, the knife edge (101) moves to a position commensurate with that pressure in the pipe (105) which operates the thermostat (57) falling below the predetermined value. The pressure in the pipe (105) could be utilized to operate a suitable alarm device for giving warning against operation of the air-heater with the coolest regions of the heat-exchange surfaces thereof below the predetermined temperature.—*British Patent No. 745,145, issued to Bailey Meters and Controls, Ltd. Complete specification published 30th November 1955. Engineering and Boiler House Review, February 1956; Vol. 71, pp. 61-62.*

Air-preheater

With air-preheaters arranged in the outlet flue from a furnace, the air is usually passed in a direction opposite to that of the gases. This arrangement, however, often brings about such low temperatures at the inlet of the air-preheater that the dew point of the gases is passed, which may cause severe corrosion. In air-preheaters consisting of several heat exchange sections arranged in series, such corrosion may be avoided if the air supply ducting is connected to one section in the centre part of the series, which is in a zone of comparatively high gas-temperature. From here, the air is passed first into the low-temperature section of the preheater and then into



FIGS. 1 *(top) and* 2 *(bottom)*

its high-temperature section. Referring to Figs. 1 and 2, the flue (1) of a steam boiler is divided into two separate channels (2, 3). Above the air-heater the channels are joined and connected to an exhaust duct (4). In each channel, an air-preheater is provided, each consisting of four sections (5, 6, 7, 8), the sections being composed of horizontal tubes through which the air passes. The space between the two gas channels is closed by lateral walls. The air is conducted to the preheater through ducts (11) connected to the sections (6), which are located in the centre of the series of preheater sections. Each series is divided into one part consisting of section (5), in which the gas temperature is lower than in section (6) and another part, containing sections (7, 8) in which the gas temperature is higher than in section (6). When the air has passed through section (6), where it would be sufficiently heated to eliminate the risk of condensation in the low-temperature part, it is led through the upper chamber (9) to the section (5). After passing through this section, the air reaches the outer chamber (12), from whence it passes section (6) and then reaches section (7). After passing through this section it passes through the lower chamber (10) and finally is conducted away through duct (13). If the boiler is operating under exceptionally low load conditions, the air can be conducted through two sections only. For this purpose supply ducts are arranged to be connected directly to the outer chambers by means of dampers (14).—*British Patent No. 743,397, issued to A.B. Götaverken. Application in Sweden made on 18th February 1953. Complete specification published 11th January 1956. Engineering and Boiler House Review, March 1956; Vol. 71, p. 90.*

Prevention of Corrosion in Oil Tankers

Heating coils in the tanks of oil tankers have the disadvantage that they are subject to much greater corrosion than that of the ship's hull. They must therefore be replaced several times during the lifetime of a tanker. It has now been determined that the heavy corrosion of the heating coils is due to the fact that the ship's hull and the coils, together with the oil, form a galvanic cell. In this case the oil constitutes an electrolyte, the ship's hull being the anode and the heating coil being the cathode of the galvanic cell. Oil is normally regarded as an electric insulator. This does not, however hold true with crude oils as carried by tankers. Since both the hull and the heating coils are made of iron, the creation of a difference of a potential between them would not be expected. In practice, different qualities of iron, varying due to different quantities of carbon, silicon, magnesium, etc., often happen to be located at different places in the thermo-electric voltage chain of the metals. This is the reason why potential differences arise between the heating coils and the hull. A further cause for the generation of the galvanic currents is constituted by the heating by steam of the coils, which attains a temperature of about 120 deg. C. as compared with that of the hull amounting to between 0 and 20 deg. C. According to the invention, the heating coils are electrically insulated from parts of the ship's hull; furthermore, they are made from metal alloy, which has a potential in the electrolytic voltage chain which, upon supply of steam to the coils, is at least approximately the same as that of the tank walls in order to avoid generation of electric currents by the walls and the coils acting as electrodes and the oil acting as electrolyte.—*British Patent No. 745,709, issued to S. O. Rygard. Complete specification published 29th February 1956.*

Welded Aluminium Boat

The chief object of the present invention is to provide a method of manufacturing such boats which will reduce production costs while providing strong watertight welded joints. The method of manufacturing the shell of an aluminium boat, comprises cutting relatively large flat aluminium plates to shapes to facilitate conforming to the contour of the hull with a minimum of jointing seams between the plates, cutting out inwardly extending gores at the edges of the plates to minimize buckling when they are caused to conform to the shape of the shell, attaching these shell plates to the frame of the boat, and butt welding the adjacent edges of the plates and the gores together along their length. The shell may then be light-hammered to flatten bulges and to cause the plates to conform more perfectly to the desired final shell shape. The initial attachment of the plates to the frame may be effected by bolts, tack welds being made at intervals along the plate gores and along the inter-plate seams, and thereafter the shaped shell may be riveted, preferably with countersunk rivet heads, to the frame, as well as to the keel and gunwale at the shell edges. The shell plates are thus "tailored" to shape in a somewhat similar manner to that used for manufacturing clothing, and normally it may suffice to have one longitudinal substantially horizontal seam in the region of the bilge, the seam ends extending upwardly to the gunwale fore and aft. Thus each side of the shell may comprise four plates, two upper plates above the seam, and two lower plates below the seam, the two upper and two lower plates each being separated by transverse seams located respectively fore and aft of the mid point of the boat. For larger boats there may be more than one longitudinal seam in the shell, but this would not normally be necessary, and there may, of course, be more than one transverse seam, although it is desirable to keep the number of separate plates to a minimum in order to save labour and gas in welding.—*British Patent No. 744,257, issued to Mechans, Ltd. Complete specification published 1st February 1956.*

Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 4, April 1956

Australian Cargo Steamship

The Australian Shipping Board has accepted delivery of a single-screw steamship from the Blyth Dry Docks and Shipbuilding Co., Ltd. This vessel, the *Talinga,* 10,000 tons d.w., is a sister ship to the *Timbarra,* built in 1954 at the same shipyard, and has been specially designed for the carriage of coal and iron ore. The *Talinga* is propelled by a superheated triple-expansion steam engine, and this is installed aft. The principal particulars of this vessel are as follows: —

Length b.p.	435ft.
Breadth moulded	58ft. 6in.
Depth moulded	34ft.
Draught	26ft.
Deadweight, tons	10,000
Horsepower, i.h.p.	3,100
Service speed, knots	11½
Cargo capacity, cu. ft.	
Grain	514,370
Bale	485,510
Coal (untrimmed) ...	447,900

The *Talinga* has a cellular double bottom extending between the fore and afterpeak bulkheads, and this is of increased depth in way of the machinery space. The double bottom tanks are arranged for the carriage of water ballast, oil fuel and fresh water. In addition water ballast can be carried in the fore and afterpeak tanks, and in the port and starboard hopper side tanks, which extend for the full length of the cargo holds. Two further tanks for carrying water ballast are arranged at each side of No. 1 hold, immediately below the upper deck. Extensive use has been made of electric welding in the construction of the *Talinga,* and riveting has been confined to the gunwale bar, the main girder connexions and the shell bilge strake. There are four cargo holds with hoppered sides and bulkheads of the corrugated type. The midship section is almost square and there is only a very small rise of floor on either side, and no tumble home. The *Talinga* is propelled by a superheated triple-expansion marine steam engine incorporating the North Eastern reheat system. driving a single-screw propeller supplied by the Manganese Bronze and Brass Co., Ltd. The engine has cam-operated poppet valves fitted to the h.p. and m.p. cylinders, and Martin and Andrews balanced type slide valves fitted to the l.p. cylinder. The balance weights are forged solid with the h.p. and m.p. crankwebs, the sequence of cylinders fore and aft being h.p., m.p. and l.p. Air and bilge pumps are fitted to the main engine and are driven by levers from the h.p. cylinder crosshead. The cylinder diameters are 26 inches, 41 inches and 73 inches respectively, and the stroke is 48 inches. The engine was built by George Clark and North Eastern Marine (Sunderland), Ltd., at the South Dock Engine Works. On trials the engine developed 3,500 i.h.p. at 90 r.p.m., and the service power is 3,100 i.h.p. at 86 r.p.m. An Aspinall governor is fitted to the engine. The piston packing has been supplied by Campbell and Banks, Ltd., and the piston rod packing by the United States Metallic Packing Co., Ltd. Steam is obtained from three cylindrical multitubular marine type Scotch boilers.—*The Shipping World, 23rd November 1955; Vol. 133, pp. 493-494.*

The 34,500-ton m.s. *Ferncrest,* the Largest Motor Tanker

The largest motor tanker with the highest powered single-screw Diesel machinery in any ship was launched in November 1955. She is the *Ferncrest* of 34,500 tons and is being built for Messrs. Fearnley and Eger, Oslo, by Eriksbergs Mek. Verkstads A.B., Gothenburg. The details are: —

Length overall	682ft. 9in.
Breadth, moulded	87ft. 0in.
Depth, moulded	47ft. 6in.
Draught, fully loaded	35ft. 0in.
Cargo capacity, tons	34,500
Tank volume, cu. ft.	1,660,000
Machinery, b.h.p.	12,500
Contract speed, knots	16

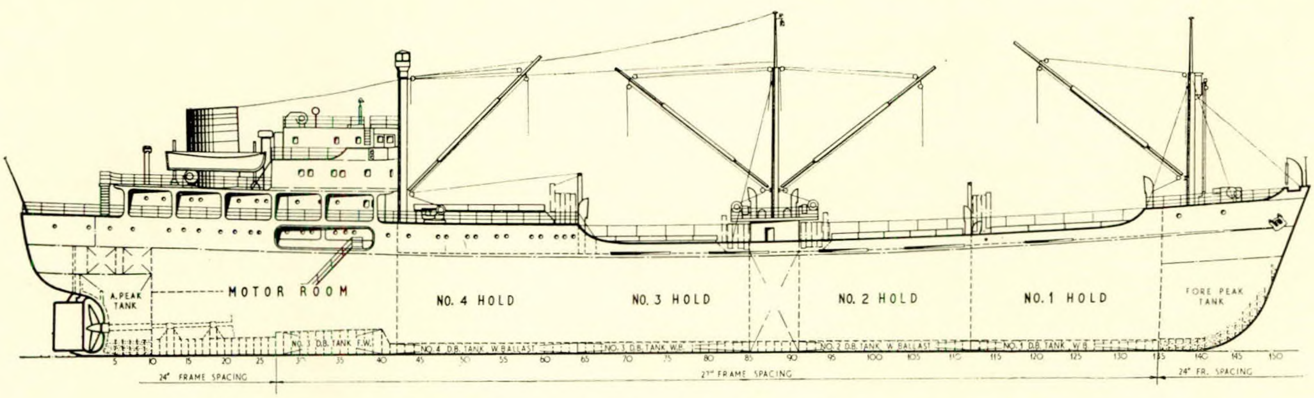
The propelling engine is of the standard Eriksberg-B. and W. two-stroke turbocharged type with 10 cylinders 760 mm. in diameter, the piston stroke being 1,600 mm. and the speed 115 r.p.m. There are four 750-ton per hour cargo pumps, two (of the centrifugal type) being installed in the main aft pumping compartment and driven by steam turbines in the engine room, and two of the vertical design, driven by vertical compound steam engines. The hull is divided into eleven centre tanks and twenty-two side tanks, by means of longitudinal and transverse corrugated bulkheads, on the builders' normal constructional system. The vessel is all welded. The three oil-fired Scotch boilers each have a heating surface of 250 sq. metres and one exhaust-gas boiler is installed. Most auxiliaries, except the cargo pumps, are electrically driven and one steam-turbine-driven and two Diesel-driven generators are installed in the engine room.—*The Motor Ship, January, 1956; Vol. 36, p. 472.*

Self-loading Bulk Sugar Ship

The first of two ships designed for direct service between the West Indies and Tate and Lyle's sugar refinery at Plaistow Wharf, London, has now been completed and has entered the company's service. This vessel, the *Sugar Importer,* was launched from the Aberdeen shipyard of Hall Russell and Co., Ltd., May 1955. The principal particulars of the *Sugar Importer* are as follows:—

Length o.a.	353ft. 9in.
Length b.p.	330ft.
Breadth moulded	50ft.
Depth moulded	26ft. 6in.
Draught	22ft. 2in.
Deadweight, tons	5,325
Horsepower, b.h.p.	3,040
Speed	13·5
Gross tonnage	4,024

The *Sugar Importer* has been built under special survey to Lloyd's Register of Shipping highest class, and is a self-trimming single-screw cargo vessel with a single deck, raked stem, cruiser type stern, and with machinery arranged aft. She is of part-welded and part-riveted construction, built on the transverse system, but fitted with longitudinal framing in the double bottom. Water ballast is to be carried in the double bottom, after peak and a large fore peak tank. The vessel has four separate holds which are designed for grab discharge, and which are fitted with MacGregor patent steel hatch covers, the forward hatch being equipped with individual pull covers and Nos. 2, 3 and 4 with single-pull covers of the combined rolling and pivoting type. There are eight 5-ton derricks with associated cargo winches, as well as a windlass and two warping capstans, all supplied by Clarke, Chapman and Co., Ltd. Topping winches have been supplied by A. and D. Turner, Ltd. The steering gear is of the electro-hydraulic type controlled from the bridge by telemotor gear. Lifesaving appliances to M.O.T. requirements include two wooden lifeboats, both fitted with Diesel engines and suspended from gravity-type davits. The propelling machinery consists of two British Polar type M48M Diesel engines having eight cylinders and developing 3,040 b.h.p. at 300 r.p.m. Each engine operates through hydraulic couplings and reduction gearing, driving the single shaft at 150 r.p.m. The twin-pinion reduction gearing is of Power Plant manufacture, and Vulcan hydraulic couplings are employed in their usual setting. The two engines for each unit are coupled together so that they can be operated by one person, and if necessary the vessel can run on one engine at about 75 per cent of the normal full speed. Electricity for power and lighting is supplied by three Ruston and Hornsby 100 kW Diesel-driven units, and one 40 kW unit of the same make.—*The Shipping World, 28th December 1955; Vol. 133, p. 597.*



Single screw motor vessel Sugar Importer

German High Speed Diesel Electric Drive

Two cargo ships of interest have been delivered to their owners, the Wechsel Dampfschiffahrts-A.G., Kiel, for service between European ports and the Canadian Great Lakes. These vessels, the *Norderholm* and the *Suderholm,* have been built by Kieler Howaldtswerke-A.G., and are said to be the first Diesel-electric cargo ships to be fitted with high-speed Diesel engines. This particular installation is unusual insofar as there are three Diesel-electric generators and three electric motors, the latter coupled to a single propeller shaft. The more conventional method is to have one, or at the most two, electric motors geared to the propeller shaft. In spite of the higher initial cost, Diesel-electric drive has many advantages. The Diesel engines can operate under the most favourable conditions at a steady speed, and do not have to be reversible. They are thus given a longer life, since the wear and tear caused by manœuvring no longer occurs, as in the case of a reversible direct-drive Diesel engine. A further great advantage is that one or more engines can be shut down for overhaul when the vessel is at sea, and this can mean a considerable saving in time and money. In addition, one or more engines can be shut down for overhaul when the vessel is running at slow speed, thus saving fuel. The advantage resulting from placing the generators on a flat above the propelling motors has not been made use of in this instance, but in spite of this a saving in engine room space has been made. Also of importance is the fact that there is no need for separate Diesel-driven generators for auxiliary purposes, the only separately driven generator required being one for harbour duty. Other savings include a reduction in the engineroom personnel. The *Norderholm* and the *Suderholm* have been built as either open or closed shelterdeck vessels. They have a length o.a. of 258·4 feet, length b.p. of 245·9 feet, and breadth of 42·8 feet. As open shelterdeckers the vessels are of 1,560 tons gross and 2,975 tons d.w. on a draught of 19·1 feet. The propelling machinery consists of a group of three Diesel-driven generator units driving three electric motors coupled through reduction gearing to a single propeller shaft. The Diesel engines are of Mercedes-Benz type, having 12 cylinders and developing 950 h.p. at 1,400 r.p.m. (730 h.p. at 1,200 r.p.m.). These engines, which are manufactured by Daimler-Benz A.G., are of the four-stroke type, pressure-charged, and of Vee design. The fuel consumption is stated to be about 168 grams per b.h.p.-hr. The generators each have an output of 635 kW at 560 volts, and are of Siemens-Schuckert-Werke A.G. make. Auxiliary electrical power comes from three auxiliary generators on the same shafts and driven by the same prime movers as the main generators. There is only one separately-driven auxiliary generator, this being a 60 kW Diesel-driven unit for use in harbour. The d.c. propeller motors have a maximum speed of 1,000 r.p.m. and an output of 600 kW. They are connected to the reduction gearing in such a manner as to form a triangle, the centre motor being mounted at the top of the reduction gear casing, and the other two outer motors arranged one on each side of the gear casing, and in line with the propeller shaft. The gearing has been designed to give a propeller speed of 130 r.p.m. A Siemens-Schuckert-Werke control desk is installed in the wheelhouse with all the navigational instruments and controls grouped together. An Anschutz auto-pilot is included in the control console. To facilitate the work of the pilot and helmsman on the Great Lakes, radio-telephone equipment has been installed in these ships.—*The Shipping World, 30th November 1955; Vol. 133, pp. 517-518.*

Form and Stability of Ships

Years ago tankers were built with a single main oil-tight longitudinal bulkhead, 'tween decks forming summer tanks and expansion trunks. This system has now given way to one in which there are two main longitudinal bulkheads. The possible advantages of finer forms are particularly marked in this class as the longitudinal bulkheads could be omitted entirely, with a consequent marked saving in the weight and complication of the hull. Drainage in the tanks will also be materially facilitated. The advantage claimed for tankers is of a different nature from that expected in other classes, for the conventional tanker is already in a class by itself so far as its powers of resistance to damage are concerned. The adoption of finer forms will not, in this case, increase invulnerability; the advantage is to be gained from savings in the structure. The increase in the reserve of buoyancy, and of the internal volume as compared with the displacement, would be advantageous for the carriage of oils of low specific gravity whether the customary sub-division were retained or not. In cargo ships the net volume of the holds will for a given deadweight be greater than for conventional ships, and the disposition of the space will be different. The shape of the hold at the bottom will be less convenient for bulk cargoes, and the 'tween decks will be larger. The advantage seems to lie with the finer form, particularly in these days when cargoes of "large cube" are the rule. The danger of shifting inherent with bulk cargoes in rectangular holds will be very materially reduced, and the shape of the side will provide a very important self-trimming effect. The problems of the variation in metacentric height with various load conditions, and of ballasting the ships, will be simplified, for the maximum variation in GM will be from a minimum value in the light condition to a maximum with a heavy homogeneous cargo. The maximum GM will correspond with the maximum inertia, and variations in the behaviour of the ship will be smoothed out. The increase in draught in all conditions, and the finer form of the bottom, will reduce both the cause and the effects of pounding. Drainage and the fitting of bilge lines will be facilitated. In train and motor car ferries constructed on the semi-circular principle, the train deck can be arranged at a level lower than the centre of the semi-circle so that the metacentric height will be approximately constant irrespective of the loading, and this value of GM can readily be arranged so as to prevent heavy or jerky rolling. Under no circumstances should the car deck extend to the full beam of the vessel. In passenger vessels full use can be made of the advantages as outlined for cargo ships, and in addition, by suitably choosing the centre of the semi-circle or minimum height of the M curve, moderate and constant GMs can be assured. This would seem to be of particular importance in very large vessels, where the acceleration effects associated with great linear dimensions and even moderate metacentric height are likely to prove most uncomfortable.—*R. Baker, O.B.E., International Shipbuilding Progress, 1955; Vol. 2, No. 12, pp. 368-383.*

French-built Cargo Liner

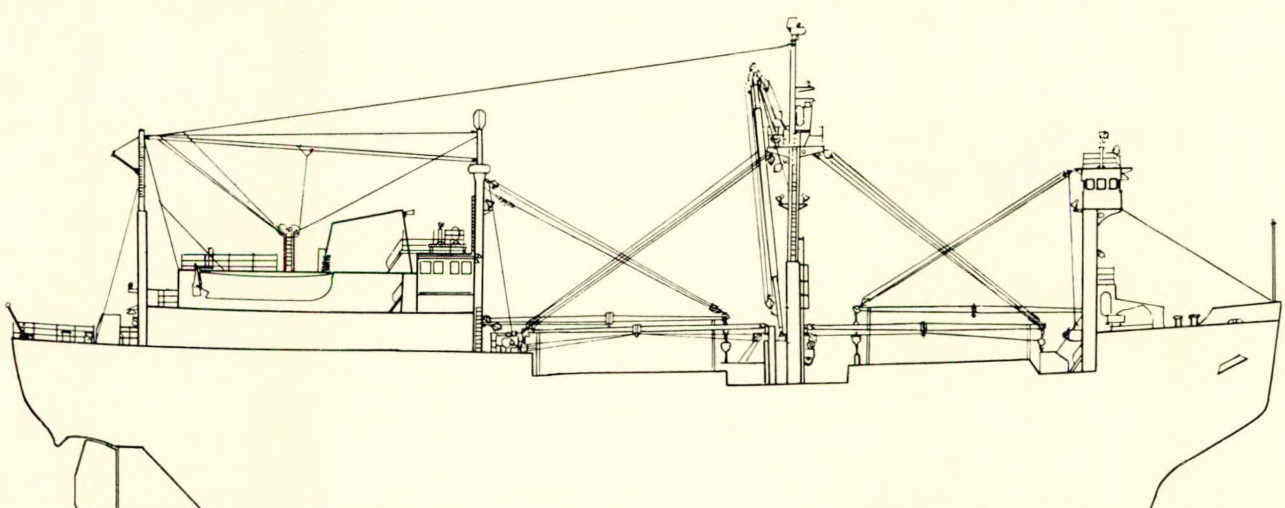
The *Ville de Djibouti* is of streamlined-design, with a well raked bridge front. The main characteristics are as follows:—

Length o.a., metres	136·00
Length b.p., metres	126·74
Breadth, metres	18·30
Depth to upper deck, metres ...	10·87
Depth to main deck, metres ...	7·89
Deadweight, tons	8,745
Corresponding draught, metres ...	7·78
Machinery, b.h.p.	6,250
Service speed, knots	16

The hull and superstructure is of almost entirely welded construction while most of the sidelights and windows have also been welded in place. There are five holds and 'tweendecks while, in No. 2 hold, a portable third deck is arranged. When not required, this deck, weighing some 50 tons, is secured on the underside of the 'tweendeck. Special lifting shackles on the corners of the hatchway enable this to be lowered by the heavy-lift derrick on to brackets and secured. The hatchway can be closed by means of two fabricated steel covers, one port and one starboard, which can be rolled inboard towards the centre. Hydraulic raising and lowering of the portable deck had been contemplated at first, but was later considered unnecessary since the heavy-lift derrick on the foremast was, in any case, available. All masts are unstayed and are of four-side construction, tapering towards the top and constructed with round-bar corners and flat plates. These are also fitted with air intakes. In the service for which this ship is designed, heavy deck cargoes are frequently carried and the decks have, consequently, been kept clear of obstructions. It should be mentioned that the standard of the welding throughout is especially good and that automatic machine welding has been adopted extensively. The cargo handling gear comprizes ten 10-ton derricks, two for 5-ton lifts, one for 30-ton and one for 50 tons. All winches are mounted on mast houses and are driven by asynchronous squirrel-cage motors and give an adequate range of speed control. Made by Brissonneau et Lotz, Paris, these winches give entirely satisfactory operation. The two capstans aft, and the windlass are of the same make. A deep tank is formed at the after end of No. 3 hold with a deep tank for molasses and wine tanks, port and starboard, arranged to facilitate the carriage of various grades. All cargo spaces are mechanically ventilated and air conditioned to facilitate the carriage of fruit and similar cargoes. There are three refrigerated cargo chambers of 50m.^{3} each, capable of maintaining independently a temperature between 5 deg.-20 deg. C. with a sea temperature of 32 degrees. The main engine, built by Chantiers et Atelier de St. Nazaire Penhöet, is believed to be the first turbocharged single-acting two-stroke B. and W.-type engine built in France. It has five cylinders with a bore of 740 mm. and a stroke of 1,600 mm., the service output being 6,250 b.h.p. (metric) at 115 r.p.m. Of the poppet-valve type and of the now standard B. and W. design and construction, the engine is equipped for operation on boiler oil. It was noted, however, that although recent turbocharged engines of this make have dispensed with the electrically driven emergency blower for scavenging air charging duties, it has been retained in this case and is driven by a 250-b.h.p. triple-slot wound a.c. motor. There are two exhaust-gas turbo-blowers, both of Rateau manufacture, the forward unit taking the exhaust gas from Nos. 1 and 2 cylinders, and the after machine operating from Nos. 3, 4 and 5 cylinders. Part of the trials were conducted with the two main turboblowers disconnected and with only the electrically driven blower in commission, the engine then maintaining at about 100 r.p.m. an output of some 3,000 b.h.p. to give a speed of 14 knots. The power and lighting circuits are all a.c., and the system adopted is of particular interest. It was decided that power-drive off the main engine shafting offered the most economical means of generating the electric supply and, accordingly, a 300-kW. 400-volt 670-amp. d.c. generator is mounted on the line-shafting aft of the thrust. This feeds to a 295-kVA., 400-volt, 3-phase, 50-cycle alternator, cos, ϕ = 0·75 running at 1,000 r.p.m. and coupled to a 300-kW. 440-volt d.c. motor. A magnetic coupling connects these sets to a S.E.M.T.-Pielstick engine—a four-stroke, exhaust-gas pressure-charged, vee-type unit—developing 400 b.h.p. at 1,000 r.p.m. The main shaft-driven generator meets all normal power requirements at sea with the engine running at between 115 and about 60 r.p.m. However, when the main engine speed falls below that required to meet the immediate electrical load, the Pielstick engine, which is constantly circulated with warm water and lubricating oil, automatically cuts-in at 1,000 r.p.m., the magnetic coupling then connecting it to the alternator set. Furthermore, overload on the shaft generator or the cutting-in of the Pielstick-engined generators, automatically brings into service one of two 215-kVA. 3-phase 50-cycle generators each driven at 500 r.p.m. by a four-cylinder Penhöet-B. and W. Diesel engine.—*The Motor Ship, December 1955; Vol. 36, pp. 370-374.*

Ice-strengthened Cargo Ship

One of the new types of ship in the U.S. Navy's current arctic shipbuilding programme is a small ice-strengthened cargo ship of the T-AK 270-272 class. The ship will be approximately 266 feet long and have twin screws, Diesel electric drive, and machinery aft. It will have a hull designed for a one-compartment standard of sub-division, with an inner as well as an ice-strengthened outer shell for protection against punctures by pack ice. Each ship of the class will have a continuous main deck and a 'tween deck which is continuous except in the way of the machinery. The double envelope formed by the inner and the outer shell of the hull up to the 'tween deck will provide tank space for Diesel oil and ballast. Above the 'tween deck a through fore-and-aft passage between the inner and outer shell is planned to permit interior personnel movement from the after quarters to the forecastle head and to the ice pilot station without exposure to severe weather conditions. The hull itself will be reinforced with a ¾-in. high-tensile steel plating along the sides from 3 feet above the deep load waterline to 3 feet below the light load waterline. The thickness of this plating will be increased to 1 inch at the bow and stern. The hull will be shaped like that of an icebreaker, but suitably modified to provide enough cubic capacity for carrying a cargo deadweight of 1,300 tons. The midbody section of the hull will have a 10 degrees outward slope from the 6-ft. bilge radius to the designer's load waterline (19 feet) at which line the tumble home will begin. There will be no dead-rise or parallel middle body. These characteristics will prevent the ship from being wedged in ice and will tend to raise her if frozen in. The hull will have a raked icebreaker bow cut away at a 30 degrees angle from about the 20-ft. waterline to the 10-ft. waterline. A modified cruiser stern fitted with an ice cutter will protect the rudder when the vessel is backing down in ice-filled waters. In addition, to prevent ice from lodging between the hull and the top of the rudder when the vessel is backing down, the shell above the rudder will be faired into a conical shape to maintain a small constant clearance at all rudder angles. The dimensions of the transverse frames and shell plating will be designed to resist the imposed ice forces when the vessel is beset. In order to resist the imposed ice forces, the main and 'tween deck beams will act in conjunction with the web frames and will be heavier than is required by the American Bureau of Shipping Rules. For additional strength the floors, lightened to suit, will be carried up to the underside of the 'tween deck in the fore and aft peak. The propeller shafts will be of solid forged steel with a diameter greater than the minimum stipulated by the American Bureau of Shipping for ice. The two 4-bladed nickel-aluminium bronze propellers will be ice-strengthened in accordance with A.B.S. Rules. This material has excellent cold weather properties. The propellers will be located so that they are entirely covered by the hull to minimize damage from ice. The rudder stock will be made 10 per cent stronger than required by A.B.S. To assure rapid loading and discharge of cargo, the two holds of the ship will have double the amount of cargo-handling gear normally found on a ship of this size. Six 5-ton booms will be fitted at every position except at the forward end of No. 2 hold where two 10-ton booms will be stepped to handle heavier loads. A 30-ton boom, fully rigged at all times, will be fitted to the forward end of No. 2 hatch. All winches serving the booms will have protected winch-operator control stations. Both hatches on the main deck level will have four-leaf hydraulically operated quick-acting covers. The 'tween deck will have the conventional aluminium board covers. All the fire stations, fuel-oil filling stations, and fresh water stations will be enclosed by deckhouses, but will be accessible from the exterior by means of small watertight doors.—*Bureau of Ships Journal, November 1955; Vol. 4, pp. 11-12.*



Small ice-strengthened cargo ship of the T-AK 270-272 class

Fiat Turbocharged Engine

The Fiat Company, at the Stabilimento Grandi Motori, Turin, have completed two years' experimental work on turbocharging their two-stroke single-acting engine. Based upon the results achieved, the eight-cylinder 4,200 b.h.p. non-turbocharged engine (680 mm. cylinder bore, 125 r.p.m.), in the m.s. *Sestriere,* has been converted to turbocharging and the ship re-entered service last month. The engine is of the same cylinder dimensions and type as that upon which the experiments were carried out, and on a 600 hours' continuous run the output was 5,800 b.h.p. at 135 r.p.m. (corresponding to 5,300 b.h.p. at 125 r.p.m.) which represents an increase of 25 per cent. During the whole period the engine ran on boiler oil. The first part of the research was carried out on an engine in the Fiat power station and it was continued on the first of two similar engines but of more modern design, built for installation in a ship under construction at the Breda Shipyard for the Societe Sidarma. This unit also has eight cylinders with a diameter of 680 mm. and a piston stroke of 1,200 mm. and is designed for a speed of 125 r.p.m. to 130 r.p.m. The system of supercharging adopted is illustrated diagrammatically in Fig. 3. It was the object of the manufacturers to maintain the structural features of the unsupercharged engine unchanged in the turbocharged model, so far as possible. Referring to Fig. 3 the exhaust gas is delivered from the manifold (7) to the turbine (1) of the turboblower. In an eight-cylinder engine two blowers are used. The exhaust then passes to the atmosphere or a waste-heat boiler. The air compressed in the blower (2) is delivered to the cooler (3) whence it enters the engine-driven scavenge pump (4). It is then further cooled after discharge from the pump, by passing through a second cooler (5). It enters the scavenge trunk (6) and is admitted to the working piston through scavenge ports, the admission being controlled by automatic disc valves. The number of scavenge pumps varies but the total displacement volume is equal to that with the similar non-aspirated engine. The builders have adopted this system for the following reasons: (1) The engine can be changed over from a turbocharged to a non-aspirated unit when it will develop 80 per cent of its rated output or the full output of the equivalent non-aspirated engine. (2) Starting, manœuvring and sudden overloading can be effected as with a non-turbocharged engine. (3) The second cooling of the air after compression in the engine-driven scavenge pump improves the thermal efficiency. (4) It provides flexibility in siting the turboblowers. (5) It enables the main structural features, the timing, etc., to be retained, hence it is possible to convert existing engines to turbocharging without excessive cost, taking into account the fact that the margin in the strength of the crankshaft and propeller shafting is usually 20 per cent to 25 per cent. The engine is essentially suitable for operation on boiler oil, the fuel injection system being specially designed for this purpose whilst the cooled scavenge and exhaust ports are kept free from deposit. There is a partition between the bottom of the cylinder liners and the crankcase preventing sludge from the cylinder walls falling into the crankcase. An examination of the test results shows that at maximum overload the exhaust gas temperature of the turbocharged engine is 400 deg. C. and the brake mean effective pressure 9·5 kg./cm.^{2} (135lb. per sq. in.) and with the non-aspirated engine (also 400 deg. C. exhaust temperature) it is 6 kg./cm.^{2} (85lb. per sq. in.). Usually with the turbocharged engine the b.m.e.p. will be 6 kg./cm.^{2} to 7 kg./cm.^{2} (85lb. per sq. in. to 100lb. per sq. in.) and in this range the fuel consumption curve is flat representing 160 gm. per b.h.p.-hr. (0·35lb.). At increasing loads, including overloads, the exhaust temperature curve does not rise as steeply as with the non-aspirated engine, and, comparing the two units running at normal rating with 300 deg. C. exhaust temperature in each case, the turbocharged engine has an increased output of 25 per cent but its overload capacity is higher. The reason is that, as the b.m.e.p. rises, the efficiency of the turbocharger increases and more air is delivered to the cylinders. The Fiat turbocharged engine is now being built in two cylinder sizes, namely (1) 750 mm. bore and 1,320 mm. stroke, and (2) 680 mm. bore and 1,200 mm. stroke. They are rated respectively at 1,100 b.h.p. and 850 b.h.p. per cylinder against 775 b.h.p. and 600 b.h.p. for the same engines, non-aspirated. The mean effective pressure of the turbocharged engines at these ratings is 6·7 to 6·8 kg./cm.^{2} (95 to 96·5lb. per sq. in.). The builders, whilst considering these pressures as wholly suitable for satisfactory continuous operation, have decided that until a considerable experience has been gained in service under normal seagoing conditions, the normal ratings shall be kept within conservative limits, and that the b.m.e.p. shall not exceed 6 kg./cm.^{2} (85lb. per sq. in.), corresponding to a specific cylinder output of 1,000 b.h.p. for the 750-mm. bore engine (termed 750S), and 750 b.h.p. for the 680-mm. engine (termed 680S), the speeds being 125 r.p.m. and 130 r.p.m. respectively.—*The Motor Ship, January 1956; Vol. 36, pp. 448-450.*

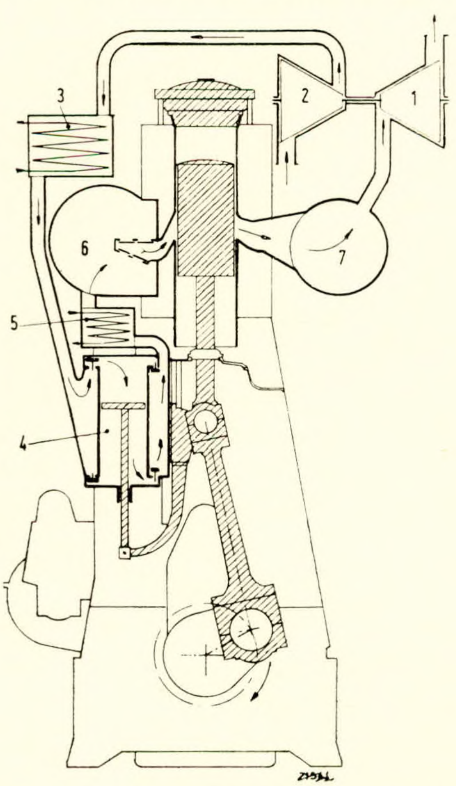


FIG. 3—*Diagram showing method of turbocharging the Fiat two-stroke engine*

Experiments on Box Girders

A ship's hull is not designed primarily as a structure. One of the objects of this research was to assess the contribution made by the superstructure to the longitudinal strength of the ship. Owing to the great complexity of ships' structures it was decided to experiment with a series of unstiffened and stiffened rectangular boxes, to gain a fundamental understanding of the behaviour of thin-walled girders; it was not intended that they should be scale representations of a ship's hull. The first experiments were carried out on simple rectangular boxes, and superstructures were added later. Most of the work described in the paper has been on steel specimens, but attention has also been given to the alternative of using small celluloid models. All the experiments described have been carried out in the laboratory using point loads applied by jacks in testing frames. The most prominent structural phenomenon in the experiments described has been elastic buckling of the plating. The buckling of a plate differs from that of a strut in that further load may be carried elastically by the plate after the initial buckling stress has been exceeded. The edges of the plate are constrained to lie in their original plane, and the effect of buckling is to spread the load from the centre of the plate to the edges, with a consequent redistribution of stress. In general, the plate buckles in more than one half-wave and high local bending stresses may occur. Further, a redistribution of stress may arise from the distortion of the hull cross-section under longitudinal bending. Where a long superstructure is mounted inboard from the sides of the hull, it is loaded by vertical and shearing forces at its junction with the deck, and the vertical forces may cause the deck to deflect transversely. Since the vertical forces must be in equilibrium the deflexion changes in sign along the length of the superstructure, so that the longitudinal curvature of the hull and superstructure is not the same. Generally the curvature of the superstructure is less than that of the hull, resulting in a reduction of superstructure stress from the linear distribution calculated by the simple bending theory. The stress pattern in a ship is also affected by the redistribution resulting from distortions of the plating in its own plane. Such redistributions are commonly described as "shear lag" effects, and they usually occur near discontinuities in the structure. Examples of these effects are to be found in the region of hatchways or other openings, superstructures, and in plating between frames, where the contribution which the plating makes to the bending strength of the frame depends partly on this effect. The contribution of the plating to the transverse bending strength of the frames is also affected by distortion of the plate out of its plane. This is due partly to transverse pressure and partly to radial forces arising from the initial or imposed curvature of the frames. All these phenomena are separately amenable to theoretical treatment in idealized cases, but in practical ships' structures, where all these factors may arise simultaneously, the difficulties of theoretical analysis are very formidable.—*Paper by J. C. Chapman and S. R. Sparks, read at a meeting of the Institution of Engineers and Shipbuilders in Scotland on 15th November 1955.*

Lubrication of Rolling Contact Bearings

The lubrication of rolling bearings is not difficult under normal conditions. Only very small quantities of a suitable oil or grease are necessary. The lubrication requirements for operating conditions must be thoroughly understood. Even though the bearings may be completely immersed in a bath of oil, adequate lubrication is not assured. The oil which actually does the work is that maintained between the surfaces under load. With very slow speed and heavy load it is not possible to preserve a film between the rollers and races unless the viscosity is extremely high, because there is time for the oil to be squeezed out ahead of the rollers as they advance. If the speed were increased under such conditions, a velocity would be reached at which there would not be time for the oil to escape from between the surfaces and a film would be maintained. Similarly, if the speed were kept constant, a film could be provided between the load surfaces by increasing the oil viscosity to the point at which there would not be time for the oil to be squeezed out ahead of the rollers. Provided rolling bearings are protected from moisture and dirt, are properly mounted, and are well lubricated, the only factor limiting their useful life is a fatigue failure of one of the component parts. The fatigue phenomenon is the result of cyclic loading and unloading of the parts and is evidenced by flaking of the material, which starts as a small crack and develops into a spalled area. The number of cycles that will be attained by a bearing before fatigue failure takes place is decreased appreciably as the stress increases. In order to keep the unit stress as low as possible, the geometry of the load-carrying surfaces is held to very close limits, and surface finishes are maintained to the highest commercial standards so that the load will be distributed over the largest area practicable. Even with rolling bearings, there is a small amount of sliding under load because of elastic deformation of the load-carrying surfaces. Without sufficient lubrication to prevent serious metal-to-metal contact of the surfaces, this sliding can cause serious damage resulting in premature bearing failure. The most positive lubrication for the majority of bearing applications is provided by oil. Mineral oils are principally used since these are rather uniform in their characteristics, and can usually be selected with regard to a suitable viscosity only. Under normal speeds of operation a wide range of viscosities can be tolerated. As the speed increases, lighter viscosities must be used and the quantity of oil controlled to prevent excessive churning and accompanying high temperature, which may exceed safe limits for both bearing and lubricant. Should the viscosity be too light there will also be a rise in temperature due to the metal-to-metal contact of the load-carrying surfaces. If operation is continued under these conditions the temperatures will become great enough to temper the bearing components, resulting in early failure and the characteristic discoloration of the surfaces generally associated with inadequate lubrication. As the speed decreases, heavier viscosities must be used under heavy load in order to prevent serious metal-to-metal contact of the surfaces and wear from the relative sliding. At very low speed there is not measurable temperature rise, even under heavy load and with an oil viscosity that is not adequate to provide necessary separation of the rolling surfaces. First visible evidence of breaking through the oil film under such conditions is a glazing or burnishing of the surfaces.—*T. W. Morrison, Lubrication Engineering, November/December 1955; Vol. 11, pp. 405–411.*

British Single-screw Oil Tank Motorship

The single-screw oil-tank motorship *George Lyras,* has recently been completed by Bartram and Sons, Ltd., of Sunderland, for Marine Enterprises, Ltd. (Lyras Brothers, Ltd., managers), London. The *George Lyras* has been awarded the highest classification certificates of both Lloyd's Register of Shipping and the American Bureau of Shipping for "vessels carrying petroleum in bulk", and has been built in accordance with the latest regulations of the British Ministry of Transport. The principal dimensions and other leading particulars of the vessel are given below.

Length overall	557ft. 6in.
Length b.p.	525ft. 0in.
Breadth moulded	67ft. 9in.
Depth moulded	38ft. 0in.
Gross tonnage	11,587·61
Net tonnage	6,558·59
Load draught	29ft. 10in.
Corresponding displacement, tons	22,979
Corresponding deadweight, tons	16,900
B.H.P. in service	6,800
Corresponding r.p.m.	119
Service speed, knots	13¾

The hull form, which is of advanced design, has been developed from the results of model experiments carried out in the Dumbarton tank of William Denny and Brothers, Ltd., in association with a model propeller of Unislip design, for which particulars have been provided by the Unislip Propeller Co., Ltd., of Newcastle-on-Tyne. The *George Lyras* is of orthodox tank-ship design, of the single-deck type, and has a long poop, bridge house and forecastle erections. The main propelling machinery is located aft. Twin longitudinal bulkheads, in association with oiltight transverse bulkheads, subdivide the main tank range into three groups, each of nine tanks, corresponding to nine centre tanks and eighteen wing tanks. Three separate groups of tanks are separated by the two main cargo-pump rooms, while oiltight cofferdams, forward and aft, separate the main tank range from the ends of the vessel. Beneath the machinery space, the double-bottom tanks are suitable for Diesel-oil, lubricating oil and feed water. The

George Lyras is propelled by an N.E.M.-Doxford, six-cylinder, opposed-piston, balanced-type, direct-reversible oil engine, manufactured and installed by the North Eastern Marine Engineering Co., Ltd., of Wallsend-on-Tyne. The main engine, which has cylinders 670 mm. in diameter and a combined piston stroke of 2,320 mm., is designed to develop 6,800 b.h.p. at 119 r.p.m. (8,160 i.h.p.). The engine is fitted with three lever-driven scavenging-air pumps. Designed to operate with heavy fuel oil having a viscosity of 3,500 seconds Redwood No. 1 at 100 deg. F., the engine incorporates the latest Doxford features and is provided with crankcase diaphragms. Alternative connexions are arranged for an immediate changeover to Diesel fuel-oil. Two, three-furnace, cylindrical boilers, each having an external diameter of 15ft. 6in. and a length of 12ft., provide the main steam supply for driving the cargo pumps and the steam-driven auxiliary machinery. Of the right-handed, four-blade type, the propeller is cast in bronze, and has a diameter of 17ft. 8in., a surface of about 120 sq. ft. and a mean pitch of 13·4ft.—*The Shipbuilder and Marine Engine-Builder, January 1956; Vol. 63, pp. 35-46.*

Rubber Containers for Liquids and Powdered Goods

A new type of container is now being introduced in the Netherlands. These containers are of American origin and are made of rubber. The new type of container can be likened to a huge hot-water bottle and apart from the fact that by its use savings on packaging are possible, storage costs can be brought down since the containers can be stored in the open air without detrimental effects to the contents by vapours, moisture or vermin. There are two types of container, namely one for the transportation of liquids and another for the carriage of powdered goods, such as cement and carbon black. The former type have a capacity of 200 litres at a weight of 18 kg., the latter type has capacities of 2,000, 8,500 and 10,500 litres respectively. Since the 8,500 litre container can take the contents of 200 bags of carbon black it is obvious that the saving of packaging is considerable. The construction of the containers is similar to that of tyres. They are made from synthetic rubber strengthened with cord. There is special strengthening at the top and the bottom and the extremities are connected by a steel cable running lengthways through the interior. Stability is increased by these cables, which also prevent bulging or heeling to one side. The cables also serve to hoist the containers safely since they are connected to an eye-piece fitted to the top. The containers can be moved with various appliances, including the fork truck, since the material is strong enough to stand such handling. The metal parts of the containers are made of stainless steel and the rubber resists the influences of the weather, moisture, oil, many chemicals, etc. The containers are filled by way of a bung hole and are then given a quantity of pressurized air to ensure a smooth outer surface for easy transportation. The air can be replaced by gas if the nature of the cargo requires this. To empty the containers the same methods are applied as used for barrels, drums and the like. Large containers must be placed upon a specially designed pedestal, and have a drain pipe in the centre. When empty the containers are folded up and in this position occupy only one-sixth of their space when filled.—*Holland Shipbuilding, December 1955; Vol. 4, p. 31.*

Structural Weight Similarity of Ships

The paper makes a plea for the more co-ordinated study of the ship structural weight problem. The more important earlier contributions to the subject are first reviewed and compared. This leads to the main thesis of the paper, the idea of ship structural-weight similarity. As in the corresponding ship-resistance problem an attempt is made to eliminate absolute size from the weight problem. This introduces the concept of the global mean thickness ratio as a means of interpreting weight similarity and faciltating what may be called the weight condensation problem. A new weight coefficient called the quadracubic number, a development of earlier cubic and quadratic numbers, is introduced and is used to generalize earlier data, to show the influence of ship proportions, fulness and type on relative weights, and to develop weight tabulations to assist the designer in the interpolation and extrapolation of his own data. The use of the 400-ft. structural geosim is also submitted. The development of the global mean thickness ratio or structural-weight comparison concept to lengths materially greater than 400 feet is considered, and a somewhat more general approach is developed for the presentation and study of the influence of length-depth ratio on weight similarity. This influence is shown to be closely related to that of transverse- and longitudinal-bulkhead weights and is likely to be felt chiefly in tanker weight presentations. The effect on weight tabulations is discussed. Finally a request is made for the publication of modern weight data to assist in the development of the subject.—*Paper by Professor E. V. Telfer, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 9th December 1955.*

Service Stresses of a T-2 Tanker

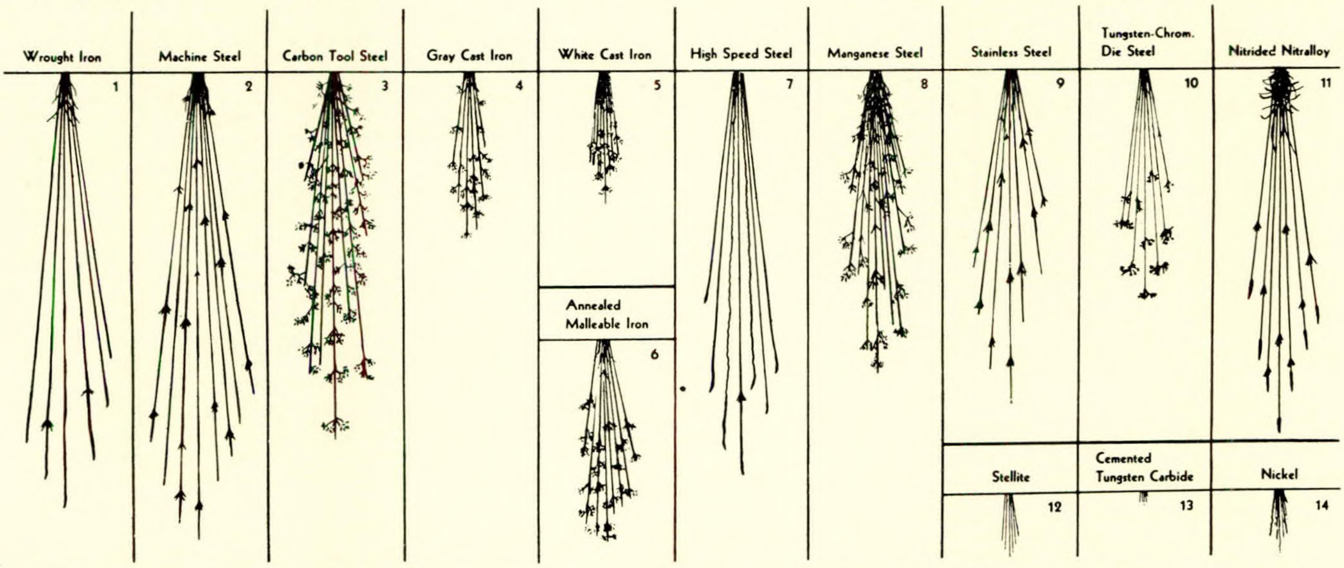
Service stresses and motions were measured on a T-2 tanker, the *Esso Asheville,* during the period from 24th August 1952 to 3rd April 1954, when the vessel was engaged in coastal traffic along the Atlantic seaboard, Central America, and the Gulf coast. The vessel is a single-deck, longitudinally framed tanker with a length between perpendiculars of 503 feet, a moulded beam of 68 feet, a moulded depth of 39ft. 3in., a displacement of 21,800 tons, and a midship section modulus of 47,700in.^{2}-ft. The general purpose of these tests was to determine the magnitudes and frequency distributions of the dynamic stresses (due to wave action) and the rigid-body motions of the ship under actual service conditions over an extended period of time. It was also possible to measure the deck stresses amidships during variations in static load distribution throughout the hull girder. Inasmuch as there have been numerous structural failures of this type of vessel, these data may be of value in assessing the relative significance of these different service stresses in contributing to such failures. Analysis indicates that the dynamic stress variations associated with the ship's motion in waves will rarely exceed 12,000lb. per sq. in. peak-to-peak. Also, the stress variations due to changes in temperature distribution occasionally are of the same order of magnitude as those due to changes in dead-load distribution. The maximum measured stress variation (free of stress concentration) corresponding to changes in temperature was about 11,000lb. per sq. in. The occurrence of wave-induced service stresses and of the ship motions experienced by the *Esso Asheville* may be approximated by a logarithmically normal distribution. Expected extreme wave-induced stresses are predicted by use of the methods of statistics.—*N. H. Jasper, Navy Dept., The David W. Taylor Model Basin, Report 960, 1955.*

Geometrically-similar Series of Model Screws

The author gives a brief description of a systematic series of experiments which have been started at the National Physical Laboratory, and reports some of the preliminary results. These experiments are complementary to those being carried out in the propeller water tunnels throughout the world for the International Towing Tank Conference. Their main purpose is to provide information by which the results of tests on models can be applied to ship propellers in service conditions. The particular aim of these experiments is to investigate the extent to which the results of routine propeller water-tunnel experiments are significantly affected by test conditions. More information is required on the effects on screw performance, both cavitating and non-cavitating, of model size and test conditions, and on the influence of tunnel boundaries. To some extent these problems are not independent. Not only are the results of experiments with model screws affected by the type of test section and the size of model relative to the section, but recent experiments have suggested that the way in which the propeller operating conditions are reproduced is significant. These operating conditions, defined by loading and speed coefficients, can be simulated in model tests at different absolute values of speeds and pressures. The experimental results given in this preliminary report tend to confirm that, particularly under certain cavitating conditions, there are significant differences in the forces measured when these parameters are varied. Other results suggest that cavitation-inception points, defined either visually or acoustically, also vary with test conditions as well as with model size.—*Paper by A. Silverleaf, read at Symposium on Cavitation in Hydrodynamics, held at National Physical Laboratory, September 1955. Journal, The British Shipbuilding Research Association, November 1955; Vol. 11, Abstract No. 10,854.*

Identification of Metals Prior to Welding

When a maintenance welder is called in, he is rarely told the composition of the metal involved which will permit him to select the correct alloy to use on the base metal. It is comparatively easy to discover if a metal is cast iron or steel, but to differentiate between the various steels requires study and experience. There is a great difference in the welding technique involved and the welding alloys recommended will depend upon the composition of the base metals. In production operations, the need for identification may not arise because the composition of the base metal is known. It is essential, however, that a rapid, easy way of identifying metals be known by maintenance welders. Fortunately, simple methods have been devised for testing metals which are available to all welders. The results will not be as comprehensive as laboratory testing, but may enable the operator to identify the metal. The chip test is an easy way of identifying certain metals. When the metal is chipped with a cold chisel the size and characteristics of the chips will vary with different metals. The spark testing of metals is a useful way of classifying them because any deviation from the known spark stream of a metal will indicate the



Metal	Volume of stream	Relative length of stream inches*	Colour of stream close to wheel	Colour of streaks near end of stream	Quantity of spurts	Nature of spurts
1. Wrought iron	Large	65	Straw	White	Very few	Forked
2. Machine steel	Large	70	White	White	Few	Forked
3. Carbon tool steel	Moderately large	55	White	White	Very many	Fine, repeating
4. Gray cast iron	Small	25	Red	Straw	Many	Fine, repeating
5. White cast iron	Very small	20	Red	Straw	Few	Fine, repeating
6. Annealed malleable iron	Moderate	30	Red	Straw	Many	Fine, repeating
7. High speed steel	Small	60	Red	Straw	Extremely few	Forked
8. Manganese steel	Moderately large	45	White	White	Many	Fine, repeating
9. Stainless steel	Moderate	50	Straw	White	Moderate	Forked
10. Tungsten-chromium die steel	Small	35	Red	Straw	Many	Fine, repeating**
11. Nitrided Nitralloy	Large (curved)	55	White	White	Moderate	Forked
12. Stellite	Very small	10	Orange	Orange	None	
13. Cemented tungsten carbide	Extremely small	2	Light orange	Light orange	None	
14. Nickel	Very small†	10	Orange	Orange	None	
15. Copper, brass, aluminium	None				None	

**Figures obtained with 12-inch wheel on bench stand and are relative only. Actual length in each instance will vary with grinding wheel pressure, etc.*
***Blue-white spurts*
†Some wavy streaks
Fig. 4.—This chart shows some of the spark patterns obtained when a metal is held against a grinding wheel (Courtesy: Norton Company, Worcester 6, Mass)

presence of "foreign" materials. When a piece of metal is held against a power grinding wheel, small particles are torn away (see Fig. 4). These are removed so rapidly that they become incandescent. The pattern of the spark stream differs to some extent with each metal and with the varying alloying elements.—*A. L. Phillips, The Welding Journal, September 1955; Vol. 34, pp. 877-881.*

Seagoing Ability

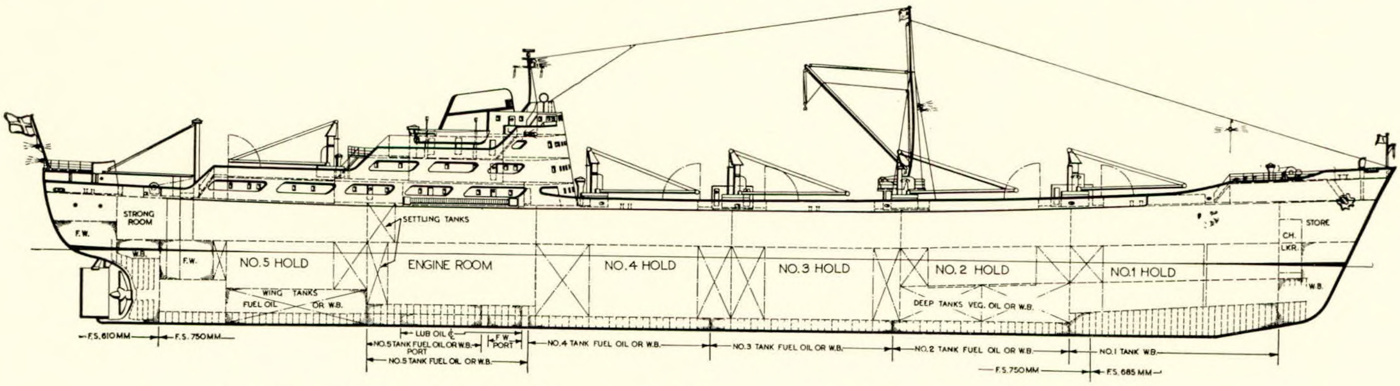
Seagoing ability is a problem in three dimensions. The practical sailor can choose both speed and heading, and would be hard pressed to say which he considers most important in his efforts to make the most of the means at his disposal in combating heavy weather. So far, model experiments have been largely confined to two dimensions. The long and narrow towing tanks customarily used for studies of powering in calm water are convenient for experiments in head seas or following seas without headway. They are nearly useless for experiments in oblique seas. But there is enough background from theory and from certain ingeniously devised, indicative experiments to show convincingly that cross-coupling of the forces and moments in all six modes of motion can have large effects. This is also self evident from practical experience. For the simpler two-dimensional case, the existence of large cross-coupling influences between heaving and pitching have recently been amply demonstrated. The next big step in the work on seagoing ability is to explain three-dimensional questions. Further broadening and deepening of concepts will be needed to successfully guide three-dimensional studies. A new variable is introduced in the influence of the rudder, which is not only an inherent characteristic of the ship but depends also on the helmsman. The steering qualities of ships in quartering seas, for example, is as much a part of the problem of seagoing ability as is pitching behaviour in head seas. The influence of the rudder (as well as of the ship form) in the yaw-roll pattern is well known from experience.—*K. S. M. Davidson, Schiffstechnik, November 1955; Vol. 3, pp. 18-20.*

A Suggested Mechanism of Erosion Damage

The various explanations of the damage associated with cavitation are reviewed, and attention is drawn to observations in practice and in experimental work for which the explanation based upon mechanical action due to cavity collapse is inadequate. A brief description is given of the action of, and damage caused by, impingement attack, and attention is drawn to the similarity between this and cavitation damage. It is suggested that it is not the collapse of cavitation voids which is the prime cause of the damage, but severe turbulence of a cavitating condition, and that cavitation damage is due to an action basically identical with that of impingement attack, with turbulence of the liquid as the major factor. Cavity collapse may cause loss of material by secondary action, and is the only feature of difference between cavitation damage and impingement attack. The mechanism proposed, which suggests that, like other manifestations of corrosion-erosion, cavitation damage is primarily a dynamic corrosion process, provides a rational explanation of those facts which are not in agreement with a mechanical-action theory.—*Paper by G. T. Callis, read at Symposium on Cavitation in Hydrodynamics, held at the National Physical Laboratory, 14-17th September 1955. Journal, The British Shipbuilding Research Association, November 1955; Vol. 10, Abstract No. 10,848.*

Swedish Cargo Ship with Ten Cranes

The Transatlantic Company of Gothenburg has ordered two cargo ships of a new type in which cranes are employed instead of winches for handling the cargo. A profile plan of one of these vessels is shown in the accompanying illustration.



10,000-ton cargo liner for the Transatlantic Company, with the engine room aft of amidships

The ship is to be of 10,000 tons d.w. and a Götaverken engine of about 8,000 h.p. is to be installed. The engine is to run on boiler oil; it is to be fitted aft of amidships. The speed of the vessel is to be 15¾ knots on trial. The length of the ship is 590 feet overall with a beam of 66 feet, the draught being 26 feet.—*The Motor Ship, January 1956; Vol. 36, p. 473.*

Microwave Course Beacon for Fishing Craft

A navigational aid for the smaller fishing vessel which does not carry marine radar has been developed by the Admiralty Signal and Radar Establishment on behalf of the Ministry of Transport and Civil Aviation. It provides an aid to entering harbour under conditions of bad visibility and consists of a shore-based 3 cm. transmitter of conventional type, which may be unmanned, and each vessel requiring homing facilities is provided with a small and extremely simple untuned receiver. The aerial radiation diagram of the transmitter is in the form of two wide lobes having a total coverage of some 120 degrees, these overlapping over a narrow sector—the line of safe aproach to the harbour—the width of overlap being about ½ to 1 degree. On one lobe the Morse letter B (– · · ·) is transmitted and on the other V (· · · –). These signals complement each other and a receiver situated within the common sector, or equisignal zone, will, therefore, receive the transmission as a steady note. A mile out at sea along the approach line, the width of overlap is some fifteen to twenty yards, this figure decreasing as the vessel nears the harbour. With the 120 degrees coverage and five to seven miles useful range of the transmitter, but outside the common sector, the signal received is, of course, that peculiar to the particular lobe in which the receiver is situated. At a recent demonstration of the equipment, the transmitter used was a modified Decca model, having a special aerial so orientated that the common sector is along the line of safe approach. The radiating system consists of two microwave slotted aerials separated by a beam dividing plate. The transmitter operates continuously, but power is switched from one slotted aerial to the other so that the Morse signals are radiated in their proper sectors, but still complement each other in the common sector.

A secondary feature of the receiving apparatus, which is inherent in its design, is that it will detect any 3 cm. transmission in the vicinity. This enables the small vessel to take evasive action if an unseen radar-equipped ship appears to be closing with it rapidly. There is, however, no fear that course signals and ship-borne radar transmissions can be confused—they are quite distinctive.—*British Communications and Electronics, November 1955; Vol. 2, p. 69.*

Volatile Corrosion Inhibitors

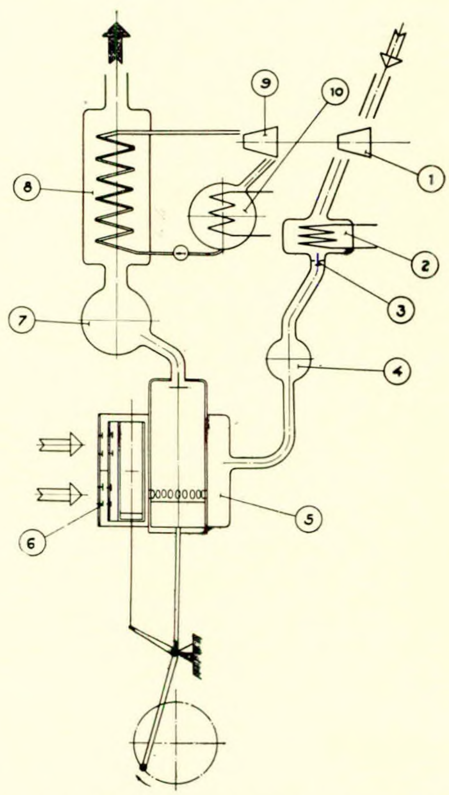
Volatile corrosion inhibitors represent the latest approach to rust prevention. These are organic chemicals that sublimate slowly and deposit an invisible film of rust inhibiting agent on surfaces to be protected. Greatest industrial use has been made in the packaging of ferrous metal spare parts where these inhibitors have simplified packaging, storage, and shipment. This form of protection permits the immediate use of packaged items without procedures normally associated with the removal of liquid or solid surface coatings before placing the equipment into service. The method is particularly advantageous where complicated mechanisms are involved. An attractive property of volatile corrosion inhibitors is their ability to reach all exposed surfaces by diffusion through the atmosphere. Only small quantities of the inhibitor are necessary to protect large surfaces; it has been calculated that condensed films only five molecules thick are sufficient to provide rust inhibition. However, an inhibitor easily deposited by condensation can vaporize just as readily, leaving surfaces unprotected. For this reason, the inhibitor vapour must be maintained above a minimum concentration, a requirement not difficult to meet in small confined spaces such as engine cylinders, packaged equipment, or even moderate sized drums and tanks. Systems involving large volumes may require special precautions. Excessive moisture, or free acids or alkalis also create problems. Wrapping papers impregnated or coated with the inhibitor are available commercially and represent the most common form of application. The dry inhibitors may also be applied by spraying, flocking, or dusting. Trays of inhibitors are also sometimes used for large spaces. If a system to be protected must be vented to the air, protection can be achieved by placing the inhibitor in the breather pipes so that air entering the chamber passes over the crystals and maintains saturation. Many volatile organic amine salts are known to inhibit corrosion of ferrous metals, and some of these have been patented as volatile corrosion inhibitors. Some are available commercially as solids. For special applications some of these materials may be dissolved or suspended in water, alcohol, or oil, and applied directly to the surfaces to be protected or to contiguous areas. —*Lubrication Engineering, September-October 1955; Vol. 11, pp. 293, 346, 348.*

Specifications for Surface Rolling Propeller Shafts

The improvement in fatigue strength obtained by surface rolling is dependent upon the depth of cold worked layer produced on the shaft surface, and the magnitude of residual stresses resulting therefrom. The depth of cold worked layer produced is in turn dependent upon the geometry of the roller and shaft, the roller load and the yield strength of the shaft material. This specification has been written for the specific purpose of expressing the fundamental relations existing between a roller and shaft, using a roller having dimensions suitable for application to marine propeller shafting. The detailed design of a complete rolling device was not intended to be part of this specification, but to be optional with users of the information presented herein. Roller loads for various diameter propeller shafts were computed for shaft steels of two different yield strengths, using a 10-in. diameter × 1½-in. radius contour work roller. These roller loads will cold work the shaft to a depth of ½-inch below the surface. The 1½-in. radius contour roller should be used in conjunction with two 5-in. radius contour rollers of similar diameter mounted on a circular frame arrangement of sufficient size to accommodate the shaft diameter being rolled. The latter two rollers would be fixed in position in the frame, the former would be hydraulically loaded and movable so as to compensate for changes in diameter encountered in rolling the tapered end of the propeller shaft. Depth of penetration is obtained with the 1½-in. radius contour, the two 5-in. radius contour rollers maintain a smooth surface finish. The feed at which the rollers traverse the shaft should not exceed $\frac{1}{16}$-inch per revolution of the shaft to obtain proper coverage. A shaft speed of 25 to 40 r.p.m. is recommended.—*H. R. Neifert, S.N.A.M.E. Bulletin, October 1955; Vol. 10, p. 27.*

12,100 i.h.p. Engine with Partial Supercharge

In connexion with the 30,200-ton motor tanker *Branita* ordered by A/S Freikoll (Ludv G. Braathen), Oslo, it was desired that a moderate increase in speed should be attainable beyond that originally specified. It was therefore decided that the Götaverken Diesel engine for this vessel should be partially supercharged, so that the output would be 12,100 i.h.p. at 110 r.p.m., this giving the ship a speed of 15 knots at full load. By this means it was unnecessary to alter the crankshaft. The system adopted, therefore, differs from that in the Götaverken turbocharged engine. Instead of using an exhaust gas turbine to drive the compressor supplying the scavenging air, a steam turbine-driven unit has been adopted. It works in parallel with the ordinary scavenging pumps and only handles the excess air which is needed. The size of the unit with its connexions is, therefore, quite moderate. The turbine is connected to the ship's steam system, the steam supplied from the exhaust gas boiler being sufficient to drive the compressor. The air, after compression, is cooled in an air cooler, passes through an automatic non-return valve and is directed through a scavenging air receiver to the scavenging belt. The scavenging air pressure is thereby raised and this increases the scavenging



Schematic diagram of the Götaverken partial-supercharge system

1 Compressor; 2 Air cooler; 3 Automatic non-return valve; 4 Outer air receiver; 5 Scavenging belt; 6 Scavenging pump with valves; 7 Exhaust gas receiver; 8 Exhaust gas boiler; 9 Steam turbine; 10 Condenser

efficiency and the amount of air trapped in the cylinder. Without any increase in the thermal stresses a larger amount of fuel is added and the output of the engine correspondingly raised. The tests carried out when the engine was tested in the shops confirmed these assumptions. The engine can deliver 90 per cent of the normal output without the compressor being brought into operation. The automatic non-return valve renders it possible to load or unload the compressor without any change in the piping system. This principle of supercharge has given satisfactory results on test, and on account of its flexibility in installation it offers a practical solution when a moderate increase in output is needed. As the location of the turbine driven compressor can be varied within considerable limits, existing engines, which admit of a higher output, can be modified according to this principle.—*The Motor Ship, January 1956; Vol. 36, p. 429.*

American Recommendations for Increasing Tailshaft Life

In 1953, the Ships' Machinery Committee's M-8 panel initiated a series of reversed bending fatigue tests on quarter-scale models of T-2 tanker tailshaft-propeller-hub assemblies. The programme was originally conceived to compare the fatigue lives of standard design specimens with those of specimens incorporating ABS-Navy stress relief modifications. The testing was done by the Timken Roller Bearing Company, which had previously conducted an exhaustive series of similar tests on railway car axle-wheel assemblies. It was suggested that surface rolling of the shafts would provide more resistance to fatigue in reverse bending than would attention to minor design details. The M-8 model programme was therefore expanded to include surface rolled specimens. The model test programme has been completed; fourteen specimens have been tested, six of which were standard design, four incorporated stress relief modifications, and four incorporated surface rolled shafts in addition to the design modifications. The results were comparable to the railway axle tests, the surface rolled specimens all showing a marked improvement in resistance to fatigue failure. The studies also show that the surface rolling will not eliminate cracks, but that their propagation will be greatly retarded and the probability of complete failure thereby reduced. —*S.N.A.M.E. Bulletin, October 1955; Vol. 10, p. 27.*

200-foot Ship Towing Tank

A description is given of the development, design, and contsruction of the new 200ft. by 6ft. ship model towing tank located at the University of California's Engineering Field Station in Richmond. This tank is equipped with a carriage which spans the tank, riding on accurately machined and aligned rails on each side of the tank. The carriage is driven by a d.c. motor system incorporating a G.E. electronic-amplidyne control, which allows close control to be maintained over the operating speed in both the forward and reverse directions. The carriage speed range is 0·2 to 20 feet per second. The carriage speed is measured electronically while the model resistance is obtained by a combined flexure-beam balance dynamometer. The expected accuracies of these measurements are approximately 1/1,000th knot for speed and about 1/1,000th lb. in resistance. Other items of instrumentation and equipment include a wave allowing practically unrestrained pitch, heave, and surge. Equipment scheduled for future construction includes a self-propulsion dynamometer and propeller boat for propulsion work and multi-component dynamometers for directional stability studies.—*Paper by J. R. Paulling, abstracted in S.N.A.M.E, Bulletin, October 1955; Vol. 10, p. 53.*

Behaviour of Riveted Joints in Aluminium Alloy Ships' Plating

The elastic behaviour, strength and water-tightness of riveted N-6 aluminium alloy plating have been observed during a research programme carried out for the British Shipbuilding Research Association. Tests were made on both lap and cover-plate joints held by cold-driven N-6 and hot-driven mild steel rivets. Specimens were designed to indicate the influences of driving method, edge distance, rivet pitch, row spacing and rivet diameter: plate thickness ratio. The principal test results are analysed, and are related where possible to theoretical predictions in this paper. Bearing behaviour and the effect of head and point size are discussed: the influence of driving method and bearing stress on rivet shear strength is examined. Bending distortions and stresses in the plating are analyzed and a basis is presented for deriving cover-plate thicknesses. This analysis is extended to indicate the requirements for caulking single shear joints. Finally, a basis for design is suggested and this is applied to indicate the most efficient joints to be used in such plating. It is concluded that steel rivets may not be used to advantage in N-6 plate, that single cover-plate thicknesses should exceed those specified by Lloyd's Register of Shipping rules for steel and that double cover joints are uneconomical.—*Paper by A. R. Flint, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 25th November 1955.*

Dutch Diesel Engine

L. Smit and Zoon, Scheeps en Werktuigbouw (Shipyard and Engineering Works, Ltd.), Kinderdijk, are building Diesel engines suitable for coasters, tugs, trawlers and all types of inland vessels. The engine produced is the original Bolnes Diesel engine, which is generally used as an auxiliary engine; Smit's, however, have made several improvements and altered it so that the engine is suitable for the propulsion of ships. To make this possible manœuvring gear was constructed, part of which is a patented invention of the late Professor B. C. Kroon, of Delft, and is shown in Fig. 1. The S.B.307 type of engine is of the two-stroke, single-acting type with longitudinal scavenging. The scavenging air is given a rotary movement for the complete cleaning of the cylinder and for thorough mixing with the vaporized fuel. The engine is produced with a number of cylinders ranging from 4 to 10 and outputs from 500 to

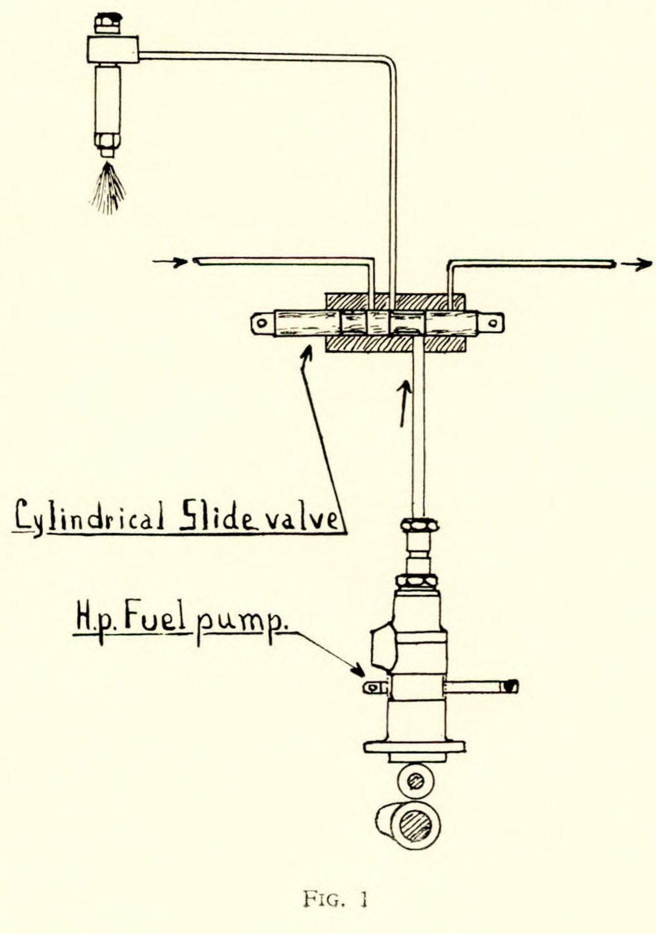


FIG. 1

1,250 e.h.p. at 275 r.p.m. Further technical details are as follows: —

Diameter of combustion cylinders ...	11·8in.
Diameter of scavenging pump cylinders	15·75in.
Stroke, approximately...	21·66in.
Medium pressure, approximately ...	72lb. per sq in.

A special feature of the Bolnes motor is the scavenging air pump being built around the crosshead. The scavenging pump piston serves as a crosshead guide, and the pump body as the guide bar (see Fig. 2). The scavenging pump is built between

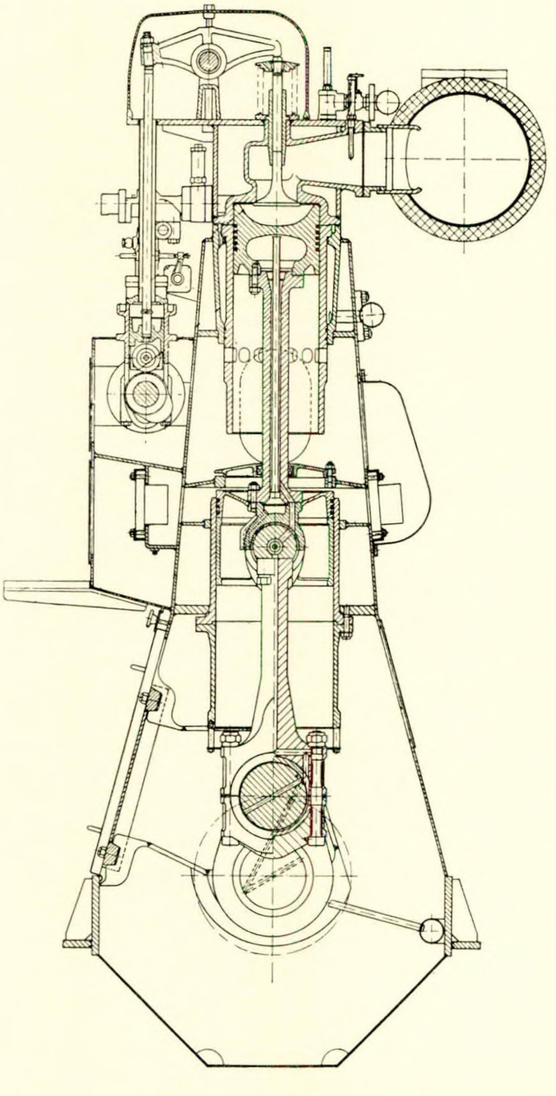


FIG. 2

the combustion cylinder and the carter; so the liner of the cmbustion cylinder is short and does not reach into the carter. An advantage of this arrangement is that no combustion particles can contaminate the lubricating oil.—*Holland Shipbuilding, December 1955; Vol. 4, pp. 22-23.*

The Atomic Merchant Ship

The atomic merchant ship will have the advantage that its fuel consumption by weight will be negligible. The fission of 1 kg. of U235 produces an amount of energy equal to that produced by the combustion of about 1,850 tons of oil. Assuming that it will be possible to burn 50 per cent of the isotope U235 before removal for reprocessing, one ton of natural uranium fuel will be equivalent for propulsion purposes to 6,500 tons of oil. With enriched fuel, or with breeder-reactors, this equivalence is still much more favourable. In a merchant vessel of 10,000 s.h.p., the weight of fuel required for a bunker radius of thirty days amounts to about 1,200 tons in the case of a motorship and 1,900 tons in the case of a modern steam turbine vessel. This weight of bunkers will be saved completely in an atomic ship. Assuming that the weight of the reactor core with the heat exchanger will be of the same order as the weight of the conventional steam boilers with their accessories, the saved weight of the bunkers will then be available. The designer of the reactor shielding will thus have a considerable figure to play with. However, the weight of the steel and concrete shielding of a land power station reactor may be of the order of 125 tons per 1,000 h.p., thus the development of shielding systems of moderate weight must be considered of utmost importance from a maritime point of view. The large amount of energy stored in the initial loading of its reactor, will enable the future atomic merchant ship to operate for several years before refueling becomes necessary. The reactor of such a ship may possibly take the form of an automatically controlled and completely sealed unit, that, with intervals of a certain number of years, will be removed bodily from the vessel, and replaced by a similar freshly loaded unit. The used-up fuel can then be taken out of the original reactor and be reprocessed, in special plants on shore.—*H. W. van Tijen, Holland Shipbuilding, 1955; Vol. 4, No. 5, pp. 16-17.*

All-aluminium Ferry Cruisers

Following successful operations under service conditions with a 40-ft. all-aluminium welded vessel, the Brauer Engineering Company, of Corpus Christi, Texas, are now building a slightly larger vessel 45ft. long. Salt water corrosion possibilities with high copper or zinc aluminium alloys led the builders to choose Kaiser's new high magnesium alloy 5083, designed especially for welded structures requiring both high joint strength and high corrosion resistance. Quarter-inch hull plates were used as an additional safety factor, though normally three-sixteenths would be regarded as adequate. All welding was done with one-sixteenth aluminium alloy filler wire using the conventional inert gas metal arc process. Vinyl base aluminium paint was used for the above-water portions and superstructure, but the bottom was coated with lacquer-type paint. This was found to be flaking off after a short initial service; the hull was then scraped to bare metal and an asphalt-base aluminium paint applied. The latter was reported four months later to be in excellent condition, with repainting not planned until early next year. The 40-ft. boat is powered with twin Diesels with a rated horsepower of 200 at 2,000 r.p.m., giving a cruising speed of 30 m.p.h. at 1,800, and a fuel consumption of 14 gallons an hour per engine. It is reported that in six months of service runs have been made through choppy, seven to eight foot high seas at 27 to 30 m.p.h. There is no indication of weakening of the welds or of other damage.—*Light Metals Bulletin, 1955; Vol. 17, No. 24, p. 1,095.*

Car and Weight Mover

The Grace Line recently placed in regular use for the first time anywhere a car-and-weight mover invented by one of the Line's cargo supervisors. The car-and-weight mover consists of a solid steel channel, the upper part having 2½-in. steel sides and a base with anti-skid lining at either end. In the bottom of the channel, which rests on the floor or deck, are set large ball bearings, 1¼-in. diameter each, and their housings, which extend through to the top side, contain a number of smaller bearings. The channels come in two sizes: 9 × 12 inches with four bearings for handling a 5-ton maximum unit and 9 × 14 inches with eight bearings, set in a special alignment, for handling up to a maximum of 10 tons. The movers weigh about 25lb. When placed under the wheels of cars or trucks or under the sides of large cases the invention enables such cargo to be manœuvred easily on deck or in the ship's hold. It greatly simplifies the stowage of vehicles and cases in close quarters, increases the ability to take advantage of all available cargo areas, and eliminates the need for drag wires and other rigging formerly required to stow this type of cargo in the wings of a hatch. It is portable, durable, easy to handle, may be manufactured in a variety of shapes and sizes, and requires no lubrication, only an occasional cleaning.—*Marine Engineering, December 1955; Vol. 60, p. 62.*

Welding of Steam and Feed Pipework for Marine Installations

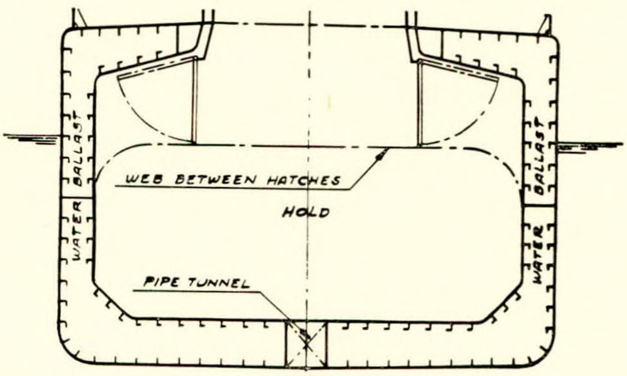
The authors state that the demand by the British Admiralty and merchant shipowners for faster vessels and more economical ships has resulted in the use of higher steam pressures and temperatures for driving the propelling machinery. The increase in steam temperatures above 850 deg. F. has made necessary the employment of alloy steels for the steam pipework, and this in turn has created problems for the welding engineer. Riveted-on pipe flanges were acceptable up to about fifteen years ago, but these were superseded by the the welded-on type, and more recently still, by the welding neck flange. It is not too optimistic to hope that in the near future all pipe joints, with the exception of terminal points, will be butt welded. This in itself would result in further economies as the total weight of pipework installations would be reduced. While the subject of welding low carbon steel pipework is discussed, the main theme of the paper is the welding, heat treatment, and non-destructive testing of joints in alloy steels made by manual methods only. In power station practice it is quite common to have fully butt welded steam and feed pipe ranges, and this necessitates the making of "Class I" welds in all positions. Recommendations are made regarding suitability of certain types of steel for specific steam temperature ranges. The paper makes reference to:—(1) Types of welded joints and preparation of tubes for welding. (2) Welding process and procedure. (3) Filler rods and electrodes. (4) Preheating. (5) Post-welding heat treatment. (6) Non-destructive examination. (7) Repairs to faulty welds. (8) Training, testing, and supervision of welders.—*Paper read by J. Chamberlain and W. L. Roe, at a meeting of the Institute of Marine Engineers, 10th January 1956.*

Abrasive Blasting

Much broader fields of use for abrasive blasting may be expected in the future on the basis of past experience with this method for cleaning and surface preparation on steel, wood, glass and other materials. The wide variety of use for abrasive blasting at the United States Naval Repair Facility at San Diego, California, indicate the trend generally in many different industries. Most of the applications observed there were relatively new, having been adopted within the last five or six years. The abrasives used range from hard crushed rock for ship hulls to a soft powder for obtaining a velvet finish on glass. One of the secrets in getting the best results is the selection of the best type abrasive for the job. Experiments at the repair facility have been successful in that respect. Remarkable saving in time is the principal benefit gained from this method of cleaning, but others also are evident, one being safety. The former power brushing method produced a shine but did not always remove foreign agents nor get down to the bare metal to reveal deep bits as abrasive blasting does. In some instances a failure to correct these conditions creates a structural hazard. Another benefit is in connexion with preparing a surface for painting. With abrasive cleaning, there is obtained not only the cleaner surface, which means a better paint job, but also an etching effect which helps anchor the paint. Diesel engines are 100 per cent abrasive blasted with cracked wheat. In cleaning cylinder heads, this method is effective in detecting possible flaws in the casting. Another advantage, for example, is the time saved in cleaning pistons. The former hand-scraping method required forty minutes, while the more positive abrasive blasting does the job in ten minutes. Overhaul and repair work have been improved in various other ways by the adoption of abrasive blasting throughout the facility. For instance, exhaust manifolds which once had to be replaced can now frequently be cleaned down to the surface and, as a result of this process, used again.—*Marine News, October 1955; Vol. 42, p. 37, p. 55.*

New Type of Bulk Carrier

Trials were carried out recently of the motorship *Abisko,* the first of five sister ships ordered by Trafikaktiebolaget Grängesberg-Oxelösund from Götaverken A/B, Gothenburg. The characteristic feature of this new type, in the design of which the builders and owners have collaborated, is that there is "a hull within a hull". The holds do not extend right out



Section through hold, showing arrangement of longitudinal bulkheads, portable grain bulkheads and feeders arranged between double hatch coamings

to the shell but are bounded by longitudinal steel bulkheads about one metre from the ship's side and these, together with the double bottom, form the inner hull. The space between the inner and outer hulls is used as ballast tanks. The ships in this series are primarily intended for the ore trade, but they are also suitable for other bulk cargoes such as coal or grain. To prevent the shifting to which grain cargoes are subject, the builders have designed a new type of portable grain bulkhead which is secured under the deck when the ship is carrying ore, but which can be hinged down and secured in the vertical position when grain is to be loaded. The builders have applied for a patent for this arrangement, which is combined with feeders arranged between double hatch coamings. The outboard profile of the *Abisko* and her sisters is also quite different from the previous ships in the Grängesberg fleet. The navigating bridge and accommodation has all been moved aft and there is no midships house. The *Abisko* has been built to the highest class of Lloyd's Register of Shipping and has the following principal dimensions:—

Length overall	490ft. 0in.
Moulded breadth	64ft. 0in.
Moulded depth	42ft. 6in.
Draught on summer freeboard...	27ft. 7in.

The ship is fitted with a seven-cylinder two-stroke single-acting Götaverken engine arranged for operating on heavy oil. The cylinder diameter is 680 mm., stroke 1,500 mm., and 6,200 i.h.p. is developed at 112 r.p.m. The three auxiliaries are also of Götaverken's design and manufacture. Each has an output of 165 kW, 300 mm. cylinder diameter and 450 mm. stroke. The contract speed at full load is $14\frac{1}{4}$ knots.—*The Shipping World, 28th December 1955; Vol. 133, p. 602.*

Patent Specifications

Oil Burner

The principal object of this invention is to provide an improved oil burner equipment of compact dimensions, capable of giving a greater heat release rate than has usually been attained hitherto, and which produces a flame of short, compact characteristics, with good combustion efficiency and without unduly high draught losses across the air-register. The invention is especially applicable to modern high-duty steam generating plant, in which type of plant, for example, there may be provided in one furnace, four burners, capable of burning a total of 9,200lb. of oil per hour with a heat release rate of the order of 500,000 B.Th.U. per cu. ft. per hr., with a draught loss of about 15in. w.g. The burner may, however, also be used in smaller units. Referring to Fig. 7, a sleeve (4) is provided over the sprayer end of the burner (3), having a portion (4a) belled towards the upstream side for directing a flow of cooling-air over the sprayer via a narrow annulus (5). A primary swirler (6) having a circumferential covering ring (6a) and radial vanes (6b) arranged in conical formation, and set at a suitable angle to give the air a rotational swirl about the burner axis, is attached to the sleeve (4). The burner (3) is surrounded by an air-register consisting of the cylindrical parts (7, 8) forming an inner primary-air annulus (9) and an outer secondary-air annulus (10) with a spill opening (11), so that air may spill from the primary into the secondary annulus over the circumference (6a) of the primary swirler. The air enters the register under suitable pressure through peripheral openings (12, 13) formed by flanged ends of the components (7, 8) and a plate (14). The equipment is adapted for combination with a refractory throat (15) of plain conical form, which forms part of a furnace refractory wall so that the primary swirler is positioned within the throat in the burning position. The throat is made concentric with the axis of the burner and has an included angle of about 22½ degrees, while the distance of the downstream edge of the ring (6a) from the narrower end of the throat is in the ratio of about 0·65 with the length of the throat. A secondary swirler (16) is arranged in the annulus (10) and has vanes (16a) directed in the same manner as the vanes (6b) of the primary swirler. The swirled secondary-air is directed towards the opening (11) over a flared member (17) which confines the air to the outer portion of the annulus (10) and induces a flow of "spill" air from the primary annulus. An air shutter (18), shown in the open position, is provided for closing the peripheral openings (12, 13) when the burner is not in use, sealing rings (8a, 14a) being incorporated for this purpose on the portions (8, 14) respectively. The shutter (18) is operable by spring-loaded rods with handles, attached to the shutter by means of lugs (20). A supply of cooling-air for the burner, independent of the combustion air, is maintained through the space (21), which is always open, between the plates (2, 14).—*British Patent No. 743,982, issued to The Commissioner for Executing the Office of Lord High Admiral of the United Kingdom of Great Britain and Ireland. Engineering and Boiler House Review, March 1956; Vol. 71, p. 91.*

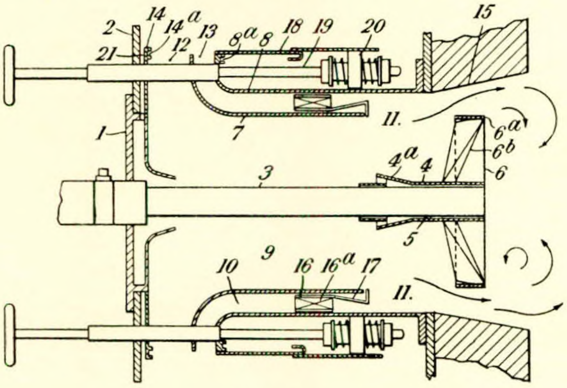


FIG. 7

Ship's Portlight

According to this invention a ship's portlight is provided with a glass carrying frame (*a*) adapted to slide in a stationary outer frame (*d*) and to be moved perpendicularly to its glazed surface into and out of sealing contact with the latter by means

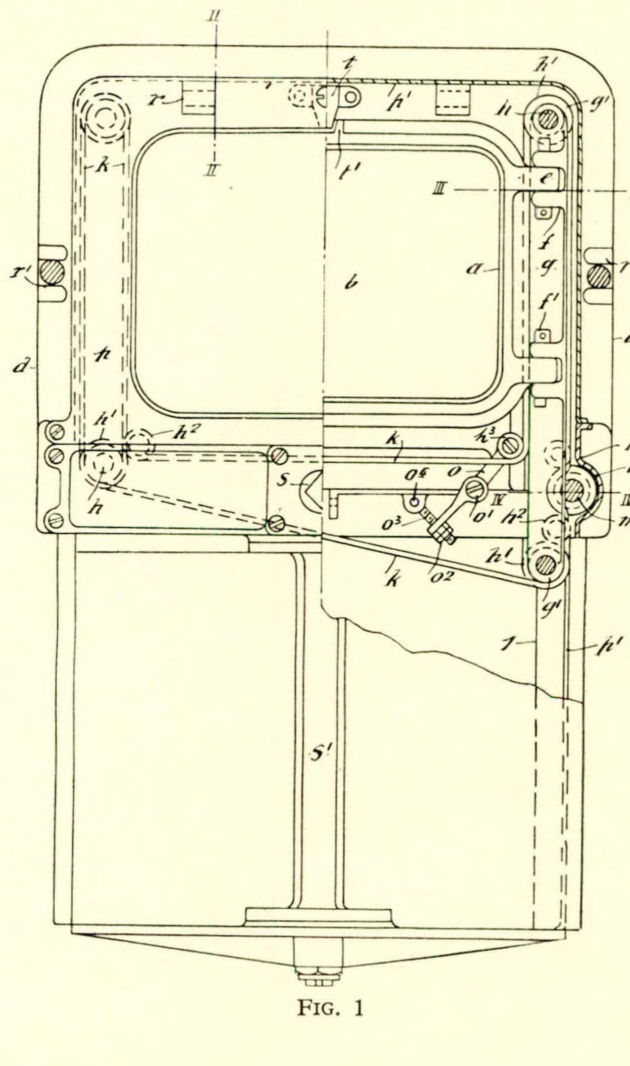


FIG. 1

of a single operating member. According to the example shown in Fig. 1, a binding screw (*h*) is provided adjacent to each corner of the glass frame, each screw (*h*) having fixed on it a pulley or sprocket wheel (*h'*) engaged by an endless driving belt or chain (*k*) travelled by the operating member (*m*). The outer frame (*d*) is provided with a cover plate, and a light brass or aluminium casing (*p'*) is welded to the frame, thus enclosing the driving belt and pulleys and binding screws. A deadlight (not shown) is hinged on pivots mounted in lugs on the outer frame. The glass frame (*a*) is raised and lowered by an operating handle applied to the squared end (*s*) of the boss of a bevel pinion engaging a similar pinion on a threaded spindle housed in a casing (*s'*), the spindle being engaged by a nut linked to the glass frame.—*British Patent No. 743,318, issued to M. W. Swinburne and Sons, Ltd. Complete specification published 11th January 1956.*

Tank Heating Coils

This invention comprises a heat exchanger for heating fuel oil or other viscous liquids carried in tanks or double bottoms of a ship, in which the viscous liquid to be heated is stored, and a plurality of pipes in a container for transmitting heating fluid internally therethrough, each of the pipes including an inner tubular steel conduit and an outer externally finned cast iron jacket mounted on the tubular conduit, a means being provided for introducing heating fluid into each conduit or pipe and for discharging the heating fluid after it has passed through the conduits or pipes. The cast iron jackets prevent the fluid contained in the tanks or double bottoms from coming into contact with the steel pipes, thus protecting the system against corrosion. Referring to Figs. 1 and 2 of the drawings, (*A*) indicates the valve connexion whereby the installation is connected to the source of heating fluid, e.g. steam. (*B*) is the steam inlet manifold. Finned heating elements (*C*) are arranged in a substantially horizontal plane near the bottom of the vessel. The fins or elements (*C*) extend radially and transversely to the axis of the elements. The heating elements (*C*) are formed in sections which are connected together by means of coupling flanges (*D*). At each opposite end, a second plurality of heating elements (*V*) are arranged in a substantially vertical plane and are fitted with radially extending longitudinal fins and connected to the horizontally arranged heating elements by means of curved connecting pipes (*E*). The heating fluid is admitted to the heating elements (*V*) through the valve (*A*) and inlet manifold (*B*) and is discharged therefrom via an outlet manifold (*F*) and a valve member (*G*) which is adapted to be connected to the discharge circuit. The inlet and outlet valves and manifold are mounted near the top of the container. As shown in dotted lines in Fig. 1, (*H*) indicates a divisional watertight bulkhead and (*I*) transverse watertight bulkheads, while the line (*L*) is the centre line of the ship.—*British Patent No. 742,683, issued to F. Casinghini Economizzatori Green. Complete specification published 30th December 1955.*

Cargo Stowage Device

In order to limit the base of very heavy cargo and thus raise the centre of gravity of the cargo and consequently to provide better navigational qualities for the vessel, there is provided on the upper plating (*d*) of the usual double bottom of the vessel and near the side of the walls of the vessel a stowage device comprising a plurality of plate elements (*a*) of suitable thickness and strengthened by strong ribs. These plate elements (*a*) are hingedly mounted by means of hinge pins on the upper plating (*d*). All the plate elements (*a*) of the stowage device co-act to form a removable internal longitudinal partial bulkhead in the hold (*h*) of the vessel. The centre of gravity of the plate elements (*a*) forming the bulkhead tends to keep them down into the rest position, as indicated, as soon as discharge of the heavy cargo is completed. The individual plate elements (*a*) of the bulkhead can be manœuvred by means of a steel cable or chain (*e*) either from the deck or from the engine room of the vessel by a simple mechanism which comprises

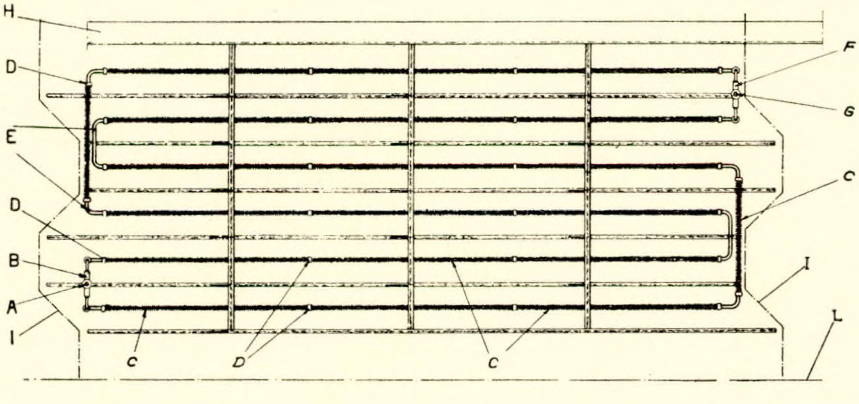


FIG. 1

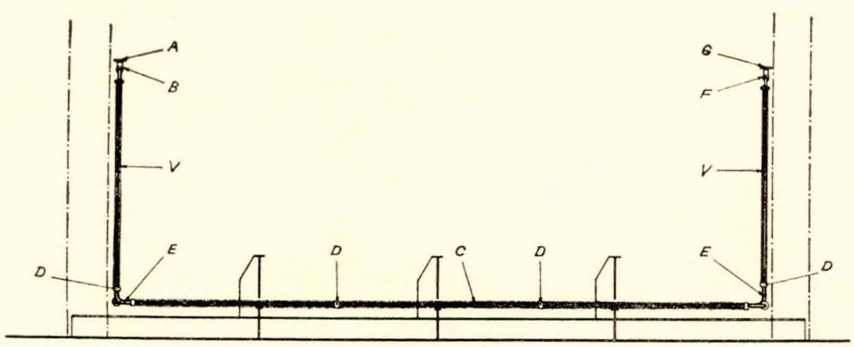
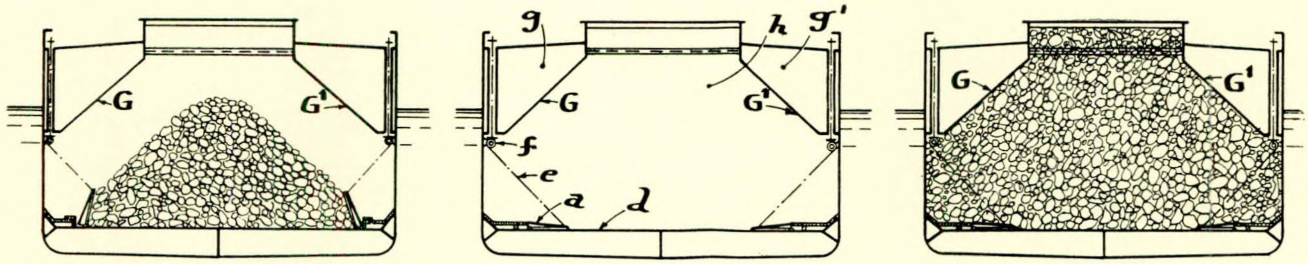


FIG. 2



FIGS. 2, 3 *and* 4

gears and shafts. For the purpose of making the vessel self-stowing the arrangement of stowage devices also provides for the provision, along the two sides of the hold (*h*) and under the deck, of two longitudinal walls (*G, G'*). These walls (*G, G'*) are located in an inclined position as shown in Figs. 2, 3 and 4 according to the angle of rest generally assumed by the cargo, which whilst allowing a complete filling of the hold (*h*) prevent any displacement of the cargo where the latter is grain or other material in bulk, without recourse to levelling being necessary.—*British Patent No. 743,963, issued to G. B. Bibolini. Application made in Italy on 24th July 1953. Complete specification published 25th January 1956.*

Improvements in Steam Boilers

The invention consists in a method of extracting heat from boiler flue gases according to which the extracted heat is passed by means of a primary heat exchanger in the flue to a coupling liquid caused to traverse a heat exchanger for heating the boiler feed water, a further heat exchanger for heating the combustion air and one or more further heat exchangers for effecting steam reheating. In Fig. 1 the flue (*a*) of the boiler (*h*) contains a primary heat exchanger (*b*), the liquid passage through which is connected by pipe (*c*) with a secondary heat exchanger (*d*) adjacent to feed water pipe (*e*) of the boiler. The secondary heat exchanger heats the feed water. A pipe (*f*) leads from the secondary heat exchanger (*d*) to circulating pump (*k*), which supplies water to tubes (*p*) in the boiler combustion space, from which the liquid at high temperature passes to the vicinity of a three cylinder steam turbine (*j, m, n*) provided with two stages of reheat. The coupling liquid divides to flow through parallel pipes (*o*) through the two reheating heat exchangers (*q, r*). Leaving the reheaters, the two flows unite, and the liquid, still at appreciable temperature, passes through a further heat exchanger (*g*) in which it is further cooled by transferring heat to the boiler combustion air supply entering at (*i*). From

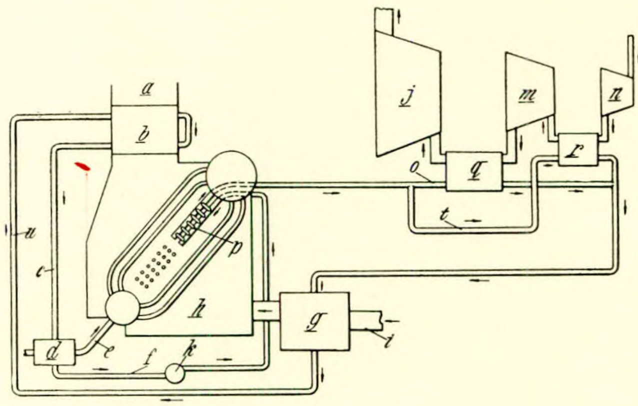


FIG. 1

the latter heat exchanger the liquid completes the circuit through pipe (*u*) by returning to the primary heat exchanger (*b*). This system lends itself to a particularly neat and simple boiler and steam turbine arrangement, while permitting maximum benefit to be obtained from reheating and air and water preheating.—*British Patent No. 743,869, issued to the Parsons and Marine Engineering Turbine Research and Development Association. Complete specification published 25th January 1956.*

Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 5, May 1956

Modified Residual Fuel for Gas Turbines

Sodium in gas turbine fuel causes rapid deposit formation as well as corrosion. Besides naturally contained sodium, sea water contamination during transportation introduces additional amounts. In order to obtain the benefits of a low sodium fuel, 90 per cent or more of the sodium is washed out of the fuel by a scheme described. The results of the desalting show that calcium also can be reduced substantially. Turbine tests of 50 to 1,500 hours' duration using these desalted fuels show that deposit can be almost eliminated by keeping both the sodium and the calcium below 10 parts per million. The steady stage decrease in turbine efficiency resulting from burning these low sodium low calcium fuels is shown to be about 2 per cent and the reduction in regenerator effectiveness about 5 points. A specification is proposed, defining a fuel which can be obtained at the point of use by means of the desalting method described and by adding a water solution of magnesium sulphate to the fuel just before it is burned. Treating vanadium containing fuels with calcium or magnesium shows that, below 1,650 deg. F., magnesium is a better inhibitor than calcium and, since magnesium does not cause deposit, it is used. Lead in the fuel in sufficient quantities is shown to spoil, somewhat, the inhibition of vanadium by means of magnesium. There now appear to be at least two methods available for modifying residual fuel to make it suitable for long life gas turbines, one of which is described.—*B. O. Buckland and D. G. Sanders, Transactions A.S.M.E., November 1955; Vol. 77, pp. 1,199-1,209.*

Optimum Diameter of Marine Propeller

In the first place, the author discusses the problem of the optimum diameter of marine propellers working in a uniform stream and finds that the results deduced by theory are in good agreement with those indicated by standard series data. The optimum diameter and optimum pitch distribution for propellers working in a single-screw variable wake stream are then examined and it is found that, when account is taken of the difference in wake velocities associated with smaller diameters, which cut off only a portion of the basic pattern, there is advantage in reducing the diameter materially as compared with the open water optimum condition. This is a most important conclusion in view of the recent increase in propeller diameters for large tankers and other high-powered single-screw vessels, in that it indicates a means whereby the weight and moment of inertia of such propellers may be reduced without sacrifice (and possibly with a gain) in propulsive efficiency. Finally, a design procedure is established which will allow the optimum diameter for given conditions to be determined by calculation without reference to standard series data, and useful diagrams are provided which will enable such investigations to be pursued as a part of normal drawing office procedure without having recourse to long and elaborate calculations.—*Paper by Professor L. C. Burrill, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 11th November 1955.*

Diesel Engine Crankcase Explosions

Injuries can be minimized and often eliminated completely in Diesel engine crankcase explosions if a safe procedure is followed. A recent report related an incident where engine room personnel received severe burns whan a crankcase cover was removed from a Diesel engine following an explosion. After an explosion or fire in an engine crankcase, the concentration of oxygen in the air in the crankcase is too low to support combustion, but the source of heat which caused the explosion may continue to exist for some time. If a crankcase cover or inspection plate is removed while the source of heat still exists, the inrush of fresh air can provide sufficient oxygen to support a second explosion which could result in serious injury or death to engine room personnel. The engine crankcase should not be opened up immediately after an engine casualty in which it is known or suspected that there has been fire or an overheated part in the crankcase. After the engine is shut down at least fifteen minutes must be allowed before the cover is removed. This practice will make sure that no spot inside the crankcase is hot enough to ignite the oil vapour when fresh air is allowed to enter the engine.—*Bureau of Ships Journal, December 1955; Vol. 4, p. 23.*

Distilling Plant for Turbine Ships

The increasing application of turbine propulsion, particularly for tankers, has raised the question in Germany and European countries of providing high-quality distillate so essential for high pressure boilers. Hitherto, successful plants built in Germany were characterized by their inordinate size, which consequently led to the individual sets being placed in unfavourable positions in the ship, leading to inefficient operation. The high distillation temperatures used produced severe scaling of the heating surfaces, and in addition were uneconomical because of the consumption of relatively high pressure steam, which could be better used for other purposes. Some years ago, C. Aug. Schmidt Söhne, demonstrated a new self-contained Monobloc sea water distilling unit. In the meantime this has been fitted to numerous turbine vessels with excellent results. The plant operates under vacuum, normally using heating steam at 9 to 11lb. per sq. in. absolute, the shell conditions being 26 to 27in. Hg. vacuum. The set is rated to produce 8,000 to 12,000 gallons of distillate per twenty-four hours at a guaranteed maximum salinity of 0·25 grains per gallon. In practice, the salinity is far lower than the guaranteed value, being normally around 0·05 grains per gallon or less, under severe seagoing conditions with fully-automatic operation. The entire plant, including evaporator, condenser, distillate cooler, pumps, salinity indicating system, instruments and interconnecting pipe lines, is shop assembled and shipped ready to be placed into the ship. It can be installed on board, coupled up and put into service without further erection work. In view of the importance of distilled water production, turbine ships are, as a rule, equipped with two such plants. An important advantage is the elimination of scale on the heating surfaces due to the low temperatures applied. Removal of the coils at short intervals and their manual cleaning are no longer necessary.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1955; Vol. 78, p. 506.*

Sulphur Dew-point Corrosion in Exhaust Gases

In many cases gas turbine power plant designers must cope with the same type of low temperature corrosion that has plagued steam plant operators for many years. In the gas turbine field low temperature corrosion problems occur at any point where the exhaust gases contact cool surfaces as, for example, in the semi-closed cycle where it is necessary to cool the products of combustion through the dew point, extract the condensed water which was formed during combustion, and then return the gases to the low pressure compressor. A typical semi-closed cycle is shown in Fig. 1. Another application in which dew-point corrosion is likely to occur is in waste heat recovery devices for gas turbines. Gas turbine exhaust gases contain large amounts of energy at an initial temperature level of 700 to 800 deg. F. These exhaust gases can be utilized to heat feed water, to heat sea water for use in a flash evaporator which converts sea water into potable water, or to provide preheated air for a conventional steam boiler. In each of these applications the exhaust gases contact cool surfaces and the danger of dew-point corrosion exists. Static exposure tests indicated that while 25 per cent chromium-20 per cent nickel, and 19 per cent chromium-10 per cent nickel stainless steels were satisfactory for use in sulphuric acid concentrations of less than 0·8 per cent, they suffered rapid attack when exposed to a 50 per cent solution of H_2SO_4. In these static tests, Hastelloy C appeared to be the most resistant of the alloys tested. A phenolic resin used in industry to coat acid containers appeared to be the most suitable coating to protect copper from acid attack. However, this coating was badly attacked in the semi-closed cycle test heat exchanger when 1 per cent sulphur fuel was used. Thus it is indicated that no suitable coating is at present available to protect heat exchanger surface materials from corrosion when high sulphur fuels are used. Tests with very low sulphur fuel (0·005 per cent S) showed a marked reduction in corrosion attack. In a series of rotating tests simulating compressor inlet conditions, it was found that Type 316 stainless steel, Inconel, Carpenter No. 20 and Discaloy had high corrosion resistance while 12 per cent chrome, Corten, Mayari-R, aluminium bronze and aluminium-nickel-bronze showed high rates of corrosion. In low temperature, moderate gas velocity regions such as are found in precoolers, intercoolers, and waste heat recovery units, Type 316 stainless steel and Hastelloy C appeared to have good acid resistance. A promising scheme for minimizing low temperature corrosion in semi-closed cycles for gas turbines is to use direct-contact coolers (spray cooling) to replace surface types of precoolers and intercoolers.—*R. L. Coit, Trans.A.S.M.E., January 1956; Vol. 78, pp. 89-94.*

American Turbocharged Two-stroke Cycle Diesel

The Kahlenberg turbocharged two-stroke cycle Diesel is reported to be the first Diesel of its kind to be developed and offered commercially in the United States. The 6-cylinder model, which has a bore of 10½ inches and a 16-inch stroke, is

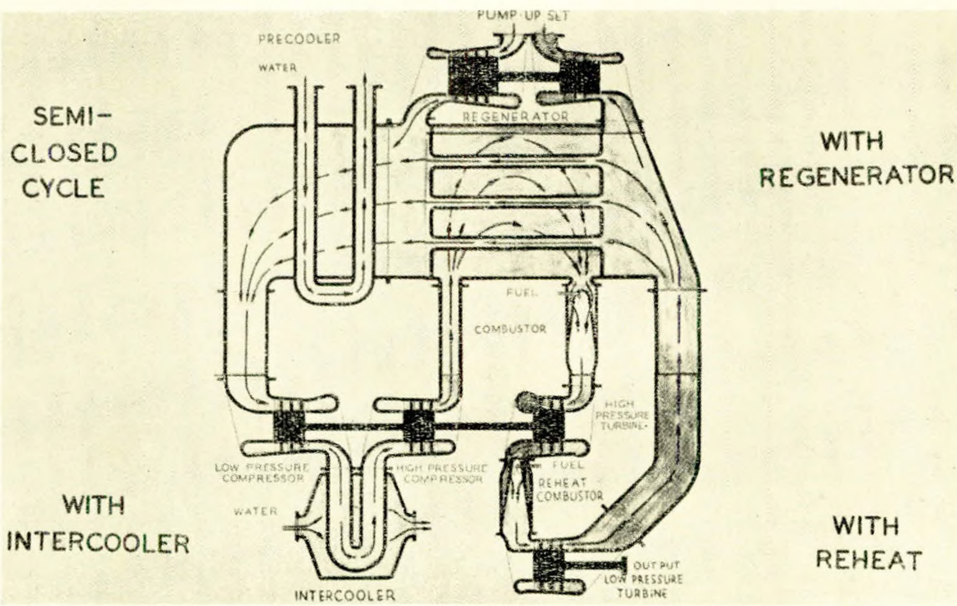


FIG. 1—*Typical semi-closed gas-turbine cycle*

about 12 feet long from the front of the engine to the flange, and stands about 6½ feet above the crankshaft centreline. Output of the new engines ranges up to 1,064 b.h.p. (for the 8-cylinder unit) at 300 to 400 r.p.m. This is a vertical, heavy-duty, direct injection engine which employs uniflow scavenging and pulse-system exhaust turbocharging. No scavenge pump, blower, auxiliary drive or other device is needed to help out the turbocharger. The Model E idles smoothly at speeds as low as 100 r.p.m. Designed for smooth and rapid reversing in accordance with positioning of the single control handle, the new engine can be used for direct drive, and for very low propeller r.p.m., reduction gears may be adapted. It is also adaptable to multi-engine geared drives. Average specific fuel consumption of 0·380lb. per b.h.p. per hr. is obtained while driving all auxiliaries, including both sea and jacket water pumps. Piston speed is low—1,066ft. per min. at 400 r.p.m. A standard Napier turbocharger was carefully matched to the engine. Sectionalized, dry-type manifolds, each streamlined and volume controlled to give utmost pulse energy at turbine nozzles, lead the exhaust gases to the two-entry turbocharger. Manifolds are lagged to retain the exhaust's heat energy and the arrangement permits the manifolds to be removed without disturbing the lagging. Scavenging air cleans out residual gases and cools engine parts. Exhaust valves are timed to permit blow-through of the air between exhaust manifold pressure peaks when the pressure is lower than that of the inlet manifold. Air from the compressor, meanwhile, goes through a large area intercooler prior to entering the air box, thus reducing charge temperature, lowering thermal loading in the cylinder, and increasing charge density to allow more fuel to be burned for higher output. Each cylinder head has two exhaust valves in water cooled cages, a fuel injection nozzle and a poppet-type air starting valve. Separate rocker arms, special valve shields and pressure lubricated valve gears are also included.—*Motorship (New York), December 1955; Vol. 40, pp. 28-29.*

Layout of Steam Propulsion Plants

Four of the main factors to be considered when selecting a marine propulsion plant are reliability, low maintenance and repair costs, low weight, and small bulk; the steam turbine shows to advantage in all of these. Fuel costs amount to only some 15 per cent of the total running costs, and capital charges account for a further 13-14 per cent. A general review is given of such devices for improving overall efficiency as bled steam feedwater heating, multi-stage superheat, inter-stage reheat, and air preheating. The various possibilities of utilizing back-pressure operation, exhaust steam, and condensate are considered; these are particularly interesting in tankers with their high steam requirements for cargo pump operation and tank cleaning, or in any ship with a heavy auxiliary steam consumption. Back-pressure turbines are already being used as auxiliaries in some large Swedish tankers. It is suggested that the exhaust steam from the auxiliary machinery can be fed into the low pressure stages of the main turbines, and that a low temperature preheat can be used. To make the best use of these possibilities it is advisable to concentrate the auxiliary load in a centralized turbogenerator. These refinements prove of the greatest advantage when the power exceeds 8,000 s.h.p. and on long voyages; at lower powers their value in terms of financial saving is doubtful, and conventional present-day practice will probably prove the best.—*E. Olderin, Teknisk Tidskrift, 15th November 1955; Vol. 85, p. 941. Journal, The British Shipbuilding Research Association, January 1956; Vol. 11, Abstract No. 11,183.*

End Launching

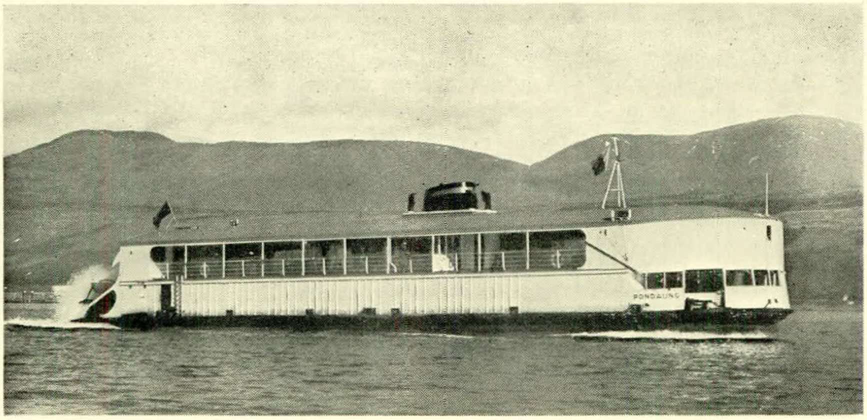
The chief dangers in end launching are excessive pressures between the bottom of the ship and the lower parts of the standing ways during the period of tipping risk and high fore poppet loads at pivoting. When launching ships into restricted waters it is necessary to control the motions of the ship. In the present work, which covers the launching up to the pivoting point, the influence of the hull weight, longitudinal position of the centre of gravity of the hull, the hull form, especially the block coefficient, the declivity and radius of curvature of the standing ways and declivity of the keel on the position of the pivoting point, the maximum fore poppet load, the required under water way length for avoiding tipping and excessive pressure conditions and the speed of the hull during launching are investigated theoretically. The results are presented non-dimensionally and are applicable for normal merchant ships of medium size. They can be used in the design of new building berths and launching equipment, determination of characteristics of ships to be built on existing berths and for controlling the motions of the ship when waterborne. The calculations were carried through for three hulls of the Series 60, which is believed to be the best systematically varied single-screw merchant ship form series available at the time of writing. The results indicate that a heavy hull causes later pivoting and demands long under water ways for avoiding tipping and unfavourable pressure conditions. Increased declivity and curvature of ways means earlier pivoting, higher P_0/W and permits shorter under water ways. Moderate declivity and strong curvature are in general recommended. Formulations for the coefficients of friction of the lubricant and the coefficient of water resistance were established. A large declivity of ways, heavy hull and high starting position cause high launching speed. Combinations of frictional and hydrodynamical drags are suggested for consideration.—*J. E. Jansson, Svenska Tekniska Vetenskapsakademien I Finland, Acta, 1955; Vol. 17.*

Reduction of Interior Bead in Tube Welding

It is well known that the manufacturers of pipes and tubes have always had trouble with the weld bead on the inside diameter of welded tubing. By means of a fairly simple change in the welding process it has now been found possible to reduce the inside bead considerably and in some cases to eliminate it entirely. It is claimed that without an interior bead the tubing has better physical properties, improved corrosion resistance, and greater formability. The solution to the interior-bead problem reverses a basic practice in roll-formed tube weld practice, in that the tube is formed so that the seam is on the underside of the pipe as it leaves the rolls, and the weld is accomplished with the electrode positioned underneath the weld. The seam is joined by a standard butt weld, using the inert-gas-shielded tungsten-arc process. Because the weld is performed upside down, the metal does not flow into an interior bead. It is stated that the new welding system, in addition to controlling the interior bead, results in many improvements in tubing and pipe from both metallurgical and mechanical aspects. There is said to be a notable absence of grooves, valleys, or undercuts in the weld area after cold working or drawing. The outside diameter weld bead can be held uniform and smooth, so that it is possible to reduce it by swaging and to improve its mechanical properties without undesirable side effects. Heavy-wall tubing and pipe will meet all mechanical tests such as flare, transverse, tensile, and reverse bend tests. The tubing and pipe are said to have better fabrication properties in the production of tube assemblies, heat exchangers, condensers and boilers. Furthermore, because of the smooth inside surface, many of the high alloys or super alloys which previously required welding can now be rolled into tube sheets.—*The Engineers' Digest, January 1956; Vol. 17, p. 4.*

Motor Vessel *Pondaung*

The first of a group of five quarter-wheel river vessels under construction at the Glasgow shipyard of Yarrow and Co., Ltd., has recently completed trials. This vessel, the *Pondaung,* has been built to the order of the Inland Water Transport Board, Burma, for passenger and cargo traffic on inland Burmese waters. The *Pondaung,* which has been specially designed by the builders, is propelled by stern paddle wheels fitted on each quarter and driven through reduction gearing by a Diesel engine. This vessel, and her four sister vessels, the



m.v. Pondaung

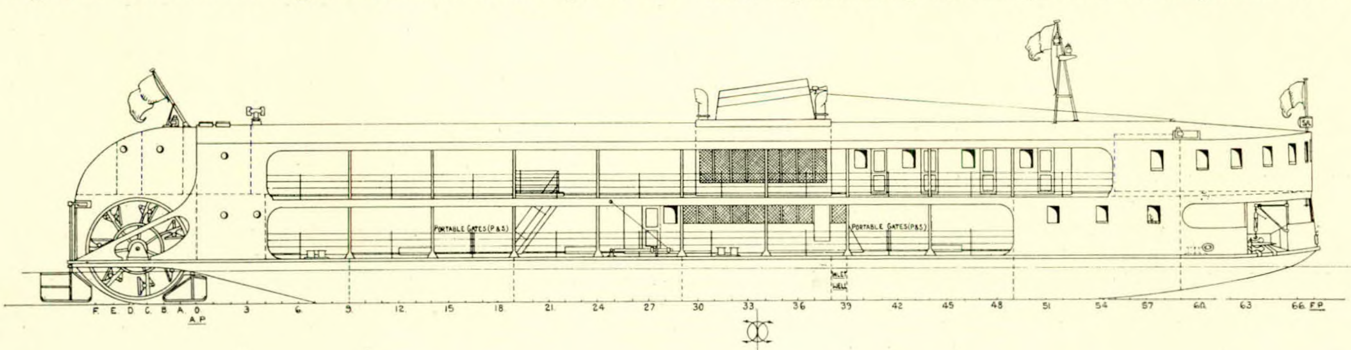
Ponnya, Padashin, Padamya and the *Padapyan,* are being towed out to Burma, the necessary stiffening and boarding-up of the hull having been carried out by the builders to Ministry of Transport requirements. The principal particulars of the *Pondaung* are as follows:—

Length, o.a.	148ft. 6in.
Length, hull ex tongue	134ft. 0in.
Length, waterline	130ft. 0in.
Breadth, moulded	34ft. 0in.
Depth, moulded	5ft. 6in.
Draught, load	4ft. 0in.
Passengers	310
Speed on trial	11 m.p.h.
Horsepower, b.h.p.	390
Deadweight, tons	170

Passenger accommodation is provided on the upper deck, which is roofed all fore and aft, the fore end being enclosed and fitted with large closely-spaced windows of opening type. Cabin passenger accommodation, arranged forward, comprises four double-berth and two single-berth cabins, together with a saloon furnished with table, armchairs and settees. Also arranged on this deck are the ship's store together with a food shop, ladies' rest room, toilets, etc., for the use of day passengers, special care having been taken in the layout of ship fittings throughout the vessel to avoid unnecessary obstruction of deck space allotted to these passengers, of whom a total of about three hundred will be carried. The *Pondaung* will carry a total complement of nineteen, who will have roomy quarters on the main deck, including three single berth cabins, appropriately furnished for leading personnel and crew respectively. Also sited on the main deck are the ticket office, galley, crew's washplaces, etc. To ensure good manœuvrability in restricted waterways, four suitably balanced steel rudders are fitted, for operation from the steering station forward by hand power steering gear. Deck machinery includes a hand anchor windlass which has a warping drum each side and is geared to ensure rates of power and speed suited to the service. Special consideration has been given to service amenities, including adequate mosquito protection and the provision of large hinged jalousies and also shutters of venetian type, fitted in conjunction with suitable fans in the accommodation spaces. Refrigerating plant is of Freon type with a motor-driven compressor. The propelling machinery consists of an eight-cylinder National R4AM8 vertical-type, four-stroke, single-acting, marine Diesel engine, working through a Vulcan-Sinclair fluid coupling, and oil operated reverse reduction gear by Modern Wheel Drive, Ltd., and a David Brown worm reduction gear, all driving the paddle wheels to give a ship speed of 11 miles per hour. The main engine is arranged with a heat exchanger for fresh water cooling and has engine driven fresh water, river water, fuel oil, lubricating oil and bilge pumps. The stern paddles are built as two separate wheels, each supported in two bearings and fitted with feathering gear operated by an eccentric carried on brackets attached to the hull structure. Two Diesel engine driven combined auxiliary sets are fitted in the engine room, each set comprising air compressor, general service pump and 5 kW generator. The general service pump is of self-priming design for bilge pumping and arranged for wash deck, sanitary and fire services. Also fitted in the engine room are an electrically driven float switch controlled sanitary pump and three hand operated pumps, two of the latter being used for filling the Diesel fuel tank and one for pumping lubricating oil from the storage tank. In order to reduce top weight, aluminium alloy has been used for the funnel structure.—*The Shipping World, 14th March 1956; Vol. 134, p. 237.*

Vibration Generator Tests

A vibration generator test was conducted on the starboard outboard and starboard inboard main thrust bearings and their foundations aboard the U.S.S. *Forrestal,* while the shafting was disconnected on both sides of the thrust bearings, to determine experimentally the lowest resonance frequencies of these



Profile drawing of the motor vessel Pondaung systems with the aim of estimating the longitudinal spring constants of the foundations. The lowest resonance frequencies were 2,230 c.p.m. on the starboard inboard system and 2,320 c.p.m. on the starboard outboard one. From these frequencies, the longitudinal stiffnesses or spring constants were calculated to be $8{\cdot}2 \times 10^6$lb. per in. for the starboard inboard system and $8{\cdot}9 \times 10^6$lb. per in. for the starboard outboard one. Additional frequency and amplitude data were obtained for use in a general study of foundations. A Lazan vibration generator was used. It is a mechanical device having two geared counter rotating shafts with adjustable eccentrics producing a sinusoidally varying unidirectional force. Its speed is continuously variable from zero to 3,600 r.p.m., and the maximum force output is 1,600lb. single amplitude. Identical test procedures were followed on both the starboard outboard and inboard systems. The vibration generator was mounted on top of the main thrust bearing housing to provide fore-and-aft excitation. A pick-up was mounted and orientated in the fore-and-aft direction at the top of the thrust bearing housing. A resonance frequency search was conducted while the system was excited with the vibration generator. During the search the eccentricity of the vibration generator was adjusted so that its maximum force rating of 1,600lb. single amplitude would not be exceeded.—*C. H. Kinsey, David W. Taylor Model Basin, Report 954 (1955).*

Temperature-induced Stresses in Ships

It is a well-known fact that changes in the temperature distribution within a structure, such as a ship, may induce stresses even in the absence of external loads or restraints on the structure. Very few quantitative data are available which would indicate the actual stress and temperature variations that might be expected throughout a ship in service. Ships have broken in half while moored in still water. Examples are the fractures of the *Schenectady, Belle Isle* and *Ponaganset,* all of which were afloat in still water at the time of failure. Most, possibly all, major hull fractures in still water took place while the temperature was changing. This, in itself, is a significant observation. Its significance is accentuated by hull girder strains measured over a nineteen-month period on the T-2 tanker *Esso Asheville.* These tests, which were sponsored by the Society of Naval Architects and Marine Engineers, indicated the presence of a slow stress variation with a period of about a day which may be ascribed to the change in temperature distribution that occurs daily. These temperature induced stress variations reached the same order of magnitude as the stresses due to the cargo loading of the ship. There is sufficient evidence to indicate that an estimate of the temperature induced hull girder stresses is warranted. It would therefore be advantageous to have a reasonably simple method which could be used by the designer to estimate the magnitude and distribution of possible temperature induced stress variations. A theoretical method is given for computing temperature induced stresses in a non-homogeneous or homogeneous beam or girder of uniform cross-section for any temperature distribution over the cross-section. It is assumed that all cross-sections have the same temperature distribution. The method is illustrated by application to a simplified model of a ship constructed of steel and aluminium and to a T-2 tanker design.—*N. H. Jasper, David W. Taylor Model Basin, Report 937 (1955).*

British-built Ore Carrier for North American Service

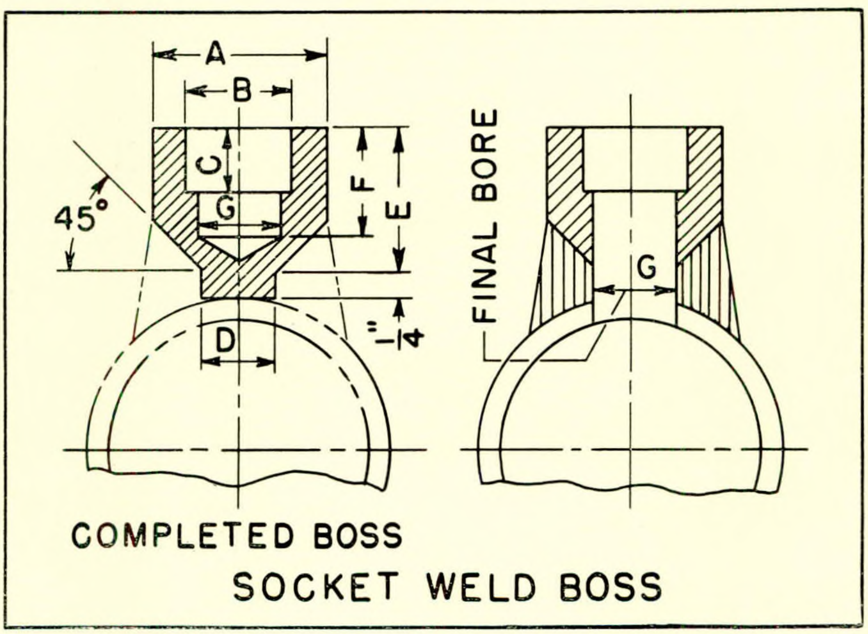
The largest ore carrier so far completed in Great Britain has now been delivered to her owners from the Tees shipyard of the Furness Shipbuilding Co., Ltd. This vessel, the *Sept Iles,* 31,000 tons deadweight, has been built for the Iron Ore Transport Co., Ltd., Canada, and will be managed by the M.A. Hanna Company, Cleveland, Ohio. The *Sept Iles* is the first of the Hanna type ore and oil carriers mentioned by W. A. Stewart in his paper on the development of ore carriers read before the North-East Coast Institution of Engineers and Shipbuilders in April 1954. The vessel compares favourably with the size of tankers that are being built today, and has been designed to load about 30,000 tons of ore in five hours and unload in twelve hours. The *Sept Iles* has now been surpassed in size by the 33,000 tons bauxite carrier *Leader,* which is now nearing completion by Cammell Laird and Co., Ltd., at Birkenhead. A sister ship to the *Sept Iles,* the *Ruth Lake,* was launched from the Wallsend yard of Swan, Hunter and Wigham Richardson, Ltd., on 15th December 1955. The *Sept Iles* is a single-screw steam turbine driven vessel designed for the carriage of iron ore from the loading terminal at Sept Iles, P.Q., principally to Philadelphia, but also to other Atlantic ports in the U.S.A. The vessel is of the single deck, poop, bridge and forecastle type with machinery fitted aft. She has a clipper type plate stem and cruiser stern, and is constructed under special survey to the highest class of Lloyd's Register of Shipping and American Bureau of Shipping for the carriage of iron ore, the scantlings and arrangements being suitable for the vessel to be assigned a tanker freeboard. The principal particulars of the *Sept Iles* are as follows:—

Length, o.a.	661ft. 7in.
Length, b.p.	630ft. 0in.
Breadth, moulded...	87ft. 0in.
Depth, moulded	46ft. 6in.
Draught, with summer freeboard	34ft. 0in.
Deadweight, tons...	31,100
Designed speed, knots	15½

The vessel is built on the longitudinal system of framing. Electric welding has been used extensively, the shell and decks being almost completely welded and the longitudinal and transverse bulkheads being all-welded. Three large holds are arranged in the centre, each about 120ft. long, having a total capacity of 588,600 cu. ft., or 35,450 tons at 16·6 cu. ft. per ton and the holds are served by nine 30ft. long by 40ft. wide hatchways fitted with side rolling MacGregor watertight steel covers. The space at the sides and below the ore holds is arranged to carry water ballast, being subdivided into ten wing tanks each side and six double bottom tanks below. A centre deep tank, also for the carriage of water ballast, is arranged between Nos. 1 and 2 holds and the capacity of this tank, along with the capacity of wing and bottom tanks, gives a total water ballast capacity in way of ore holds of 943,350 cu. ft. or 26,950 tons at 35 cu. ft. per ton. Oil fuel is carried in deep tanks forward of ore holds and wing tanks and large settling tanks at fore end of machinery space, having a total capacity of 111,850 cu. ft. or 3,007 tons at 37·2 cu. ft. per ton. The propelling machinery consists of a single set of Richardsons, Westgarth-Brown Boveri double reduction geared turbines designed to develop 12,500 s.h.p. at 105 r.p.m. in normal service and a maximum continuous output of 13,750 s.h.p. The h.p. ahead turbine is of impulse reaction design and the l.p. turbine is of all-reaction design. The h.p. turbine casings are of cast steel and the l.p. turbine cylinder is of fabricated construction with cast steel shells built into a mild steel fabricated casing. At normal power the h.p. turbine runs at 4,350 r.p.m. and the l.p. turbine at 3,000 r.p.m. The astern turbines, comprising an h.p. turbine of impulse design and an l.p. reaction element, are incorporated in the h.p. and l.p. casings respectively and are capable of developing 65 per cent of the normal ahead power. Suitable bled steam tappings are provided for feed heating and air preheating purposes. Double reduction articulated-type gearing is installed. The gearcase is of fabricated steel construction. Each turbine is connected to its primary pinion by a flexible claw-type coupling, the secondary pinions being driven through quill-drive shafts and flexible couplings from the primary gearwheels. The main gearwheel and the primary gearwheels have cast iron centres with pinned and shrunk forged steel rims. A separate main thrust block of Michell single-collar type is fitted immediately aft of the gearcase and the shaft is carried in Michell self-lubricating water cooled bearings. The propeller is of Heliston design cast in Novoston alloy. Two Richardsons, Westgarth-Foster Wheeler D-type boilers are carried on a flat aft of the gearing and above the thrust block. Each boiler has a total generating surface of 15,065 sq. ft., a superheater surface of 1,680 sq. ft. and a maximum evaporation of 80,000lb. of steam per hour at stop valve conditions of 600lb. per sq. in. and 850 deg. F. The steam and water drums are fusion welded and the convection type superheaters consist of U-type elements expanded into mild steel headers, the outlet header being of alloy steel. A Green's economizer of all-welded construction and consisting of solid drawn 2-in. outside diameter steel tubes with shrunk-on cast iron gilled rings is supplied for each boiler. A closed feed system is employed which includes two Weir motor driven extraction pumps, one two-stage Weir air ejector, a gland steam condenser and a combined l.p. feed heater and drain cooler, both of Richardsons, Westgarth manufacture. The deaerator with storage tank is also by G. and J. Weir, Ltd. The heating steam is obtained from the turbofeed pump exhaust, and the feed water is raised to a temperature of 240 deg. F. before passing to the feed pumps and thence the boilers. The three main feed pumps are of Weir three-stage pattern, each with a duty of up to 182,000lb. of water per hour. Two Weir distilling plants are carried on the same flat as the l.p. steam generator. Each is of horizontal, single effect, submerged tube-type having an internal vapour purifier, a two-stage air ejector and a combined distiller condenser and feed preheater. These sets, which are complete with observation and test tanks, brine and extraction pumps, are capable of providing 47 tons of made water per day when supplied with saturated steam at 5lb. per sq. in. In normal service the evaporators will be supplied with steam bled from the turbines at a pressure of 7½lb. per sq. in. absolute.—*The Shipping World, 11th January 1956; Vol. 134, pp. 70-72.*

Method of Installing High-pressure Bosses

A new method of installing high-pressure bosses for piping systems has been suggested. The shank on the end of the fitting is held to ¼-inch from the bottom to the beginning of the taper. The fitting is tacked in place and welded to the pipe. Then the final boring is done through the shank and pipe wall. When the drill penetrates the inner wall, all chips are removed, and boring is completed with a magnetic drill. Formerly, the pipe was drilled first, a procedure that allowed hot slug to drip in. The suggested method eliminates the danger of slug falling into the pipe.—*Bureau of Ships Journal, February 1956; Vol. 4, p. 41.*



Socket weld boss showing final bore made through shank and pipe wall

German Fruit Ship with Clear Water Stern

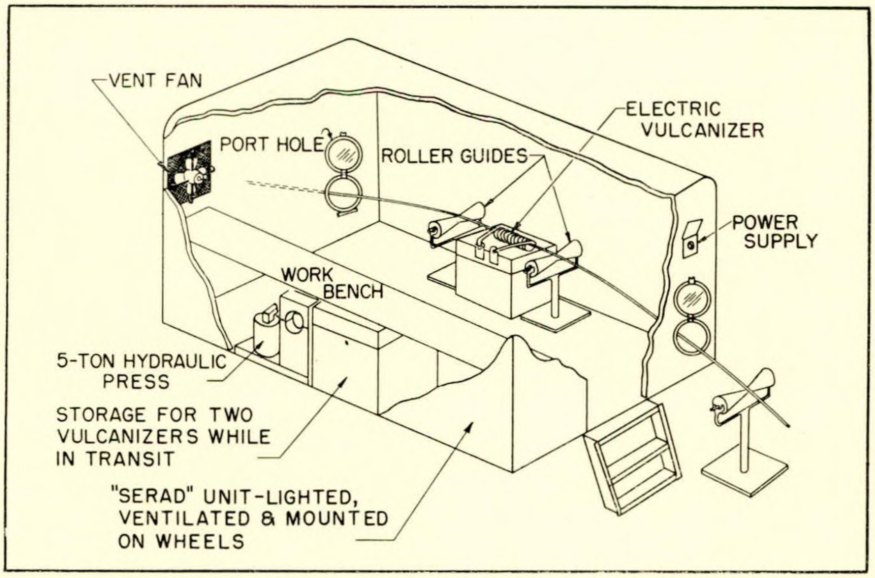
The 17½-knot motorship *Brunshousen,* recently completed by the Kieler Howaldtswerke for Willy Bruns G.m.b.H. of Hamburg, has most remarkable stern lines. The design is by Dipl.Ing. van Dieren of Rotterdam, consulting naval architect for the ship. The bossing protrudes some 9ft. 9in. from the stern frame and the propeller is thus well away from the hull. The design is intended to improve propulsive efficiency of the screw and reduce the vibration transmitted from the screw to the hull. An improved efficiency was in fact established in the towing tests and trial runs. Moreover, the ship runs exceptionally quietly. The stern is a fabricated structure using flat bent plates and has a distinct chine and the suspended spade rudder is carried from a yoke on the main deck. An A.E.G.-Atlas-Werke quadrant steering gear for a shaft moment of 10 metre-tons is provided.—*The Marine Engineer and Naval Architect, January 1956; Vol. 79, p. 28.*

Purifying Sea Water by "Zone Refining"

An investigation is now in progress to study the possibility of purifying sea water by "zone refining", a term which has been borrowed from metallurgical practice, where it denotes utilization of the fact that metal impurities have different solubilities in solid and molten metal. This difference in solubility is used to remove impurities by moving a molten zone along a metal bar, sweeping, as it were, many impurities to the ends of the bar, and leaving the major portion of the bar purer than it was at the beginning of the process. It is believed that zone refining may be applicable to sea water purification. In this case, a frozen, instead of a molten, zone would be used to sweep the natural salts through a column of sea water. Water reformed from ice after freezing would be pure enough for drinking and irrigation purposes if this method proves successful. From the scientific point of view, the method would have at least two advantages:—firstly, it takes less energy to convert water into ice than it does to convert it into the steam needed in distillation processes, and secondly, since most natural sources of water are nearer to its freezing point than to its boiling point, less energy would be needed to move water through the shorter temperature range to its freezing point. It will be interesting, however, to see whether these advantages will outweigh the considerable mechanical energy requirements of the refrigeration cycle which will have to form part of the system.—*The Engineers' Digest, January 1956; Vol. 17, p. 2.*

Mobile Hut for Cable Vulcanizing

A metal hut is in service at the Charleston Naval Ship-



Vulcanizing hut has portholes and reels for passing cable through it as well as work space and storage facilities for material and equipment

yard for manufacturing, repairing, and vulcanizing electric cable, material handling slings, and deckhouse expansion joint parts. It has proved a valuable addition to the electric shop. The hut is a miniature mobile repair shop which can be used in any location. Work can be continued inside regardless of bad weather. Materials and equipment for vulcanizing are stored inside to be readily available when needed. Also, vulcanizing heat can be maintained without using extra materials to cover the work. The hut is 5 feet wide by 6 feet long by 7 feet 1 inch high. It is mounted on a trailer truck for easy transportation from job to job. Scuttles and cable reels are installed in each end so that cable passes through the hut as work on each section is completed.—*Bureau of Ships Journal, Vol. 4, February 1956; p. 37.*

Slip Couplings for Diesel Engines

The action of the French D.E.M. friction coupling depends on the variation of the coefficient of friction between surfaces as the degree of lubrication of the surfaces varies. The driving element consists of a hub carrying a number of radial blocks of tapering cross-section, which can move radially outwards under the action of the centrifugal force. This force presses the blocks against corresponding conical surfaces formed on the inside of the outer driven part of the coupling. The coupling contains a certain amount of oil which is thrown on the conical surfaces when the hub starts rotating; the lubricating action of the oil prevents direct contact between the driving and driven surfaces, and permits a certain amount of sliding. As the speed increases, more oil is squeezed out from between the surfaces by the increasing pressure of the blocks, and by the centrifugal force acting on the oil itself. Thus progressively more friction is introduced, until the driven part rotates at engine speed. The oil drains into an annular space round the periphery of the coupling. If an overload is put on the Diesel engine, it will slow down and the blocks will start sliding again, and relieve the engine. A well designed coupling will be sensitive to quite small overloads (of the order of 10 per cent), which is a valuable property of the mechanism. A very small slip is present in the coupling even at normal speed, and this tends to damp out the torsional vibration of the shaft. The torque transmitted by the coupling is proportional to the square of the speed and, therefore, the coupling is particularly suitable for ventilators or propellers, the power absorbed by which also varies as the square of the speed. Powers of up to 1,200 h.p. have been transmitted by this type of coupling, and it is probable that it would be suitable for even higher outputs.—*Technique Moderne, 1955; Vol. 47, p. 393. Journal, The British Shipbuilding Research Association, December 1955, Vol. 10, Abstract No. 11,053.*

Measurement of Combustion Chamber Volume

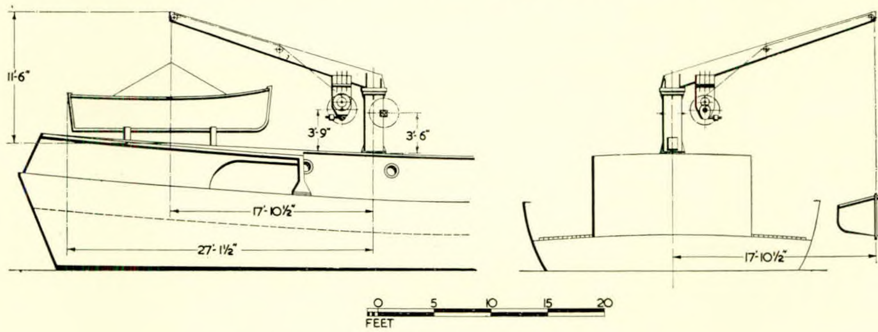
The volume of the combustion chamber of an internal combustion engine cylinder or of carbon deposits can be measured with a high degree of accuracy by using air as the measuring medium. The idea of using air instead of liquid as a measuring fluid is not in itself new. The most recent innovation in this technique is the development of instruments which can measure volume by sensing an air pressure which is periodically varied in the combustion chamber. The frequency of oscillations is then compared with that of a known reference volume, so that the chamber volume can be deduced. In this method a jet of air or an acoustic transducer in the sparking plug opening initiates air oscillation in the chamber. The sound is produced at 100 to 300 c.p.s., depending on the throat dimensions and the chamber size. This sound is picked up by a microphone and is filtered, amplified, and shaped into a series of square voltage pulses. An electric counter then determines the number of pulses occurring in a given interval of time, and the measured resonant frequency is compared with that of a reference volume. It is stated that this sonic comparison under ideal conditions can sense volume changes of $\pm$ 0·02 cm.^{3}. Attention must be paid to the fact that a temperature sensitivity resulting in an error in volume of approximately one per cent exists for every 5 deg. F. difference between the combustion chamber and the reference chamber. In spite of the great potential accuracy of this method, the frequency shift caused by cylinder leakage and carbon deposits makes it difficult to determine the volume with an accuracy higher than one per cent. When the precise amount and density of carbon deposit is to be determined, pneumatic or static volume measurement is required.—*The Engineers' Digest, January 1956; Vol. 17, p. 1.*

Contra-rotating Optimum Propellers

Known theories of a contra-rotating propeller are either restricted to uniform inflow or include arbitrary assumptions concerning both the applicability of the Goldstein function and the orientation of the resultant induced velocity relative to the free vortex sheets. These assumptions are avoided in the following considerations which make use of the so-called induction factors of vortex sheets. A criterion for optimum flow, expressed in terms of the direction of the free vortex sheets, is obtained from first order considerations. This criterion leads to a non-linear integral equation for the optimum circulation or, approximately, to a set of non-linear algebraic equations for the Fourier coefficients of the circulation. For uniform inflow, the free vortex sheets become of a true helical shape and the equations for the circulations reduce to a linear system. A design method, which follows from the considerations, is outlined taking approximately into account the effects arising from the difference of the wake at the propeller discs and from the contraction of the race between them. Finally, the optimum circulation obtained by Theodorsen for uniform inflow by means of an electrical analogy is compared with the result from the developed relations.—*H. W. Lerbs, David W. Taylor Model Basin, Report 941 (1955).*

Centre Line Davit for Trawlers

Trawlers and many other small vessels carry a single lifeboat stowed on the centre line aft, and in the case of trawlers it is usually suspended from the mizzen boom. Its launching involves some difficulties and with this in view, Schat Davits, Ltd., have introduced a new type of single arm centre line davit, in the design of which they have co-operated with trawler builders and owners. There is a pillar with an arm sufficiently long to bring the boat outboard either to port or starboard. A hand slewing gear is provided, also a winch with centrifugal and "dead man" brakes for lowering control. The boat is under single part wire falls and the winch provides means for recovery by hand. The weight of the davits is about 1 ton. About fifteen revolutions of the crank handle are sufficient to turn out the boat.—*The Motor Ship, February 1956; Vol. 35, p. 517.*



Prototype centre line Schat davit for trawlers

Structural Weight Similarity of Ships

The paper makes a plea for the more co-ordinated study of the ship structural weight problem. The more important earlier contributions to the subject are first reviewed and compared. This leads to the main thesis of the paper, the idea of ship structural weight similarity. As in the corresponding ship resistance problem an attempt is made to eliminate absolute size from the weight problem. This introduces the concept of the global mean thickness ratio as a means of interpreting weight similarity and facilitating what may be called the weight condensation problem. A new weight coefficient called the quadracubic number, a development of earlier cubic and quadratic numbers, is introduced and is used to generalize earlier data, to show the influence of ship proportions, fullness and type on relative weights, and to develop weight tabulations to assist the designer in the interpolation of his own data. The use of the 400-ft. structural geoism is also submitted. The development of the global mean thickness ratio or structural weight comparison concept to length materially greater than 400 feet is considered, and a somewhat more general approach is developed for the presentation and study of the influence of length-depth ratio on weight similarity. This influence is shown to be closely related to that of transverse- and longitudinal-bulkhead weights and is likely to be felt chiefly in tanker weight presentations. The effect on weight tabulations is discussed. Finally, a request is made for the publication of modern weight data to assist in the development of the subject.—*Paper by E. V. Telfer, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 9th December 1955.*

Bending and Impact Tests of Valve Bodies

Drop-weight impact tests at room temperatures and slow-bend tests at 900 deg. F. were conducted on standard 6-in. gate valve bodies made of ferritic nodular iron, of Class B cast iron and of cast steel in order to compare their performance. The last two materials were standard commercial products; the nodular iron was heat treated to ensure a ferritic matrix with less than 10 per cent pearlite, and silicon and phosphorus were held to the lowest limits consistent with commercial production, in order to minimize the embrittling effects previously reported for these elements. The tests showed that no brittle failure was obtained under impact at 40 deg. F. for the cast steel or nodular iron bodies, whereas the cast iron shattered in a brittle manner under relatively low impact. Under repeated drop-weight tests, the damage to the nodular iron valve body was less than to the cast steel body. The load carrying capacity of the nodular iron valve at 900 deg. F. exceeded that of the cast steel valve. In the former, a tear was initiated after considerable permanent deformation, but the fracture did not propagate. The cast steel valve body suffered so much plastic distortion that the test could not be carried to fracture. The cast iron valves failed catastrophically with no perceptible permanent deformation at significantly lower loads in this test. The water quenching of cast iron valves from 900 deg. F. under load did not induce failure from thermal stresses. It was therefore concluded that this treatment would not affect the other materials if the heating temperatures were below the critical. The physical properties of ferritized nodular iron of the composition used for these tests are not affected by drastic quenching until the temperature exceeds 1,400 deg. F. Although more exhaustive testing is obviously necessary, the performance of these nodular iron valve bodies under the severe conditions imposed indicates that ferritic nodular iron of the proper composition may be expected to perform as well as, or even better than, commercial cast steel.—*J. O. Jeffrey and R. H. Hanlon, A.S.M.E., Paper No. 55-A-10, 1955. Journal, The British Shipbuilding Research Association, January 1955; Vol. 11, Abstract No. 11,194.*

Inspection of Electrical Insulation

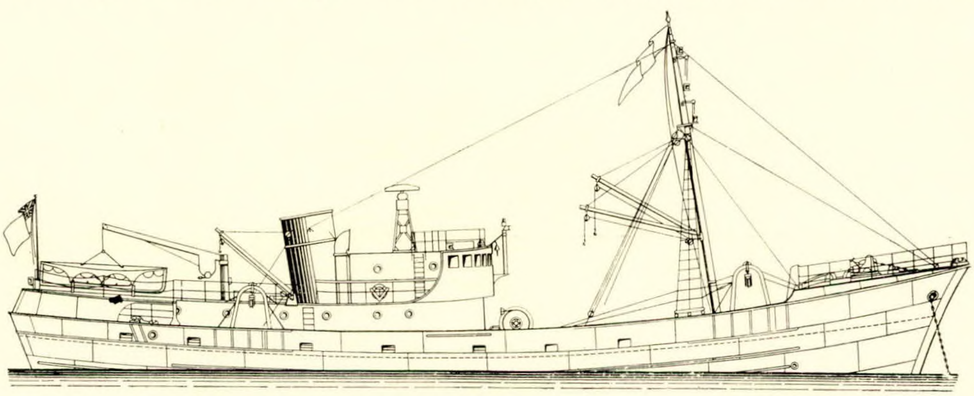
Various methods for checking the soundness of insulation between the live wires and a ship's hull are described. The methods covered are applicable to two-pole d.c. constant voltage systems; two-pole d.c. variable voltage systems (e.g. Ward-Leonard system, constant current system, etc.); and a.c. constant voltage systems. It is pointed out that no method of checking or supervision will guarantee that all leakage currents that may lead to the outbreak of fire will be detected. The argument that two-pole systems are safer than one-pole systems because leakage currents in the former can be detected is therefore unsound. Conditions favourable for checking leakage currents are present when metal-sheathed single conductor cables are used, the sheath being earthed (i.e. connected to the hull). This will eliminate to a great extent any leakage currents flowing between the live wires themselves, and leave only the leakage currents flowing between the conductor and the earth. Another way to make the checking of insulation easier is to divide the electric installation into separate circuits. But even with these measures, difficulties will be caused by the fact that the potential of the conductor with respect to the hull may undergo periodical fluctuations which are difficult to account for. On the whole, it is best to have one point in the network permanently earthed. This practice is usual in land installations, but in marine installations is followed only in the U.S.A. and Germany. German practice is to earth the negative pole in a d.c. installation (except in tankers, where earthing of the system is not allowed); and the star point in a.c. installations. In the American three conductor d.c. systems that were formerly used, the middle conductor was always earthed, while in a.c. systems the star point is earthed.—*W. Vogler, Schiff und Hafen, 1955; Vol. 7, p. 645. Journal, The British Shipbuilding Research Association, December 1955; Vol. 10, Abstract No. 11,107.*

Diesel-engined Trawler

A new Diesel-engined trawler, in which many innovations have been incorporated, has been built by Cochrane and Sons, Ltd., Selby. This vessel, the *Wyre Vanguard,* is the first of a new class of trawler being built for Wyre Trawlers, Ltd., Fleetwood, a company of the Associated Fisheries group. A sister ship, the *Wyre Defence,* was expected to be delivered early in January 1956. Both trawlers are powered by Mirrlees turbocharged Diesel engines, and the innovations include a flush deck, unusual in medium size trawlers, and a single arm lifeboat davit. The principal particulars of the *Wyre Vanguard* are as follows:—

Length, b.p.	127ft. 6in.
Breadth, moulded	27ft. 0in.
Depth, moulded	13ft. 6in.
Length, o.a.	143ft. 9in.
Registered length...	132·05ft.
Horsepower, r.p.m.	736

The propelling machines consist of a Mirrlees 7-cylinder direct reversing, vertical, four-stroke cycle Diesel engine, fitted with an intercooler. An exhaust gas driven turbocharger is mounted on the engine, which is capable of developing 736 b.h.p. at 235 r.p.m. in service. The engine is direct-coupled to the shafting through a Michell thrust bearing and thrust shaft to the propeller shafting and propeller. Bilge or fresh water standby, salt water and lubricating oil pumps are driven from the main engine. A closed circuit fresh water system is provided for cooling the engine cylinder jackets. The propeller is of the four-bladed Nikalium solid type made by the Manganese Bronze and Brass Co., Ltd. The sterntube bearings are arranged for oil lubrication and a Newark oil retaining gland is fitted at the outer end of the sterntube. The forward sterntube gland is fitted with metallic packing made by Universal Metallic Packing Co., Ltd., Bradford. The intermediate shaft bearings are of Michell make. The electric trawl winch equipment is of Robertson/Laurence, Scott make, and comprises a mechanical portion of the winch having two barrels each capable of holding 1,200 fathoms of $2\frac{3}{4}$in. circular wire rope and a winch motor of Laurence, Scott and Electromotors, Ltd., supply, the latter being found suitable for supply from a Ward-Leonard generator set developing 175 b.h.p. at 600 r.p.m.—*The Shipping World, 4th January 1956; Vol. 134, pp. 13-14.*



Profile drawing of the Diesel-engined trawler Wyre Vanguard

Forces in Coupled Derricks when Handling Cargo

When cargo is being handled with two derricks coupled to a common hook, i.e. when the married-fall system is in use, the forces in the derrick guys, booms, and topping lifts are often appreciably higher than when each derrick works independently. There are several methods by which these forces can be calculated for a given position of the booms and hooks, but these methods have the drawback that they do not indicate directly which of the positions is the least favourable. The author first treats the subject in a general way and develops expressions for the maximum values of the forces, valid for any position of the booms relative to each other. He then shows how to apply the results of this analysis to practical examples of loading and discharging cargo.—*R. Bennet, Forchungs. Schiffstechnik, September 1955; Vol. 2, p. 243. Journal, The British Shipbuilding Research Association, December 1955; Vol. 10, Abstract No. 11,087.*

Repairs to Welded Ships

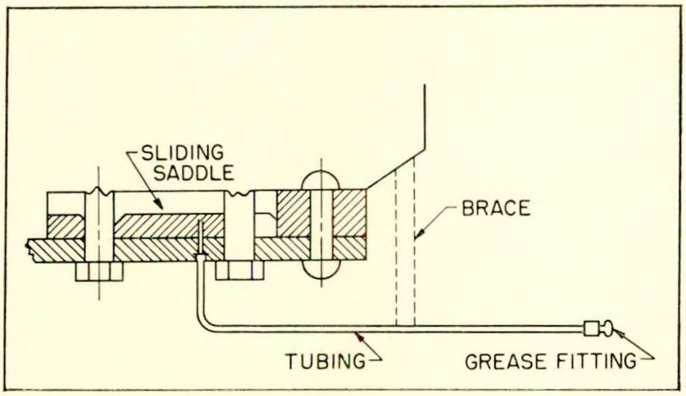
It is emphasized that the ship repairer should have the fullest knowledge of the factors affecting the efficiency of welded work. The aspects discussed include planning the sequence of operations, removal of damaged material, joint preparation, weld procedures, holding parts in position for welding, workmanship, and organization and supervision. There are also special notes on preheating, peening, and structural steel forgings and castings. Typical repairs are illustrated by diagrams which give instructions for the procedure to be adopted. They include renewal of single plate in deck or shell, side shell damage (plates erected singly), side shell damage (new material prefabricated), bottom damage, fractured deck plating at hatchway corner, and fractured connexion at deckhouse corner.—*Admiralty Ship Welding Committee, Report No. M.3. Journal, The British Shipbuilding Research Association, January 1956; Vol. 11, Abstract No. 11,128.*

Denny-Brown Ship Stabilizers

The designers and builders of the stabilizers are naturally always very anxious to prove the correctness of their figures and predictions by full scale trials. It is very seldom the case that a ship just fitted with stabilizers and going on trial will meet such weather as to give adequate results for analysis. The easiest way to prove the efficiency of the gear is to reverse the action of the fins and make them roll the ship. This can be conveniently done by reversing the leads to the gyros and start rolling the vessel by a small hand switch on the bridge. Once rolling has commenced the gyros will take over and the fins will roll the ship. Such trials were carried out on many sloops and destroyers during the war, but on passenger ships, especially large liners, this type of trial is rather difficult to carry out due to so much loose gear present on board. The P. and O. liner *Chusan* was actually rolled with the fins to 34 degrees out to out on the Arran Measured Mile, which figure agreed very well with that from the model tests. The only other two larger vessels force rolled in this manner were the *Parthia* and *Media* of the Cunard Line. If a ship is rolled by the fins to about 36 degrees out to out it can be confidently assumed that in service a roll of about 33 degrees out to out could be reduced to average 3 degrees out to out, or the total roll reduction would be around 30 degrees. Since shipowners are not very enthusiastic about forced rolling trials, in the latest trials the fins were only worked to a small angle, so that the forced roll never exceeded 10 degrees out to out and thus no damage could be done to crockery, furniture, etc. However, on all stabilizer trials an attempt is made to record the static heel of the vessel at speed with one fin set 20 degrees up for'd and the other 20 degrees down for'd in order to check on the calculated static heel of the fin design. The most important data are those collected from voyage results. But if a captain has a stabilizer gear on board and the weather becomes rough, he will put his gear into operation and it could hardly be expected from him, as the comfort of his passengers are his paramount interest, to withdraw the fins again and let the ship roll freely for a certain period in order to obtain a direct comparison between unstabilized and stabilized ship. One such record was actually taken on the Bergen S.S. Company's vessel *Venus* on her delivery passage from Leith to Bergen without passengers, when the vessel in relatively bad weather was allowed to roll freely without stabilizers for ten minutes at 21 knots speed. After these ten minutes the fins were put into operation, when an average roll of 17 degrees out to out with some odd swings up to 27 degrees was reduced to averagely 2½ degrees out to out.—*H. Volpich, International Shipbuilding Progress, No. 15, 1955; Vol. 2, pp. 530-536.*

Greasing Boiler Sliding Feet

All boilers are installed on foundations called boiler drum saddles. These saddles are designed to give the boiler rigid support and at the same time allow the boiler to expand. For this reason two of the saddles are fixed to the boiler foundation and at least two others permit the boiler drum to slide as it expands. A provision has been made to grease the sliding saddles. In many cases the saddles have been neglected because of the difficulty in reaching the grease fitting. As a result the sliding feet are unable to perform their function, and become rigid. This condition prevents the boiler from expanding as it heats, and sets up stresses in the boiler parts. These stresses may be severe enough to cause tubes to begin leaking at rolled sections. An alteration to the grease fitting has been developed to extend the fitting out from under the saddles to the outside of the boiler casing. This is done by removing the grease fitting and inserting ⅛-inch pipes and elbows between it and the saddle. This method is further improved by using flexible alemite tubing instead of the pipe fittings. The end of the tubing can be secured to the side of the boiler casing or nearby ship's structure, plainly visible, when not actually in use. There is no appreciable weight increase and the alteration is within the capacity of ship forces. Periodic inspection of the sliding boiler saddles should be made to ensure their freedom of movement.—*Bureau of Ships' Journal, February 1956; Vol. 4, p. 22.*



Typical saddle arrangement

Welding in the Shipbuilding Industry

An increased application of machine welding in shipbuilding is of vital importance. Thought and development should be concentrated on butt welding processes, which require the minimum of plate edge preparation and the minimum deposition of weld metal. A technique that requires large volumes of metal to be removed in the plate preparation, only to be replaced in the welding process, is almost as inefficient, from a production viewpoint, as drilling holes in plates only to fill them again with rivets. In general, butt welding carried out in the shops can be performed with maximum efficiency when a submerged-arc process is used. This gives improved penetration with a small volume of weld metal, and at the same time distortion is reduced and a smoother finish is obtained. However, the process demands a high degree of accuracy in plate edge preparation. The visible-arc method of welding, on the other hand, is more tolerant to plate edge inaccuracies and is more flexible in use. In this climate, the visible-arc machine is the only one of the two processes that can be used satisfactorily out of doors. There is still room for the development of a machine for welding vertical and horizontal-vertical butts on site work, for both types of weld are very costly to make by hand. In stiffened plate structures the greater proportion of welding is of the fillet variety. It is only quite recently that horizontal-vertical fillets could be made by submerged-arc machines; even now the sections used must be new and specially cleaned. Further developments include double-headed machines which will be able to weld both sides of a stiffener simultaneously but much of the advantage of these machines is offset if shot blasting is necessary on stiffeners that are only lightly corroded. Little progress appears to have been made in fillet welding by visible-arc machines; development on this line would lead to fillet welding by machines on work out of doors.—*R. J. W. Rudkin, British Welding Journal, January 1956; Vol. 2, pp. 22-24.*

Measuring Grain Size with Ultrasonics

An important property of ultrasonics in metals is its ability to detect a wide variety of flaws. This method of testing is rapid and non-destructive, so that in manufacturing processes where sound, flaw-free metal is important, ultrasonic testing is today extensively used to segregate pieces of objectionable quality. Not so extensively utilized, however, is the fact that absorption or loss of energy is characterized by interior grain structure. In instances where grain size is important, and perhaps dependent upon process variables not strictly under control, this property permits the use of ultrasonic testing to non-destructively ensure uniformity of grain structure. Ultrasonic vibrations travel through metals with a wavelength that is dependent upon their velocity of propagation and vibrational frequencies. The degree to which energy is scattered and absorbed in the metal is to a great extent dependent upon the relative magnitudes of this wavelength and the average grain diameter. Since the velocity of longitudinal waves in most metals exceeds 10^5 i.p.s., testing these materials with frequencies of a few megacycles per second usually results in a wavelength that is many times larger than the average grain diameter. Under these conditions the energy loss in the metal is low and the ultrasound is transmitted efficiently. If the frequency is increased, however, or if the average grain size is large and nearly equal to the wavelength, the energy loss is extremely severe and the ultrasound is unable to penetrate the metal any appreciable distance. It is doubtful, of course, that ultrasonic techniques of measuring grain size will ever eliminate the need for metallographic measurements. They are, however, valuable as supplementary methods. Since there is no need for cutting, polishing, etching, etc., and since the answer is obtained immediately, considerable savings in time and laboratory costs result. Being non-destructive, the method also permits complete inspection, rather than the sample testing allowed by metallographic methods. Another obvious advantage is the fact that the measurements may be made remotely; measurements have, in fact, been made at distances of 20 feet.—*D. L. Worlton, Nondestructive Testing, No. 6, 1955; Vol. 13, pp. 24-26.*

Further Tests with Models of Coasters

An earlier publication of the Swedish State Shipbuilding Experimental Tank, viz. No. 24 *Tests with Models of Coasters*, describes a series of experiments carried out with systematically varied models of coasters. These investigations comprised resistance tests with a family of seventeen models in which the length-breadth and breadth-draught ratios, the block coefficient and the longitudinal position of the centre of buoyancy were systematically varied. The results of the above tests were expressed in terms of dimensionless ratios and they thus make it possible to calculate the resistance of similar forms and other forms of the coaster type. The present paper deals with a systematic investigation of the propulsive qualities of coasters. Four models with the same block coefficient ($\delta = 0{\cdot}65$) but different length-breadth and length-displacement ratios were tested at both full load and light draughts. The form coefficients and ratios of the models were the same as in Series A:2 of the earlier tests. The models in question were selected as being, in the authors' opinion, those most interesting to study from the aspect of their propulsive characteristics. Self-propulsion tests have been carried out with each model using four different propellers in turn, in order to determine the effect of propeller revolutions on the propulsive characteristics. The primary results of the model tests have all been worked out for ships of the same displacement, namely $V = 816\ m^3$ at load draught on an even keel and $V = 408\ m^3$ at light draught with a trim by the stern. The range of revolutions covered by the four propellers at a speed of 11 knots was about 190 to 370 revolutions per minute.—*H. Lindgren and A. O. Warholm, Swedish State Shipbuilding Experimental Tank; Publication No. 35, 1955.*

Effect of Accelerated Cooling upon Properties of Ship Plate Steel

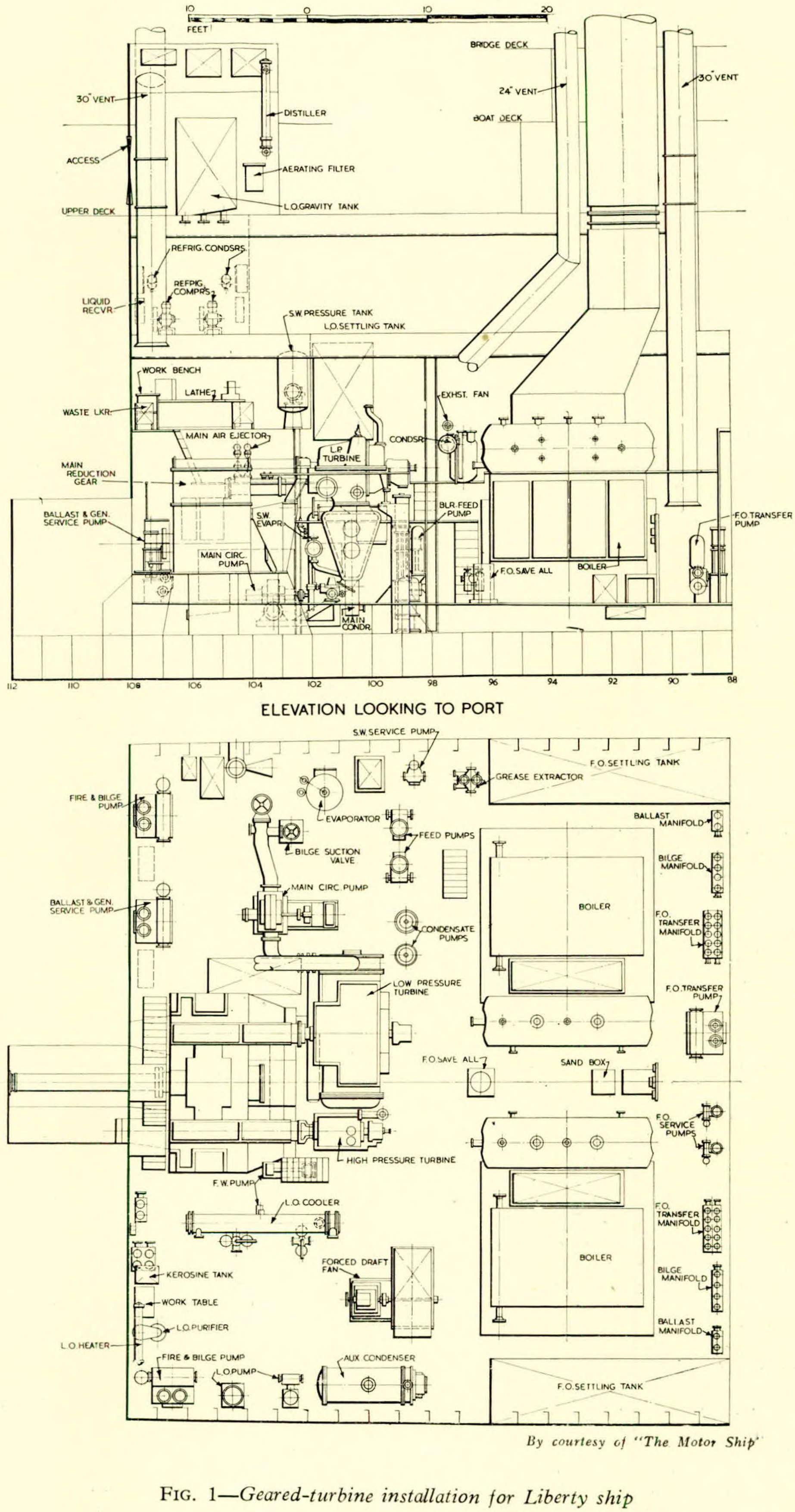
The notched-bar properties of ship plate steels reheated to temperatures above 1,500 deg. F., are affected by the rate at which they cool to room temperature. Previous work has shown that cooling in an air blast produced better properties than slower cooling rates. This suggested that faster cooling from the hot rolling operation might improve the properties of ship plate steels. Work at the Inland Steel Company indicated that changing the rate of cooling between 1,100 and 125 deg. F. does not significantly affect the properties of semi-killed steels. It appears, therefore, that cooling rates at temperatures above 1,100 deg. F. were of greatest interest. With this background the effect of accelerated cooling from the final rolling pass was investigated. Two open-hearth steels of conventional ship plate composition were used for the experiments. The plates were time-quenched as they left the rolling mill at 1,850 deg. F. The quenching periods were kept short in order to develop a microstructure of ferritic and pearlite in the final plate. The plates were cooled to room temperature in air after the time-quenching treatment. Keyhole Charpy and tear tests were made on samples from plates cooled from the final rolling pass at four different rates. The results of this work may be summarized as follows: water quenching $\frac{3}{4}$-in. plates for six seconds did not raise the hardness in the centre of the plate. Longer quenching times increased the centre hardness, an indication that the ultimate strength of the plate was increased. The hardness at the edge of all plates quenched was approximately 95 R_B, with the higher carbon steel having the highest surface hardness. The microstructure of the centre of plates, quenched for periods longer than six seconds, was no longer typical of as-rolled steel, but, instead, tended to show ferrite outlining the original austenite grain areas. The centres of the quenched plates also showed some Widmanstätten structures. The transition temperature, when the 12ft. per lb. keyhole notch Charpy criterion was used, was lowered by quenching the plates from the last hot-rolling pass. Longer quenching times gave lower transition temperatures. The higher manganese steel with 0·78 per cent manganese appeared to be more adaptable to quenching than the steel with 0·52 per cent manganese. In general, increasing the length of the quenching time lowered the tear test transition temperature. An exception was a plate of the steel with lower manganese content which was quenched in water for twenty-five seconds before being air cooled. This plate had a higher transition temperature than the plates which had been quenched for shorter times or air cooled from the last hot-rolling pass.—*R. H. Frazier, F. W. Boulger and C. H. Lorig, BUShips Project NS-011-178; Report Serial No. SSC-89, 1955.*

Steel Plates and Sections in Shipbuilding

Mill scale on plates and sections is an annoyance to both shipowners and shipbuilders. In former days there was time to descale the plates by exposure to the open air, but the faster working tempo of modern yards tends to mean that the steel in the finished hull is inadequately descaled. More and more shipowners are demanding in their specifications, vessels with fully descaled hulls. Builders can use wet or dry sand blasting, steel grit blasting, pickling or flame cleaning for this purpose, and all of these methods are in fact used—in each case with varying degrees of success. After descaling, the prefabricated sections or compartments must be derusted before the first coating can be applied. This is normally done by polishing with rotating steel wire brushes; it is a dirty job and a hindrance to other workers (electricians, pipe fitters, joiners, painters, etc.) during the fitting-out and rigging of the hull. Some yards now descale and derust plates and sections before machining them, coating them immediately with a welding primer. The author believes that the steel mills themselves might well descale the plates and sections before shipment, giving them a universal welding primer which would preserve the steel for several months, at least. This primer would have to consist of some mixture which would not unfavourably affect welding, or produce any dangerous gases during the welding process; it would also have to be suitable as a foundation for any paint or other coating, and be easy to remove if this were necessary. The fact that steel treated in this way would be more expensive must be weighed against the advantages of working with such material. Cleaned plates and sections would mean cleaner shipbuilding sheds and less wear and tear on machines, as well as more economic flame cutting and better quality welding.—*J. H. Krietemeijer, European Shipbuilding, No. 6, 1955; Vol. 5, pp. 130-136.*

Liberty Ship Conversions

One of the most notable ship building projects now being undertaken is that for which the Office of Ship Construction and Repair of the U.S. Maritime Administration is responsible. Its object is to ascertain the best means of re-engining Liberty ships to increase their propelling power from the present figure of 2,500 i.h.p. to some 6,000 s.h.p. and thus render them efficient cargo carriers, competitive with modern tonnage. There are at present nearly 1,500 Liberty ships laid up in the U.S.



By courtesy of "The Motor Ship"

FIG. 1—*Geared-turbine installation for Liberty ship*

reserve fleet—over 15 million tons d.w.c. They have a service speed of about 10 knots and a fuel consumption of 25 tons of oil daily. Defence requirements have demanded, however, that the power of Liberty ships—which comprise some 85 per cent of the Defence Reserve Fleet—should be increased to 6,000 s.h.p. to enable a service speed of 15 knots to be maintained. It was decided to convert four ships and each will have a different class of machinery. All vessels except those to be steam-turbine propelled will have the bows lengthened. The conversions comprise the following:

1. *Steam turbine;* existing boilers, but with new superheaters, to be retained, also the pumps, while the present condensers are to be modified. A new steam turbine and reduction gear (shown in Fig. 1) will be fitted. Retention of the existing bow gives an opportunity to investigate the strength, speed characteristics and sea-kindliness of existing Liberty ships when the horse-power is increased from 2,500 i.h.p. to 6,000 s.h.p. Modifications are also to be made to the cargo gears to facilitate carrying military cargoes.

2. *Geared-Diesel machinery* to be installed, while the length of the bow is being increased to assure the minimum sustained speed. Experimental cargo-handling gear incorporating cranes will be fitted.

3. *Open-cycle gas-turbine propelling machinery,* coupled to a variable-pitch propeller to be installed. The existing cargo gear is retained but the bow is being lengthened. The contract was awarded to the General Electric Company, of Schenectady, New York, for a two-shaft, open-cycle, gas turbine, to drive a variable-pitch propeller through double-reduction gearing. When installed, this will be the most powerful gas turbine in marine service.

4. *Free-piston gas turbine machinery* to be installed. It was intended originally to have a multiple-Diesel-electric installation but reports on the potentialities of free-piston machinery were encouraging and it was considered advisable to adopt a second gas-turbine installation. The existing cargo gear will be retained. The contract was awarded to the Cleveland Diesel Engine Division of General Motors for the free-piston gas generator and turbine propelling machinery, to consist of six GS-34 gas generators, two 3,000 s.h.p. Alsthom-type gas turbines with an astern element in each, one main reduction gearbox, miscellaneous controls and auxiliary equipment. Briefly, the free-piston engine, or gas generator, comprises a single power cylinder with two opposing pistons. Combustion is on the principle of a two-stroke Diesel engine and the power is produced by the exhaust gases and the air driving the turbines. Each of the turbines develops 3,000 s.h.p. at 5,500 r.p.m. and has six ahead stages and three astern, mounted on the same shaft. Control valves apportion the gas power between the ahead and astern inlets (two ahead and two astern) according to the power demand. No special provision need be made for high temperatures since the maximum gas temperature at the turbine inlet is only some 875 deg. F. A feature incorporated in each gas turbine is the masking of the astern turbine wheel, to decrease windage losses in the astern stages when running ahead. Compared with the weight of 463·8 tons for the existing 2,500 i.h.p. reciprocating steam machinery—for main and auxiliary machinery, boilers and accessories, piping, evaporators, service tanks, etc.—the 6,000 s.h.p. free-piston installation has a weight of 385·4 tons. The heaviest moving part of the gas generator is 650lb., and the heaviest stationary part requiring maintenance, less than 1,400lb. Each gas generator weighs 18,000lb.—*The Motor Ship, December 1955; Vol. 36, pp. 384-387.*

Critical Whirling Speeds of Shaft-disc Systems

The study of the lateral vibrations of shaft-disc systems, with special application to the propeller shafts of ships, was initiated by the U.S. Navy Department as a direct consequence of the numerous fractures of propeller tailshafts which had occurred on a number of classes of single-screw ships. The purposes of the present paper are:—(*a*) To familiarize the designer with the problem of whirling vibration so that he will give it proper consideration in the design of shafting and shaft supports. (*b*) To provide the designer with an approximate method for computing the fundamental critical whirling speed of the tailshaft system. This method is to be simple enough to be readily usable and yet it must consider the effects of bearing flexibilities, of propeller and shaft masses, and the rotatory inertia of the propeller. (*c*) To indicate more exact but more complex methods that are being studied by the Taylor Model Basin for possible application to the whirling problem. These methods will not be suitable for direct application by the designer; rather they will require the utilization of analogs or of digital computers. Procedures for computing the natural whirling frequencies are illustrated by application to the propeller shafting system of a number of ships. Computed and experimentally determined natural frequencies are compared in order to obtain some measure of the accuracy obtainable.—*N. H. Jasper, International Shipbuilding Progress, January 1956; Vol. 3, pp. 37-60.*

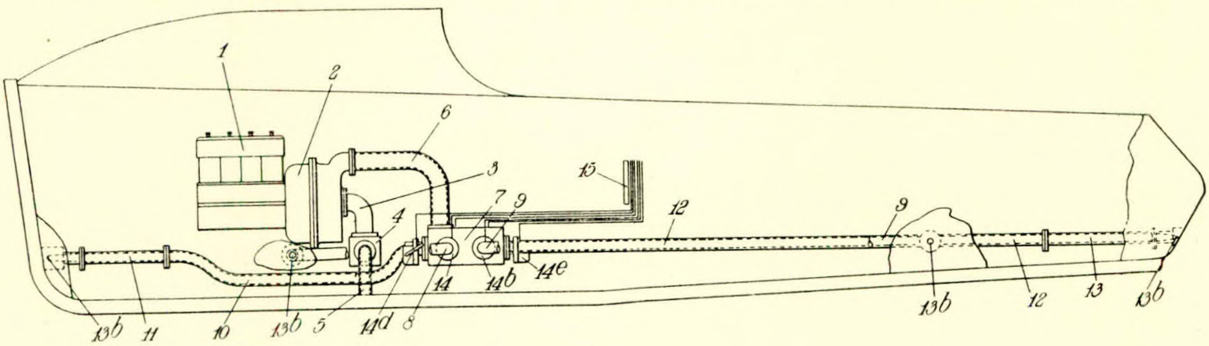
New Mercury Lamp

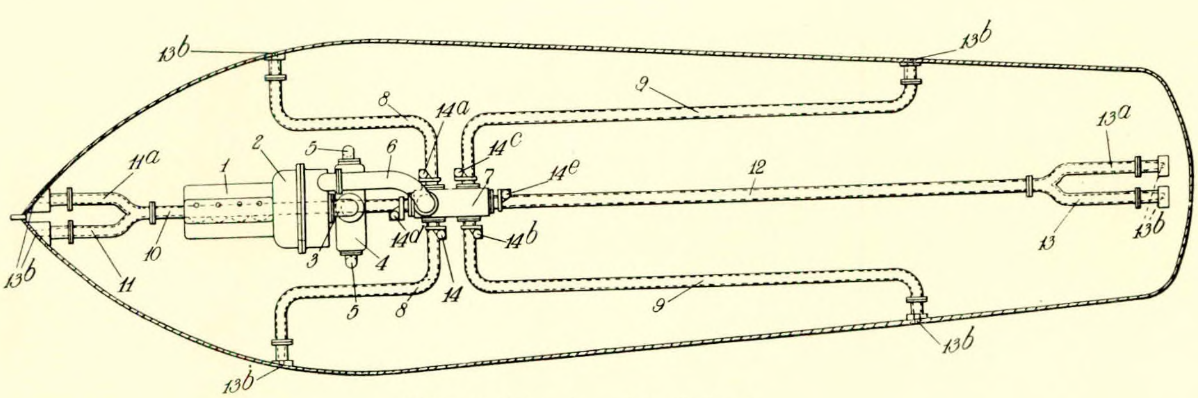
Mercury lamps continue to enlarge their area of usefulness. The use of several atmospheres of xenon in short-arc mercury lamps has added valuable characteristics for searchlight operation. Formerly, short-arc mercury lamps utilized a small standby electric heater outside the bulb to vaporize the mercury when a substantial amount of light was desired immediately. No special heaters are needed in the xenon-mercury lamp. The xenon is a gas at all ordinary temperatures, and serves as a path for the arc when the lamp is first turned on. This arc provides initially about 25 per cent of the final light output of the lamp, and supplies the heat necessary to vaporize the mercury. Some 2,000 of these new lamps will be used to convert 12-inch marine signalling searchlights from incandescent to mercury-arc lamp operation. These searchlights serve a dual purpose—sending messages by Morse code blinker system, and for general searchlight work. The lamps will be installed in such a way that a simple flick of a lever will throw their beams in or out of focus. When focused, the new 1,000-watt searchlight produces about three million beam candlepower or more than ten times that of the old lamp, which greatly increases the range of the searchlights, particularly for daylight signalling; when out of focus, the signalling beam is wider and can be seen more easily when the ship rolls.—*Westinghouse Engineer, January 1956; Vol. 16, p. 31.*

Patent Specifications

Water Jet-propelled Vessel

This invention proposes an improved system of ship propulsion whereby the ship can be driven both ahead and astern and also manœuvred as desired. As shown in Figs. 1 and 2, the vessel is provided with a motor (1) which drives a centrifugal pump (2). The inlet port of the pump connects through duct (3) to chest (4) which in turn connects with a pair of ducts (5). The pump discharges through duct (6) into a chest (7) to which are connected ducts (8) which discharge to port and starboard sides of the vessel near the bow, ducts (9) which discharge to port and starboard sides near the stern and a forwardly extending duct (10) which is forked to form twin branches (11, 11a) discharging at the bow. The rearwardly-extending duct (12) is forked to form twin branches (13, 13a) discharging at the stern. The outlets of the ducts (8, 9) and the branches (11, 11a and 13, 13a) are each provided with a discharge nozzle (13b). The ducts (8) are provided with control valves (14, 14a), the ducts (9) are provided with control valves (14b, 14c), the duct (10) is provided with a control valve (14d) and the duct (12) is provided with a control valve (14e). If desired the valves may be selectively operated by remote control, the controls being mounted on a panel (15) as is indicated diagrammatically in Fig. 1. Normally the pump will be continuously driven.—*British Patent No. 746,383 issued to T. Quinn McGawn. Complete specification published 14th March 1956.*





FIGS. 1 *(above)* and 2 *(below)*

Anti-rolling Means for Ships

The primary object of this invention is to provide anti-rolling means in ships adapted to maintain the ship on an even keel when travelling in rough sea with a minimum of rolling movements. The invention comprises a seagoing ship including a downwardly decreasing breadth of hull at least in a zone adjacent the water line, so as on listing of the ship to make the ship area adjacent the surface of the water larger in one direction than the corresponding area in the opposite direction and a steering member mounted on the fore part of the ship and arranged to cause slight change of course of the ship in the same direction as and simultaneously with listing movements initiated by waves. The hull of the ship illustrated in Figs. 1 and 2 is substantially of the form of a V, the

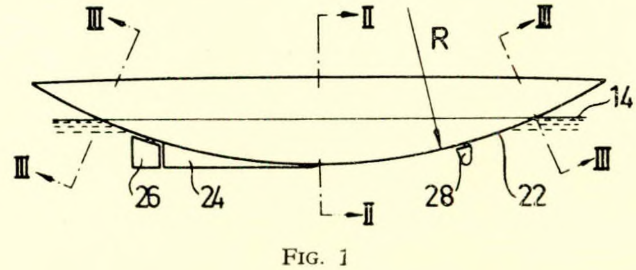


FIG. 1

limbs (10) of which constitute circular arcs with the radius (*r*). The ship may be built with ribs or frames, all of which have the same radius of curvature. In its longitudinal direction

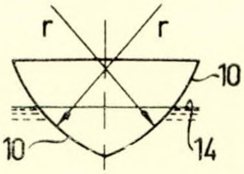


FIG. 2

the hull is in the form of a partial body of revolution, the centre of which is located amidships above the ship, as is indicated by the radius (*R*). The forepart (22) is provided with a steering member or rudder (28) carried by a shaft (30) projecting through the bottom (29) of the ship (Fig. 7). The shaft (30) is connected through a transmission (31) with a gyro-rotor (32), the axis of rotation of which extends athwartships. The gyro-rotor operates so that on a rolling movement of the ship, to the right, for example, it automatically turns the

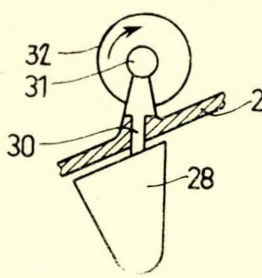


FIG. 7

rudder (28) so as to cause the ship to change its course in the same direction. Such a gyro may be constructed in any known manner. It is preferred additionally to build the ship with bottom tanks (34 and 36) communicating directly with the sea through relatively large openings (38) (Fig. 4). Extending

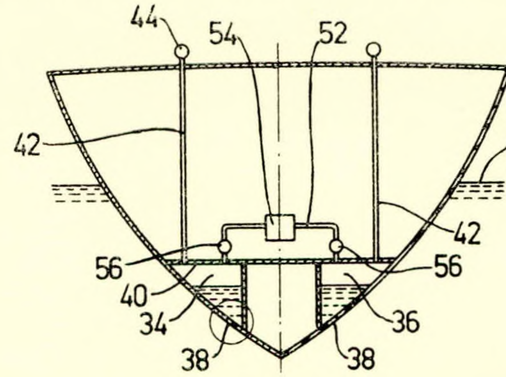
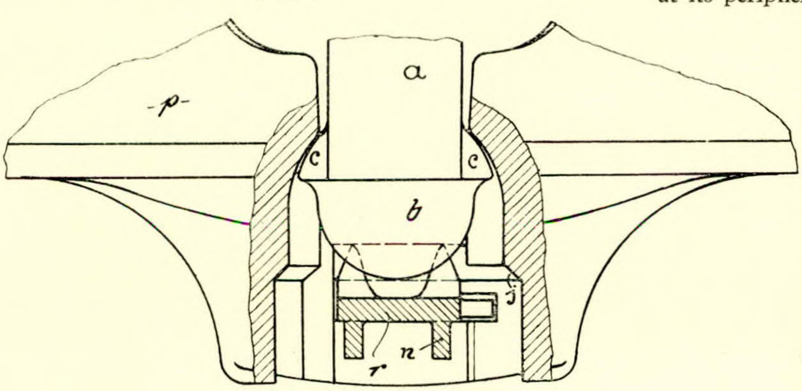


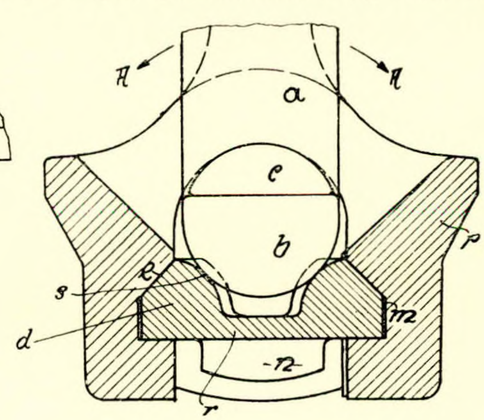
FIG. 4

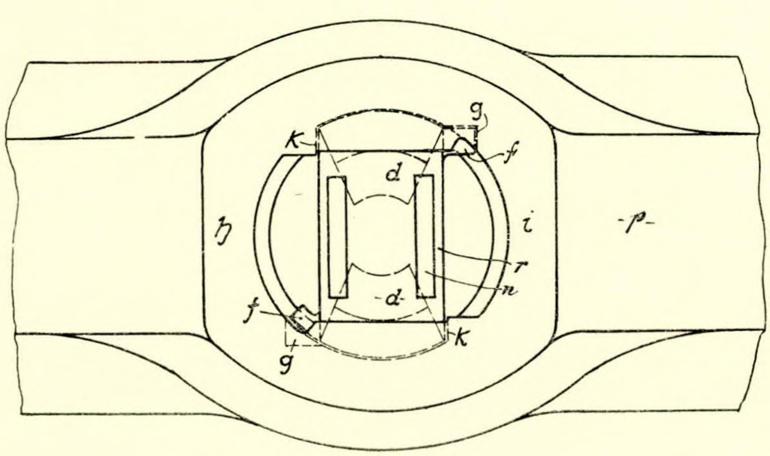
from the upper bounding wall (40) of the tanks are conduits (42) provided at the top with valves (44). When these are opened, air present in the bottom tanks will rapidly escape and water will enter the tanks through the openings (38).—*British Patent No. 747,447, issued to F. Ljungstrom. Complete specification published 4th April 1956.*

Stockless Anchor

This invention relates to stockless anchors. Referring to Figs. 1, 2 and 3 the shank (*a*) which is of rectangular cross-section, has at its bottom end a hemisphere (*b*) which merges at its periphery into part spherical sections (*c*), which in turn



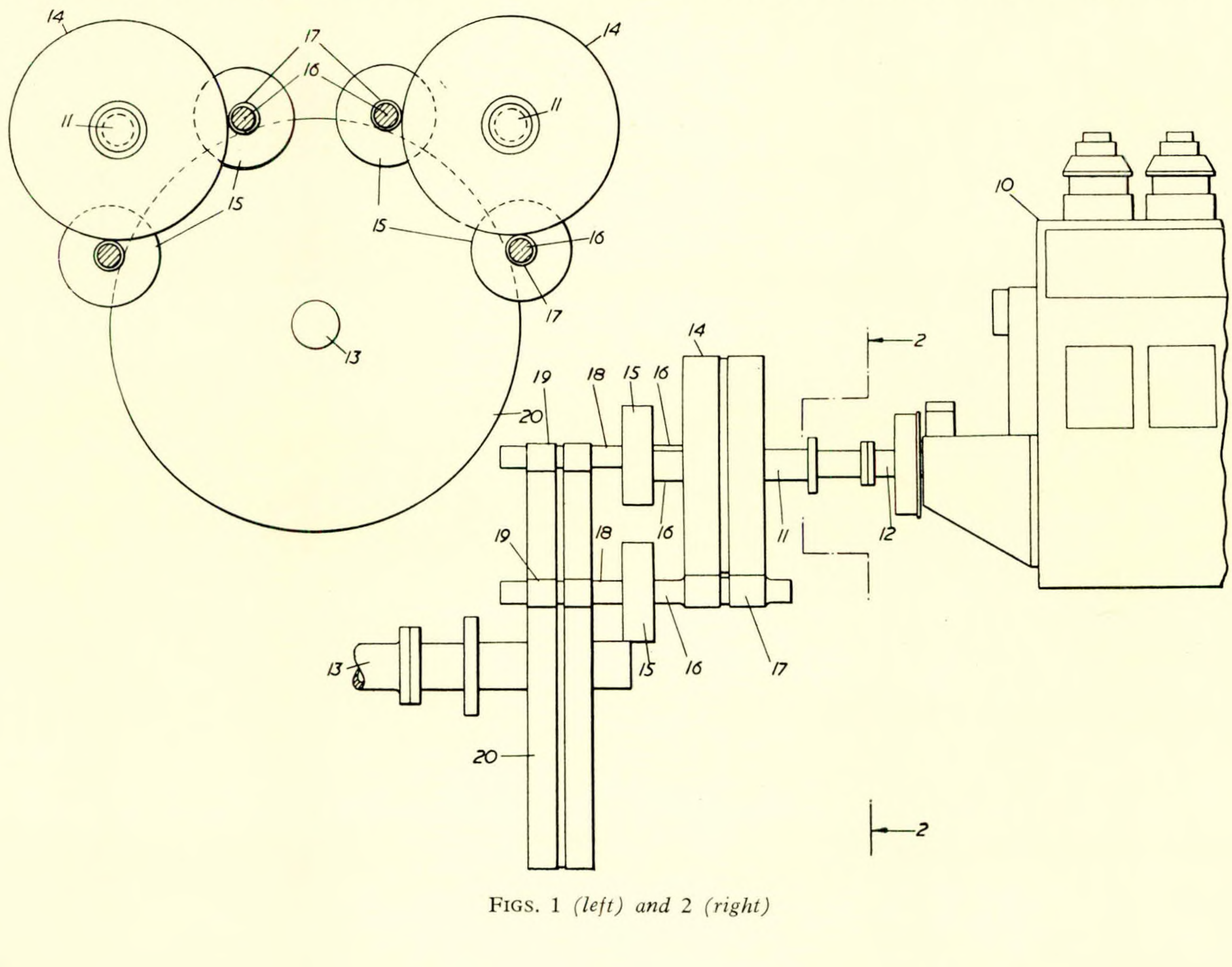




FIGS. 1 *(above left)*, 2 *(above right)* and 3 *(left)* are connected to the longitudinal side of the rectangular shank (*a*). These part spherical sections (*c*) form the supports or the turning surfaces for the anchor head (*p*). The closure element consists of a rectangular plate (*r*), of which the narrow sides merge into segmental projections (*d*) which have tapered, sloping, or wedge formation faces (*e*). Arranged underneath the plate (*r*) are two ribs (*n*) which extend parallel to one another and which are used when fitting the closure element into the anchor head. Arranged laterally on each end of the plate (*r*), that is, diagonally opposite one another are projections (*f*) which, after the closure element has been placed in position in the anchor head and rotated into the end position, are driven into recesses (*g*) in the anchor head, after heating, to serve as locking means. These projections may be arranged not only diametrically, but also in any other position.—*British Patent No. 746,011, issued to Dortmund-Hoerder Huettenunion A.G. Complete specification published 7th March 1956.*

Speed Reduction Gear

This invention relates to a speed reduction gear to be interposed between a reciprocating engine and a propeller. Referring to Figs. 1 and 2, two side-by-side Diesel engines (10) are used, each having a capacity of 2,500 b.h.p. Only one of the engines is shown in Fig. 1, but two shafts (11) are shown in Fig. 2, which are flange-jointed extensions of the engine crankshafts (12). The engines drive a single propeller shaft (13) through a speed reduction unit. This unit includes a pair of large primary gear wheels (14), which, in the example, are connected directly to the extension shafts (11), respectively, being driven by the crankshafts (12) of the engines at a speed of, say, 250 r.p.m. In the example, the unit includes four fluid slip couplings (15), each a hydraulic coupling designed to transmit 1,250 h.p. at an input speed of 1,650 r.p.m. The pump wheel shaft (16) of each coupling is connected to a primary pinion (17), which meshes with one of the primary gear wheels (14), there being two pinions (17) to each gearwheel (14). The turbine wheel shaft (18) of each coupling is connected to a secondary pinion (19), so that in the speed reduction unit there are four of these pinions (19) in all. These secondary pinions all mesh with a large secondary gear wheel (20) on the propeller shaft (13). This secondary gear wheel (20) is about twice as large in diameter as the primary gear wheel (14). The overall arrangement of the speed reduction unit is such that the secondary gear wheel (20) is rotated at 110 r.p.m., the propeller shaft transmitting 5,000 s.h.p. at this speed to the propeller. The pinions and gear wheels are all of the double helical type.—*British Patent No. 745,229, issued to the Fairfield Shipbuilding and Engineering Co., Ltd. (inventor A. W. Davis). Complete specification published 22nd February 1956.*



FIGS. 1 *(left)* and 2 *(right)*

Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 6, June 1956

Fretting and Fretting Corrosion

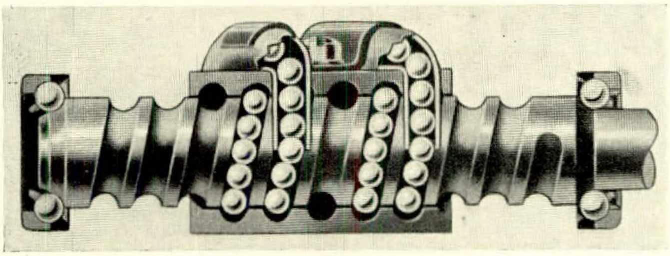
It is now recognized that fretting is a form of wear caused by two surfaces rubbing together, generally with a reciprocating motion of limited amplitude. Such motion is usually linear, oscillating or vibratory. The general phenomenon of fretting is not dependent upon chemical attack. Fully oxidized materials such as ruby or glass will fret when rubbed together under suitable conditions. Also some fretting of base metals such as steel will occur even if oxygen is excluded; therefore, mechanical wear appears to be the primary factor in fretting. Not all vibration will produce fretting; its amplitude must be sufficient to cause relative slip between the surfaces. Conversely a point is reached where increased amplitude of oscillation may mitigate fretting by breaking down dams of debris and dragging in fresh lubricant as in the case of grease-lubricated antifriction bearings. Directly opposed opinions exist regarding the effect of load on fretting. The probable explanation is that the amplitude of vibration and the type of mechanism must be considered in each case. For instance, in fretted parts which are not supposed to show relative movement, a practicable increase in load may suppress vibration and prevent any relative slip from taking place, thus eliminating fretting. However, in the case of an antifriction bearing which is designed to oscillate a limited number of degrees, increase in load may increase fretting because the greater areas of contact produced under load cause more slip as the rolling elements go through the load zone. Both smooth finishes and rough finishes are claimed to minimize fretting. The bulk of the evidence, however, points to the superiority of a rough surface over a smooth surface when a lubricant is used. It has been shown that vapour blasting the raceways of ball bearings will reduce weight loss due to fretting corrosion—the lubricant is retained in the tiny pockets of the rubbing surfaces. The process of roughening, however, should not be carried to the point of producing a loose fit. In the case of needle bearings, for instance, it has been shown that using a tighter fit eliminates "jiggling" and skewing of the needles and thus decreases fretting corrosion. Only meagre quantitative information exists on the effects of hardness in minimizing wear under conditions of true fretting. However, it appears that increased hardness is associated with lower susceptibility to attack, as with normal wear. This does not hold true when stainless steel is one of the materials.—*Lubrication, February 1956; Vol. 11, pp. 13-23.*

Fretting Corrosion

Fretting corrosion is defined as the particular kind of damage which occurs when two surfaces in contact experience slight periodic relative movement. Examples are quoted of its appearance in very diverse circumstancees such as press-fitted hubs, riveted structures, and electrical switching gear. It can lead to loss of fit, or seizure, and it is a possible source of fatigue cracks. There is as yet no clear indication whether the appearance of cracks in fretted regions is due to the pits formed acting as stress raisers, although their shape could very well produce such an effect, or whether the conditions producing fretting also cause surface fatigue. The amount of damage increases approximately linearly with increasing amplitude of relative motion and increasing normal loading. It also increases as the temperature is lowered or as the atmosphere is more corrosive. The fretting corrosion of steel is reduced in a non-oxidizing atmosphere. There appear to be three possible processes involved: (1) mechanical abrasion by grinding or welding; (2) abrasion by hard particles of oxide; (3) continual mechanical rupture of otherwise protective oxide films. Probably all three mechanisms may be important in different cases, but most of the experimental data for the fretting corrosion of steel is best explained by the third mechanism. Preventive measures are classified according to their effectiveness in (*a*) reducing relative movement by increased friction force, such as increased normal load, electroplated metal coatings of high coefficient of friction, elastic inserts; (*b*) reducing friction by lubrication or low friction inserts, such as polytetrafluorethylene; (*c*) excluding the atmosphere with rubber gaskets or flooding with lubricant; (*d*) increasing the abrasion resistance of the surfaces; and (*e*) separating the surfaces. It is emphasized that a measure which is a remedy in one case may aggravate the damage in another, indicating the need for careful diagnosis.—*Paper by R. B. Waterhouse, submitted to The Institution of Mechanical Engineers for written discussion, 1955.*

Circulating Ball Type Screw and Nut Assembly

There are many methods used for the transmission of mechanical power or motion. One fundamental method is the power screw which utilizes a screw and nut arrangement to raise a weight or to overcome a resistance. A simple form of power screw, for example, is the familiar screw jack in which either the screw or nut may be stationary while the other is movable. A revision of the fundamental theory of power screw operation is represented by the ball bearing screw assembly in which the rolling ball principle is applied to a screw and nut to produce a highly effective means for efficiently translating rotary motion to linear motion or linear motion to rotary motion. The conventional design of the ball bearing screw assembly utilizes a screw and mating nut, each of which has a specially formed, concave, helical ball race. Within the nut, the length of the helical race is filled with steel balls which act as the medium of engagement between the nut and



Circulating ball transmission. This principle was applied by the Hyde Windlass Company for naval steering gear

screw. Each ball is of the same diameter and carries an equal share of the applied load. Fitted to the nut are tubular ball guides which interrupt the path of the balls and deflect them from the helical race. The balls, after being deflected, are guided diagonally across the outside of the mating nut and back again into the helical race. The heart of a multiple circuit ball bearing screw assembly is a series of helical races. Each race is an integral part of a closed circuit through which the rolling balls recirculate continually as either the screw or nut rotate relative to each other. Each circuit, the length of which is equal to a specific number of turns, carries a full share of the load and every ball within the circuit does an equal share of the work. If any closed circuit should fail, the remaining circuits continue to function without interruption, with the load being shared among them. The early application of the ball bearing screw assembly was in the steering mechanisms of passenger cars, trucks and buses. Since then, many highly diversified applications have been found for use of the assembly outside the automotive industry. As an example, the ball bearing screw assembly is used for actuating landing gears and control surfaces for aircraft and for controlling feed screws on heavy duty grinders. The assembly can be combined with either electrical, mechanical, hydraulic or pneumatic mechanisms.—*The Marine Engineer and Naval Architect, January 1956; Vol. 79, p. 30.*

Fuels for U.S. Navy Gas Turbines

Base-load gas turbines must have long life and high operating economy. Such gas turbines must operate at high inlet gas temperatures to produce high specific output at high thermal efficiencies. Great difficulties are encountered, however, due to the continuous exposure of metals to the high temperatures especially when burning cheap residual-type fuels. The high temperatures result in creep of metals and loss of strength; some residual fuels result in corrosion of blade materials and deposits. Considerable benefit could be obtained by use of a compound, two-stage power plant wherein the temperature of the combustion gases is reduced in the primary stage to a value consistent with acceptable gas turbine performance. The primary power plant would be specially designed so that it could withstand high temperature combustion and efficiently burn residual fuel. The combination free-piston gas producer-gas turbine engine is suggested as a suitable compound power plant for development into a residual fuel burner. In this type of power plant, it is possible to obtain automatic adjustment of working fluid properties to obtain good part-load efficiencies and to make use of the ability to modify gas flow rates to produce excellent torque characteristics. Also, some of the air compressed behind the power piston might be used to aid the atomization of the heavy fuel. Some preliminary work has been initiated at the U.S. Naval Engineering Experiment Station to determine how to use Navy special in a Diesel engine. The results of this exploration should be of benefit in designing a composite, two-stage power plant for use with heavy fuels. Some of the potential problems which may require solution include: (*a*) high cylinder pressures; (*b*) plugging of injectors; (*c*) high cylinder and piston-ring wear; (*d*) piston-ring deposits (sticking); (*e*) valve-seat wear; (*f*) valve-stem deposits (sticking); (*g*) injector-valve sticking; (*h*) cold starting; (*i*) smoke. Because the gas producer is still in its infancy, excellent opportunity is afforded for the exercise of ingenuity in designing the injection, combustion, and fuel-handling systems so they will burn the cheaper grades of fuel most efficiently.—*H. F. King and H. V. Nutt. Trans.A.S.M.E., January 1956; Vol. 78, pp. 185-196.*

Dutch Whaling Factory Ship

The largest whale oil factory ship ever to be built in the Netherlands. and probably the largest vessel of its type in the world, was completed last year. This vessel, the *Willem Barendsz*, has a displacement of about 44,000 tons, and a deadweight of 26,500 tons. This deadweight is surpassed only by the *Abraham Larsen*, 28,500 tons d.w., owned by United Whaling, Ltd. The *Willem Barendsz* was built at the Schiedam shipyard of the Dok en Werf Maatschappij Wilton Fijenoord N.V., for the Nederlandse Maatschappij voor de Walvisvaart N.V., Amsterdam. The *Willem Barendsz* is also designed for carrying oil cargo in the tanker trade, and is equipped with forty-eight tanks; rather more than would be necessary in an oil tanker of similar deadweight, which would have two longitudinal bulkheads and probably thirty tanks. Particular attention has been given to the accommodation in this ship, which carries about 500 persons. The principal particulars of the *Willem Barendsz* are as follows:—

Length, o.a., metres...	206
Length, b.p., metres	190
Breadth, moulded, metres	27·5
Depth, moulded, metres	19
Draught, loaded, metres	10·7
Deadweight, tons	26,500
Gross tonnage	26,830
Nett tonnage...	15,090
Displacement, tons	44,500
Speed, knots	14
Engine output, s.h.p.	10,500

The *Willem Barendsz* is of welded construction with the exception of the sheer strake, bilge strake and the fore-and-aft frames. Much of the work was prefabricated and erected in sections of from 20 to 70 tons in weight. It is understood that the deckhouse, weighing about 250 tons, was subcontracted to John Cockerill, S.A., and was transported through the canals and locks by two tugs. The main propelling machinery consists of two Wilton-Fijenoord-M.A.N. single-acting two-stroke six-cylinder Diesel engines, each having an output of 5,250 s.h.p. at 112 r.p.m., and designed to give the ship a speed of 14 knots. Electricity for power and lighting is obtained from four turbogenerators and two Diesel generators. The four steam-driven sets each has an output of 600 kW at 220/380 volts, 50 cycles, three-phase, and is directly coupled to a 15-kW exciter. The two Diesel engines are of M.A.N. make each having an output of 440 s.h.p. driving generators of 300-kW capacity. In addition to the 380-volts supply, there is a 110-volts system for lighting and for supply to the whale-catchers when they are lying alongside. Steam is supplied by eight Scotch boilers arranged in two rows of four boilers. Most of the steam is used for the processing plant. A considerable amount of low pressure steam is used on board the *Willem Barendsz* and for this reason a large number of reducing valves are fitted in the steam lines.—*The Shipping World, 11th January 1956; Vol. 134, pp. 77-79.*

Torque Meter without Sliprings

Many different designs of torque meter have been tried by various workers. Normally the shaft itself or more often a specially inserted measuring shaft is equipped with two collars, and the torsional angle between these is measured by means of an inductive or capacitive gauge, usually bridge connected. Connexion to these rotating elements is normally by means of conventional slip-rings. It is clear that there is a distinct requirement for a simple slip-ring-free torque meter for rotating shafts, especially for shafts having a large diameter. The torductor would appear to have possibilities to meet this demand in many cases. The construction of the turductor is shown in principle in Fig. 1. It consists of two U-formed

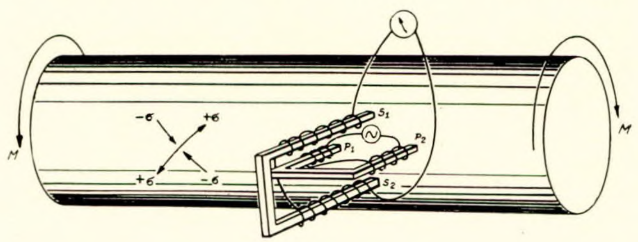


FIG. 1

electromagnets of transformer laminations at right-angles to each other which are placed adjacent to the shaft to be regulated. Air gaps of some millimeters can be used without impairing the sensitivity too much. One of the electromagnets is connected to a source of alternating current, for example, the power line, the other is connected to the regulator or amplifier or, in the case of large shaft stresses, it may be directly connected to a sensitive rectifier instrument. If the shaft is subjected to a torque M, principal stresses $\pm \sigma$ are obtained in the surface of the shaft, making angles of 45 degrees to the shaft axis as shown in Fig. 1. When the shaft is subjected to torque, which results in the principal stresses $\pm \sigma$ as shown in the figure, the reluctances, which lie in the direction of tension will be reduced, whereas the reluctances which lie in the direction of compression will be increased. The result is that an unbalanced magnetic flux will flow through the bridge arm $S_1 - S_2$ in proportion to the reluctance changes, which, under suitable conditions, are proportional to the impressed torque.—*O. Dahle, Process Control and Automation, January 1956; Vol. 3, pp. 30-31.*

Bearings for Marine Geared Turbines

The prime requirements of bearings for marine geared turbines, reliability and efficiency, are considered. It is shown that the correct choice of length/diameter ratio and clearance ratio is essential in order to attain these requirements, and it is indicated that for the conditions which occur in most marine turbine and gear bearings, relatively short bearings with length/diameter ratio between two-thirds and one-third, and clearance ratios between one and two thousandths of an inch per inch diameter, give the best results. Bearing and shell materials are discussed. The advantage of high-tin white-metal as bearing material are shown, and the relative merits of non-ferrous and ferrous shell materials are considered. It is concluded that the best general design is one of thin white-metal on a steel shell; the shell may be of normal thickness or it may be of thin shell type, and the advantages of this design are considered. The requirements of utmost reliability in a marine bearing involves, if possible, the ability for limited operation under a condition of lubricating oil failure. The shortcomings in this respect of present bearings are mentioned, and an improved design which overcomes them is described.—*Paper by A. D. Newman, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 10th February 1956.*

Unusual Cause of Shipbottom Pitting

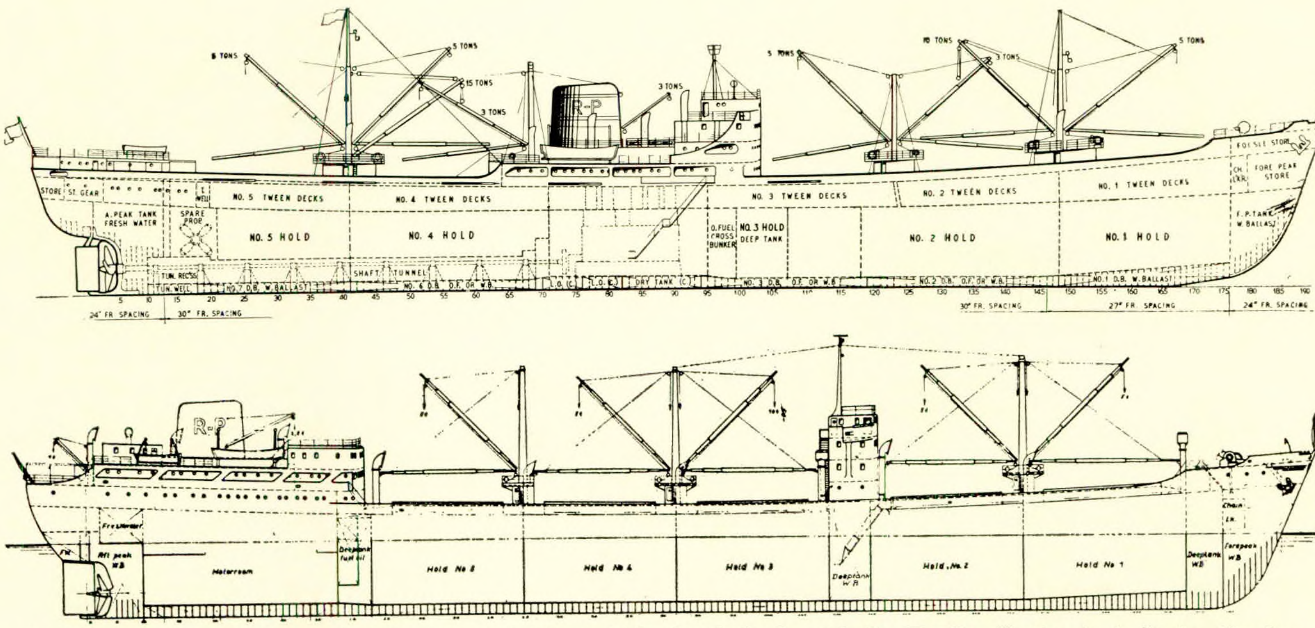
Two unusual and severe cases of shipbottom pitting were encountered within the space of a few years. Although the two incidents occurred in polluted harbours 3,000 miles apart, the vessels involved showed the same symptoms. These symptoms were rapid pitting, inactivation of the blackened antifouling paint and good electrical conductivity of the black surface film. The black conversion product, found only in the upper layer of the antifouling paint, was shorted to the steel hull. A study of the painting history of the vessels involved and of the conditions to which they were exposed in service indicated two common factors were present on ships that pitted. First, there was contact between the antifouling paint and the steel hull and secondly, there was exposure to sulphide forming waters. When one of these factors was missing, vessels exposed to the other condition did not show unusual pitting. Inasmuch as it is not possible to avoid anchoring in such waters for some periods, the only alternative is to avoid application of antifouling to bare steel. At the very least, this means that all touch-up painting at bare spots, etc., should be followed by a full coat of anticorrosive prior to the application of any full coat of antifouling. It also would seem advisable when sandblasting a bottom to "fleet" the vessel and fully paint the bilge and main keel block areas. It this cannot be done then steps should be taken to ensure that the application techniques used do not allow antifouling paint to be applied where there is no anticorrosive. This is just one more reason why the anticorrosive and the antifouling should be of different colour.—*R. P. Devoluy, Corrosion, January 1956; Vol. 12, pp. 33t-38t.*

Cargo Tramps for Norwegian Owners

An interesting contrast in modern tramp ship types is presented by two dry cargo vessels recently completed for a Norwegian shipowner, Bj. Ruud-Pedersen. In fact, the two ships that have been built represent the two types of dry cargo tonnage into which modern cargo tramps can be divided: one is a specialized bulk carrier, while the other is of the large and fast general purpose tramp type. The bulk carrier, the *Estello*, is of 12,500 tons deadweight, and is notable as the largest ship of its type yet built. Much larger ships have, of course, been built as ore carriers, but these are quite distinct from the general purpose bulk carrier such as the *Estello* which, although a single-deck ship, has sufficient cubic space to allow the carriage of such cargoes as grain or sugar as well as ores. The ship was designed for the owners by a Copenhagen naval architect, Knud E. Hansen. It is a self-trimmer, and the hatch trunks are designed to serve as feeders when grain is carried. With this cargo, too, specially designed removable divisions are used. The principal dimensions of the *Estello* are as follows:—

Length, o.a.	475ft. 0in.
Length, b.p.	440ft. 0in.
Breadth, moulded	62ft. 0in.
Depth, moulded	36ft. 3in.
Draught	27ft. 8in.

The *Estello* was built in Germany by Nordseewerke, Emden. The layout of the ship is typical of the modern bulk carrier, with the bridgehouse amidships and the machinery aft. In order to avoid restricting the hatch sizes on either side of the bridge structure, this latter is kept as short as possible: the accommodation for deck officers is aft, and only the minimum navigational requirements are provided amidships. The length occupied by hatches is considerable. Longitudinal framing is used for the deck and double bottom, with transverse framing for the sides, and the longitudinal strength is further augmented by making the hatch coamings continuous throughout the length of the cargo holds. Rounded gunwales are employed. There are five holds, two forward of the bridge and three



Profiles of the Espen *(top), built by Short Brothers, Ltd., Sunderland, and the* Estello *(bottom), built by Nordseewerke, Emden*

between the bridge and the after deckhouse, with a deep tank for water ballast under the bridge. The capacity of the holds is 590,000 cu. ft. The hatches are all 30ft. wide. One is 42ft. 9in. long, the remainder being 40ft. 8in. long. Eight 5-ton and two 10-ton derricks are carried on unstayed masts, and are served by electric winches. The main engine consists of a six-cylinder M.A.N. Diesel engine; it is a two-stroke engine, and has a bore of 700 mm. and stroke of 1,200 mm. It is designed to give 4,000 b.h.p. at 125 r.p.m. in service, and the speed of the vessel at full load is 12½ knots. The general purpose tramp is the *Espen,* and this vessel has been built in Great Britain by Short Brothers, Ltd., Sunderland. In general, the design of the *Espen* runs more along conventional lines than that of the *Estello.* The size of the ship does, however, represent a considerable advance on the war-built 10,000-ton closed shelterdecker, while its speed, which is about 14½ knots at full load is also an advance on earlier ships. The principal dimensions of the ship are given below:—

Length, b.p.	450ft. 0in.
Breadth, moulded	60ft. 9in.
Depth moulded to shelter deck	38ft. 8in.
Depth moulded to main deck ...	30ft. 2in.

The layout of the holds and other spaces is normal. The bridge and machinery are amidships, and there are three holds forward and two aft. No. 2 hold is a long hold extending part of the way beneath No. 3 'tweendeck, and No. 3 hold is a deep tank for cargo or water ballast. It is served by two hatches each 12ft. 6in. square. The total capacity (grain) of the holds is 600,855 cu. ft., of which the deep tank represents 31,400 cu. ft. The propelling machinery consists of a five-cylinder Harland-B. and W. Diesel engine built by John G. Kincaid and Co., Ltd. It is a two-stroke opposed-piston engine, with a cylinder diameter of 750 mm. and a combined stroke of 2,000 mm. It develops 5,500 b.h.p. at 110 r.p.m. to give a speed in service of about 14½ knots. The main engine is arranged to burn heavy fuel.—*The Shipping World, 21st December 1955; Vol. 133, pp. 582-583.*

Hull Vibration Investigation

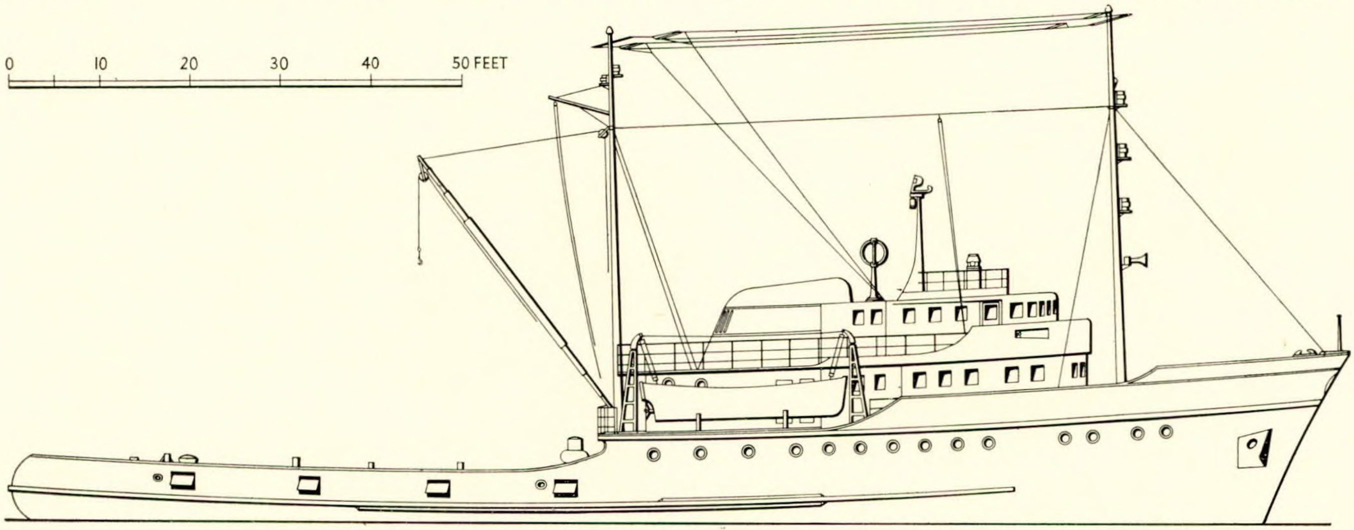
In recent years advances in computing techniques have made it possible to deal with the problem of vibrating hull both with analogue and digital computers, and to extend the range of calculations to modes for which graphical methods have not been successful. Instrumentation and testing techniques also have been developed which permit controlled excitation of the hull and accurate measurement of vibrations, up to frequencies well above the operating blade frequencies, including vertical, horizontal, and torsional vibrations, forced as well as resonant. The vibration tests on the *Gopher Mariner* reported in this paper were primarily set up to evaluate the accuracy of the available analytical methods and calculating procedures by comparison of calculated versus measured results. This comparison indicates the following: (*a*) The accuracy of calculations is limited by the uncertainty of the parameters used in the basic equations and by increasing departure of the ship from beam-like vibratory responses as the range of exciting frequencies is extended. (*b*) A definite start has been made in predicting non-resonant forced responses of hulls, and it would appear that in many instances precise estimates of the critical frequencies are not necessary for predicting the levels of service vibration. (*c*) There is reason to believe that improved accuracy in calculating horizontal and torsional modes only can be expected when these motions are treated as coupled. (*d*) The explanation of the common phenomenon of stern vibration at blade frequencies, with negligible vibrations elsewhere in the ship, appears to be possible on theoretical grounds and the concept of mechanical impedance in the stern appears to have practical application in predicting levels of hull vibration in the cases of frequent occurrence in which the operating blade frequency is above the range of frequencies of hull modes that can be appreciably excited.—*R. T. McGoldrick and V. L. Russo (S.N.A.M.E. paper, abstracted in Marine Engineering, February 1956; Vol. 61, p. 79).*

Advantages of Gas Turbine Plant

There is little question that a gas turbine installation is essentially a simple arrangement with the turbine, the compressor and the combustion chambers comparing with the boilers, turbines and main condenser and their associated equipment. In respect of compactness, for the foregoing reasons a simple gas turbine plant makes up the smallest and lightest installation for the production of useful power yet devised by the mind of man. As to efficiency, the gas turbine presently appears to be able to produce power on a competitive basis with other and older methods of power production. If the plant is made more complex indications are that the gas turbine may exceed present-day Diesel engine efficiencies. With regard to safety, with its almost instantaneous conversion of combustion products to mechanical work the gas turbine is free of the stored-up energy associated with the steam plant. It has been said that an express boiler up to pressure has the equivalent of 1 ton of T.N.T. of energy stored within its pressure parts. Considering design flexibility, there is a very wide range of types and configurations that can be used with the gas turbine. The range covers the simple gas turbine up to the free-piston gas turbine arrangement.—*Marine Engineering, February 1956; Vol. 61, p. 83.*

Tug with Electro-magnetic Slip Couplings

A multi-engined tug of 1,750 h.p. to be named *Barentsz Zee,* is at present under construction at the yard of L. Smit and Zoon, Kinderdijk, for L. Smit and Company's Internationale Sleepsdienst. The tug, which will have a length of 134ft. 6in. b.p., a moulded breadth of 30ft. 2in., and a depth of 15ft. 7in., will be commissioned before the end of the year. Propelling machinery will consist of four Deutz Diesel engines, two of the SA6M-428 type and two of type RA6M-428, driving the single propeller through Smit-Slikkerveer electromagnetic slip couplings, and a Lohmann and Stolterfoht reverse reduction gearing. A Kort nozzle will be fitted. An unusual feature of the installation is the fitting of generators between two of the main engines and the electromagnetic couplings for the supply of electric current to the ship's mains when the main engines are in operation. When manœuvring it will be possible to switch off one or two of the main engines from propulsion to drive the generators and thus render the installation of large auxiliary sets unnecessary. The *Barentsz Zee,* which will be built to the requirements of Lloyd's Register of Shipping, will be fitted with all modern salvage equipment including radar. Accommodation, although confined to a limited space, will be of a high standard and air-conditioning will enable the vessel to operate in all latitudes.—*Shipbuilding and Shipping Record, 9th February 1956; Vol. 87, p. 138.*



Waterline profile of the motor tug Barentsz Zee

Stability and Trim Computer

This paper describes a practical and inexpensive stability and trim computer, devised by the author, which is rugged in construction and extremely simple to operate. The computer, designed for one class of vessel, may be adapted to any other class by simply altering a set of hydrostatic curves. The device, by means of a simple integrator and a cam, simultaneously solves for trim and KG. In addition, the mean draught, displacement, and KM are registered for any condition of loading. The cross curves of stability for the proper displacement are automatically recorded. This is all accomplished by merely positioning two small wheels under consignments of cargoes pictured on a scaled cargo plan and turning a knob representing the weight of the cargo. The corrected statical stability curve may then be sketched on a slate on the upper surface of the computer. A triangular device corrects the stability curve for vertical and transverse shifts in G.—*Paper by C. R. Cushing, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, February 1956; Vol. 11, p. 50.*

Notable Ruston Diesel-engined Trawler

One of the most unusual trawlers yet constructed was commenced last month at the Chantiers de la Seine Maritime. She is to be named *Cap Fagnet III,* and is for the Societé des Pêcheries de Fécamp. The length overall is 245ft. 5in., or 224ft. 9in. b.p., with a moulded breadth of 37ft. 9in. and a maximum average draught of 17ft. 7in. The maximum draught astern is 19ft. 4in. The fish hold capacity is 1,240 cu. m. and 230 tons can be carried in the ballast tanks. The cod liver oil tanks have a capacity of 90 tons and the bunker tanks can hold 535 tons. There are three eight-cylinder Ruston engines, each of 750 b.h.p., running at 750 r.p.m., coupled to 510 kW 300-volt generators, which supply current to two propulsion motors of 950 b.h.p. They drive a single shaft through double reduction gearing. The speed of the trawler, fully loaded, with the machinery developing 1,280 b.h.p., will be 12·5 knots.—*The Motor Ship, February 1956; Vol. 36, p. 519.*

Preliminary Powering of Single Screw Merchant Ships

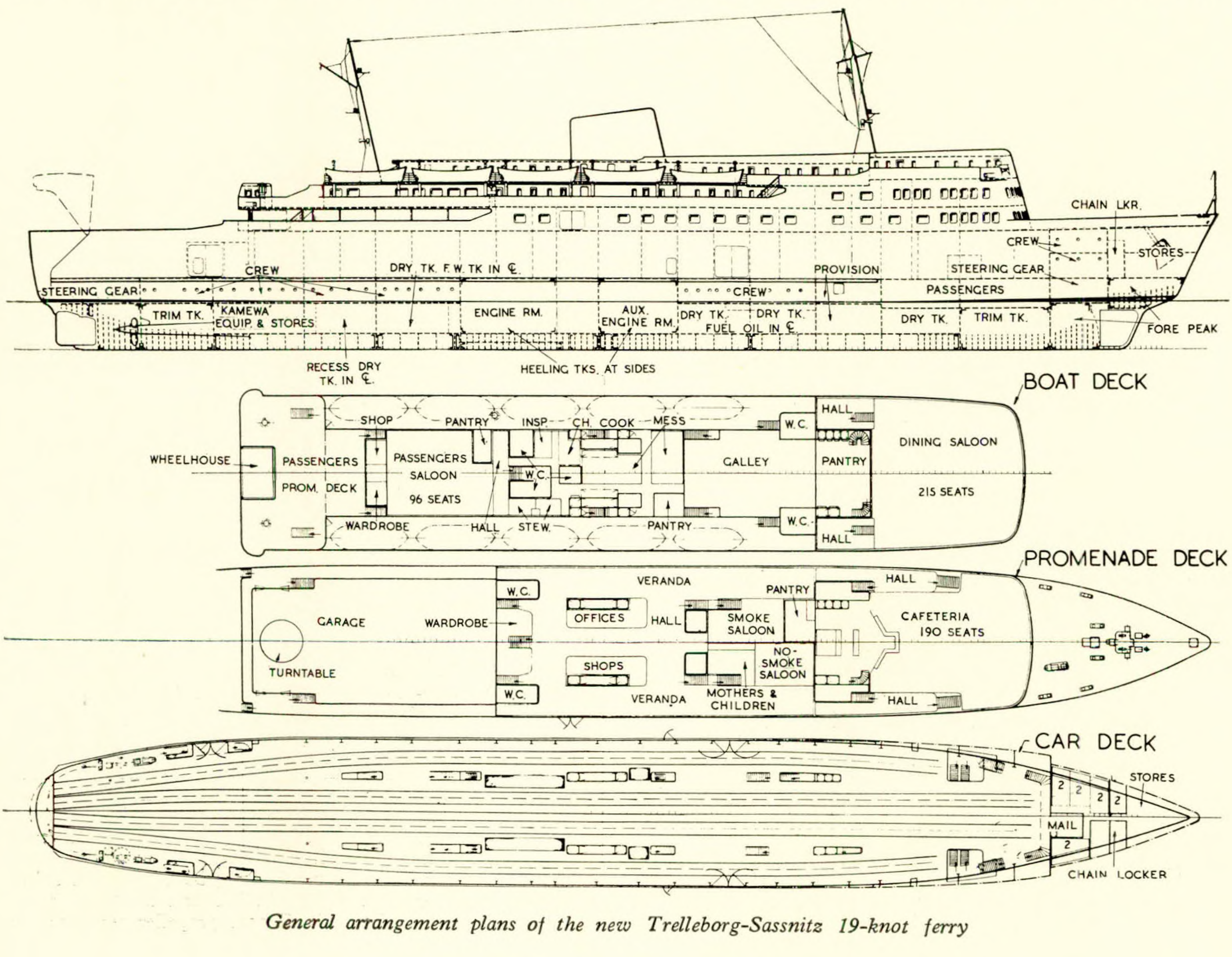
Present formulations for the definition of service and trial speeds of ocean going merchant ships are unrealistic and inconsistent when applied to recent systematic test results and analyses at present available in this country and abroad. A different approach to such formulation leads to simple relations between the main parameters of optimum hull forms and their resistance at the newly defined smooth water trial and sustained sea speeds that can be used for preliminary design as well as for a rapid gauging of merits of new designs. The estimation of the propulsion coefficient e.h.p./p.h.p. by existing methods presents certain difficulties with regard to a rather crude estimate of the thrust deduction coefficient in the preliminary design stage. A rational evaluation of this problem is proposed by the introduction of a new conception, the "substitute screw", which propels the hull under simplified hydrodynamic conditions. The characteristics of two principal kinds of substitute screw are investigated: (1) the propeller of optimum revolutions for given diameter, and (2) that of optimum diameter for given revolutions; both for given ship's speed and e.h.p. or shaft power. It is found that these characteristics as derived from the Troost propeller series are of surprisingly simple shape. By their expression in design formulas, the consultation of propeller charts for preliminary powering becomes redundant. The theory of the substitute screw helps to explain some hitherto rather obscure propulsion phenomena and enables the determination of the optimum value of the thrust deduction coefficient in terms of wake factor and advance coefficient and therewith a gauging of merits of propeller arrangements. It is finally shown how some of the results can be used for simplification of tug screw design with respect to maximum tow-rope force.—*Paper by L. Troost, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, February 1956; Vol. 11, p. 48.*

New Swedish Train Ferry

The Swedish State Railways have ordered from the Elsinore S.B. and E. Company one of the largest and highest powered train ferries yet to be constructed. The new vessel is for the Trelleborg-Sassnitz service and will have four rail tracks, the total length being about 400 metres, which will allow thirty-eight to forty wagons to be transported. This is believed to represent an additional capacity of 50 per cent compared with the largest Swedish ferry yet constructed. There is space available for fully loaded wagons carrying approximately 1,000 passengers, and in a separate garage motor cars will be accommodated. A stabilizer is to be fitted. The ferry will be 137 metres in length with a beam of 18·3 metres, and is to be equipped with two turbocharged Elsinore-B. and W. engines each of 5,000 i.h.p. They have eight cylinders, 500 mm. in diameter with a piston stroke of 900 mm. and are of standard type. Each drives a Kamewa variable pitch propeller, which is a new development for train ferries of such a size. The maximum speed will be 19 knots.—*The Motor Ship, February 1956; Vol. 36, p. 486.*

Fuel Oil Additives

It has been proved that combustion efficiency can be improved by the use of additives to the fuel oil, and a larger number of foreign shipowners are now profiting by the use of these products. Many of the troubles that appear in Diesel engines, particularly in those burning heavy fuel, can be traced to the fuel which today has a much higher sulphur content than it had a few years ago. This high sulphur content is, of course, contributable to cylinder liner corrosion. A compound of a number of chemical constituents, is being marketed by the Slip Product group of companies, London. These additives incorporate a combustion catalyst, an oil-soluble copper compound that becomes copper oxide on combustion, which ensures total utilization of the fuel, and therefore controls and minimizes carbon and similar deposits resulting from incomplete combustion. In addition they dissolve, by means of their aromatic solvent content, all the engine-clogging asphaltenes and gums formed by the combustion of heavy fuel oils. They also reduce engine and liner wear by neutralizing the effect of highly destructive sulphurous gases formed during combustion, and facilitate the use of the heavier, cheaper fuel oils. Some idea of the cost of using an additive may be obtained from the following figures. Taking, for example, an average mixing ratio of 1:2,000, the outlay for



General arrangement plans of the new Trelleborg-Sassnitz 19-knot ferry the additive necessary for a quantity of 5,000 tons of fuel oil would be about £625. This is representative of about 1 per cent of the cost of marine Diesel fuel and about 1½ per cent in the case of Bunker C. A good additive should have corrosion inhibiting properties, and this is again achieved by metallic soaps, together with lanolin and an organic phosphate. On combustion the metallic soaps form basic oxides which are deposited throughout the engine, thus inhibiting the effect of corrosive sulphurous gases and ensuring that the majority of them are passed out with the exhaust. The question is frequently raised whether it is possible to neutralize the sulphur content of the fuel oil by using an additive, and it must be understood that it is not possible to neutralize the sulphur, but its corrosive effect only can be overcome, which is, of course, an indirect action, not a direct one. By using a good and reliable additive, it is possible to inhibit the effect of the sulphurous gases and the life of the engine is thus prolonged, as also is that of the cylinder liners, and the time between overhauls increased. Not only are the corrosive effects of sulphur lessened, but the elemental carbon deposited is also reduced. All these metallic soaps have a multi-functional and synogistic effect, which means that they are more active together than when used individually and, as their action is accumulative, the longer they are employed, the better the result.—*The Shipping World, 11th January 1956; Vol. 134, pp. 43-44.*

World's Largest Tanker

What is believed to be the largest oil tanker yet to be launched in the world entered the water on 2nd December 1955. This vessel, the *Spyros Niarchos,* 47,750 tons d.w., was launched from the Barrow yard of Vickers-Armstrongs (Shipbuilders), Ltd. The *Spyros Niarchos* will be propelled by high-pressure, high-temperature steam turbines developing 20,000 s.h.p. This is the largest power ever to be employed for a single-screw merchant vessel. On completion the *Spyros Niarchos* will be employed carrying, as her normal trade, crude oil from the Persian Gulf to United Kingdom ports, and will be on charter to Shell. Her principal particulars are as follows:—

Length o.a., feet	757
Length b.p., feet	725
Breadth moulded, feet	97
Depth moulded, feet	52
Draught maximum, feet	37
Deadweight, tons	47,750
Maximum power, s.h.p.	20,000
Designed speed at 36 ft. draught, knots	17

The *Spyros Niarchos* is of welded construction throughout, with the exception of the riveted seams on the bottom shell, the top and bottom seams of the bilge strake, and the lower edge of the sheerstrake, the stringer angle, and two seams on the upper deck. Longitudinal framing is arranged, apart from the extreme forward end and in the machinery spaces where transverse framing is adopted. Twin longitudinal bulkheads are fitted and these, together with the transverse bulkheads dividing the cargo space into thirty-three tanks, are horizontally stiffened, with deep transverse and longitudinal webs. In the wing tanks between the shell and the longitudinal bulkhead, horizontal struts are arranged at each transverse web. With the exception of No. 6 port and starboard wing tanks, which are not fitted with piping, all thirty-three tanks will be used for oil cargo. The tanks are separated from the cargo hold and the oil fuel tanks forward by a cofferdam and a pump room, while a cofferdam, the oil cargo pump room and the oil fuel settling tanks separate the cargo tanks from the machinery space. Each cargo oil tank will be fitted with Colvin-Smith cast iron heating coils. The cargo pumping arrangements consist of four turbo-driven horizontal centrifugal pumps, each having a capacity of 1,000 tons of water per hour, and three steam-driven vertical stripping pumps, each of 150 tons per hour capacity. There are four 14-in. cargo pipelines fitted and two 10-in. direct filling connexions. A 6-in. ring main stripping line is arranged with branches to each tank. No. 11 port and starboard wing tanks are also arranged for the carriage of oil fuel if it is required. The vessel will be propelled by a single screw, driven by a set of geared turbines of Pametrada design, capable of developing a service power of 18,000 s.h.p. and a maximum power of 20,000 s.h.p. with propeller revolutions of 101·4 and 105 per minute respectively. The h.p. ahead turbine is of the impulse type and l.p. ahead turbine of the impulse-reaction double flow type. The h.p. astern turbine consists of a two-row impulse wheel carried on an integral extension at the forward end of the h.p. rotor with an entirely separate cast steel casing. The l.p. astern turbine comprises one two-row Curtis wheel. and one single-row wheel housed in a separate casing incorporated in the l.p. ahead turbine casing. Steam will be supplied by three watertube boilers of Foster Wheeler "D" type, with cast iron gilled economizers, at 600lb. per sq. in. pressure and 860 deg. F. temperature at the superheater outlet. The boilers will burn oil fuel under a system of forced draught. Suitable forced draught fans are to be fitted for this purpose, together with an automatic combustion control system. An air heater of the Weldex bled steam type is to be fitted to each boiler.—*The Shipping World, 14th December 1955; Vol. 133, p. 558.*

German Turbine-driven Trawlers

The Seebeck yard of the A.G. Weser have delivered the *Braunschweig,* the first of three ships for the Deutsche Heringsfischerei G.m.b.H., Cuxhaven, who are associated with the well-known "Nordsee" Deutsche Hochseefischerei A.G. The ship is basically of the Seebeck standard 1954/55 type with the following principal particulars:—

Length overall	203ft. 6in.
Length between perpendiculars...	184ft. 0in.
Extreme breadth	30ft. 0in.
Depth	16ft. 4in.
Draught	14ft. 2in.
Gross tonnage	653
Net tonnage	243
Volume of fish hold, cu. ft. ...	16,600
Fish capacity about, crans ...	5,000
Fuel capacity, tons	260
Speed, knots	13½

The *Braunschweig* is the first trawler to have true geared turbine machinery as opposed to a reciprocator-Bauer-Wach combination. A watertube boiler built by the A.G. Weser and having a heating surface of 1,720 sq. ft. delivers steam with stop valve conditions of 440lb. per sq. in., and 790 deg. F. Semi-automatic combustion on the Borger system is employed. The main turbine was provided by the Hamburger Turbinenfabrik of Nürnberg (formerly Brückner-Kanis of Dresden) and is of multi-stage all-impulse non-reversing type. The service output is 1,000 s.h.p. at 200 r.p.m., corresponding to 8,000 turbine r.p.m., and a maximum of 1,400 s.h.p. can be attained. A feature of the design is that the turbine casing is as symmetrical in cross-section as possible, steam being admitted to three nozzle groups through automatically-opened valves mounted in a separate steam chest alongside the turbine. The double reduction gearing was supplied by Wülfel of Hanover. The main thrust block is incorporated in the casing and an extension of the secondary shaft, which runs at 1,500 r.p.m., is taken to a 105 kW, 380-volt auxiliary alternator for ship's service. As the turbine is non-reversing, a variable pitch propeller by Escher Wyss of Ravensburg has been provided. The intention is to run the propeller at constant speed and to adjust the power by varying the pitch, the turbine being controlled by a sensitive speed governor. Bridge or engine room control can be chosen at will. The electrical installation is quite unusual for a ship of this type. Most of the auxiliary machinery is motor-driven from a 380-volt, three-phase, a.c. system. A combined generator/alternator set is driven by a geared turbine similar to, but smaller than, the main turbine. This set consists of a 155-kW Ward-Leonard variable voltage direct current generator for the trawl winch coupled in tandem with a 130-kVA alternator for ship's service. There is also a 92-kVA Diesel generator set (air cooled Deutz engine) and the 105-kW shaft-driven alternator already mentioned. A low pressure evaporator is provided for boiler make-up feed. The trawl winch has Ward-Leonard control and the two drums can each carry 1,000 fathoms of warp. The fish hold insulation is cased with light alloy sheeting and the refrigerating equipment is installed beneath the fo'c'sle. Electro-hydraulic steering by Atlas-Werke is of the trunk piston type. An A.E.G. control desk installed in the wheelhouse for electro-hydraulic control of the propeller pitch also incorporates a second steering position and all the supervisory instruments, so that the captain can take the operation of the ship into his own hands. Electrical remote control for a variable pitch propeller is a new development by A.E.G. Schiffbau and enables practically stepless variation to be made of the propeller pitch. Considerable economy in weight, space, and fuel consumption is expected with this installation, which will extend the limit of endurance to thirty-five days and enable the ships to operate as far afield as Greenland waters.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1955; Vol. 78, pp. 500-501.*

Aluminium Alloy in Auxiliary Equipment

The desirability of economy in upkeep and of the reduction of corrosion in oil tankers has led to various experiments to determine whether aluminium alloys can be successfully employed in such ships, with their arduous service of alternately carrying oil and salt water ballast. Satisfactory progress has been made, and much information has been gained from the practical experiments with ladders and other internal structures and fittings. The problem has, to a great extent, resolved itself into the provision of adequate safeguards to avoid the electrolytic corrosion associated with dissimilar metal combinations. The use of aluminium alloys for the heating coil pipes of tankers appears to have proved successful, not only from the point of view of reduction in weight—and the heating coils could be a considerable item—but in providing a high degree of heating efficiency and, what is perhaps more valuable, good resistance to corrosion; these coils are stated to outlast steel coils by a number of years. Light alloy engine room platforms, gratings, and ladder ways are also common. A number of patent forms of tread have been developed to give a sure foothold even under oily or wet conditions. Funnels and masts are designed for construction in light alloys almost as a matter of course in many classes of ship where stability is of prime importance, and especially where, as in passenger ships, these items are to be free from the unsightly result of corrosion. Hatch covers and hatch boards are increasingly being fabricated from welded and riveted light alloy sheet, possibly in the form of hollow stiffened structures with extrusions at the ends and sides. Complete hatch covers of normal variety and also of the patented movable type have been approved by the appropriate authorities, and are in service. Hatch boards in aluminium alloys are of particular value in vessels such as coasters and short sea colliers, where the hatches are frequently opened and closed. Their constant weight—possibly one-third of that of a wet wood board—make them quicker and easier to handle; this, and the freedom from splinters, also makes them less dangerous. Light alloys are also proving of advantage in oil tanker hatch covers.—*Paper by E. C. Goldsworthy, read at the Symposium on The Use and Welding of Aluminium in Shipbuilding on 8th December 1955.*

Arc Welding on Waterborne Vessels

Failure to ground properly the leads on arc welding machines when welding is being done on waterborne vessels will result in serious damage to the underwater body, shafting, and propellers by pitting and deterioration. Welding motor generator sets or rectifiers should be installed so that the welding and ground leads from shore to ship or from the repair ship to the ship alongside will be connected only to the vessel on which welding is to be done. The welding lead as well as the ground lead should be thoroughly insulated and at no time should be submerged in the water. Welding should be done on only one ship from one source of welding current. The ground lead should not be electrically connected to any object ashore or to the repair ship or other vessel except the one on which welding is being done. The ground cables should be secured by metal-to-metal contact to an integral part of the vessel on which the welding is done. It is completely safe to place the welding generator on the pier, or to have it installed permanently on a repair ship, provided both positive and negative welding cables to the ship are well insulated from ground and all other grounded structures, and that no welding cables are returned from the vessel to shore or adjacent vessels for welding in either location. Figs. 4, 5 and 6 illustrate incorrect methods for installing welding generators. Figs. 4 and 5 illustrate the condition when a welding generator, placed

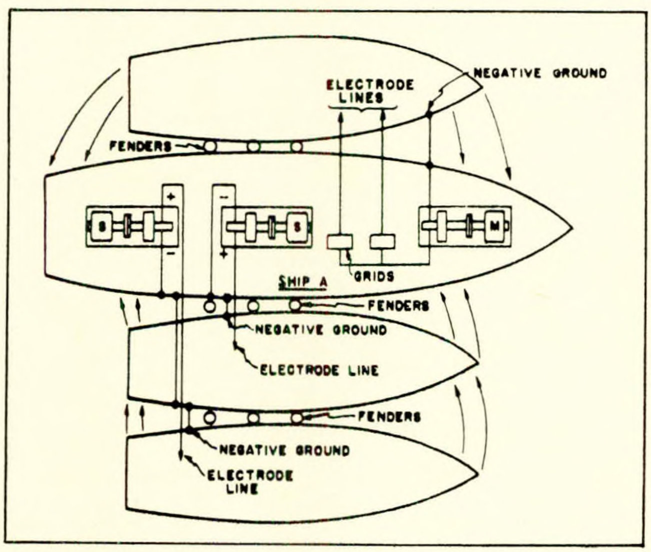


FIG. 4—*When generators on one ship, grounded to that ship, are used to weld on other ships, part of the welding current returns from those ships through the water to ship A*

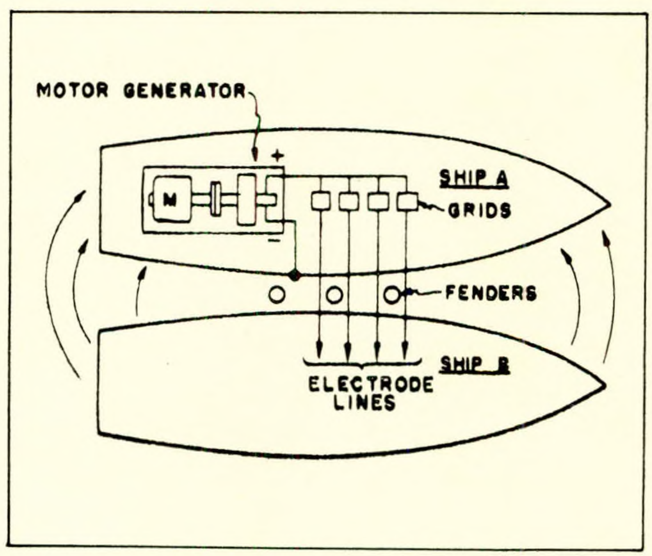


FIG. 5—*When a generator on one ship, grounded to that ship, is used to weld on another ship without a ground, all of the welding current returns from ship B to ship A through the water*

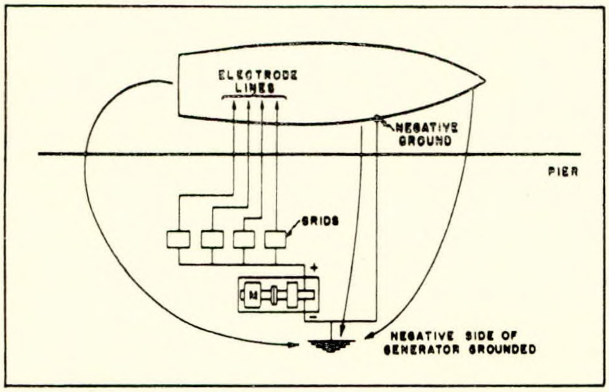


FIG. 6—*With negative side of welding generator grounded, part of the welding current flows from the ship's hull to the water and eventually reaches the negative side of the generator*

on a vessel with the negative cable grounded to that vessel, is used to weld on another vessel. This situation often occurs when a welding generator on a tender or repair ship is used to weld on another ship. The way to correct this situation is to insulate the negative cable of the generator from ship A and run both positive and negative leads to the ship where the welding is being done. Fig. 6 shows the condition when the negative side of the generator is grounded at the pier. This might occur if the negative leads are connected to crane tracks, pipelines, or submerged or buried structures, or if the negative cables are immersed in water at some points. If the positive side of the generator becomes grounded to the vessel, the situation would be considerably worse since the entire generator voltage would cause a continuous short circuit current to flow from the positive cable to the ship's hull.—*Bureau of Ships Journal, February 1956; Vol. 4, pp. 17-19.*

American-built Turbocharged Two-stroke Engine

The Cleveland Diesel Engine Division of General Motors has announced the introduction of a turbo-pressure charged two-stroke Vee-type Diesel engine designed particularly to meet the increased demands for greater horsepower in the marine and industrial markets. Known as Model 498, it is a uniflow scavenging design and has cylinder dimensions of 8¾in. bore by 10½in. stroke providing 175 b.h.p. per cylinder at 850 r.p.m. Four sizes of engine are available with six, eight, twelve and sixteen cylinders, and the table gives the main data relative to each. The normal operating speed range is 350 to 850 r.p.m., the piston speed at the latter being 1,488ft. per minute; the compression ratio is 13·2 to 1. Among the claims made for the new units is that they give, in comparison with a normally aspirated unit, 60 per cent more horsepower per cu. ft. of engine volume and the horsepower per lb. is increased by a similar amount.

Number of cylinders ...	6	8	12	16
Rated b.h.p. at 850 r.p.m. ...	1,050	1,400	2,100	2,800
B.M.E.P. at rated b.h.p. ...	129	129	129	129
Number of main bearings ...	4	5	7	9
Air intake volume (cu. ft. per min.) ...	4,300	5,700	8,200	10,700
Exhaust volume (cu. ft. per min.) ...	10,000	13,300	19,100	24,900

Fuel consumption at the rated speed is given as 0·36lb. per b.h.p. per hr., and 0·380lb. per b.h.p. per hr. as the maximum fuel consumption from 50 to 100 per cent of the horsepower range. Lubricating oil consumption is 0·02 gallons per hr. per cylinder, which is equivalent to more than 6,000 b.h.p.-hr. per gallon at the rated b.h.p. The engine main frame and crankcase is of welded construction, thoroughly stress relieved and shot peened to reduce stress concentrations.—*Gas and Oil Power, December 1955; Vol. 50, pp. 369-370; 372.*

Turbine Suction Dredger for Suez Canal

I.H.C. Holland, the group of six Dutch shipbuilders specializing in dredging equipment, have delivered from the Gusto shipyard (formerly A. F. Smulders), Schiedam, an interesting non-propelling craft to the Suez Canal Company. Modern and powerful equipment is now vitally necessary to meet the new deepening programme now being carried out and to counter the 2 to 16in. annual fill-in due to sandstorms in the vicinity. The new vessel, *Louis Perrier,* has been designed to maintain a depth of up to 46 feet, but can be adapted to dredge down to 60 feet should this ever become necessary. The dredger must be in operation night and day without interruption and a crew of sixty-five men is provided for. Consequently, spacious accommodation has been provided on two continuous upper decks. Vessels pass through the Suez Canal in two convoys in both directions every twenty-four hours. The dredger, which will be working in the middle of the Canal, will therefore have to interrupt dredging operations while the vessels pass, and must be quickly moored at the bank of the Canal, together with the floating delivery pipeline. This requires special berthing arrangement both for the dredger and for the long floating pipeline. The *Louis Perrier* is 197 feet long, 44 feet in breadth and 13 feet deep. As mentioned above, she is non-propelling but nevertheless she has a powerful machinery installation, the dredge pump being driven through double reduction gearing by a steam turbine and the cutter head by an 500 h.p. W.L. motor supplied by a separate turbo alternator set. Steam is generated at 440lb. per sq. in., in three Verschure-Foster Wheeler boilers operating with automatic firing. Both the turbines are of Stork manufacture and are of impulse design. The turbine for driving the pump is of eight-stage type, developing a maximum of 3,000 h.p. at 3,750 r.p.m. This turbine takes steam at 400lb. per sq. in. and 700 deg. F. and exhausts to a condenser which also serves the other turbine. An overload of 3,300 h.p. can be carried and this output can be obtained over a speed range from 3,375 up to 4,500 r.p.m., corresponding to 225 to 300 r.p.m. of the pump shaft. The turbo alternator set is also eight-stage type, having an output of 1,050 h.p. at 6,000 r.p.m., this being reduced to 1,000 r.p.m. at the alternator.—*The Marine Engineer and Naval Architect, Annual Steam Number, 1955; Vol. 78, p. 495.*

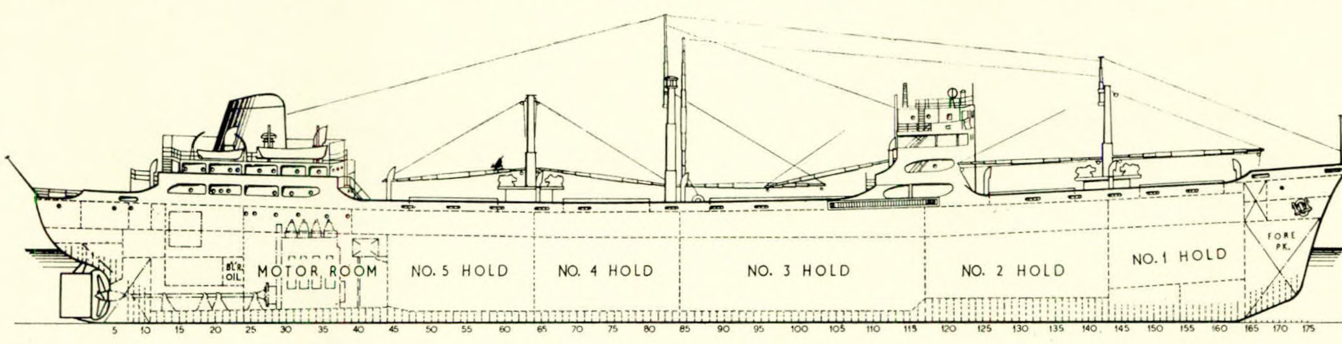
Current Practices and Future Trends in Marine Propulsion

The paper is divided into five sections. The first section is historical in nature and describes the marine propulsion gear as it developed with the first steam engines, which were so slow as to require speed increaser gears, to the modern gears driven by turbines and Diesels. The second section is a brief description of the steps in manufacturing gears and pinions and the special machinery used in their manufacture. Pictures of hobbing and shaving operations are included. The third section describes current types of reduction gears, including single reduction and simple, nested, and locked train types of double reduction units. Various details, including lubrication and bearings, are discussed. Details of articulated drives are introduced and reasons for their use presented. Use of the K factor and typical values are given. There is also a description of special gear problems. The fourth part of the paper describes the methods of calculating allowable tooth loads, which determine the size of the gear elements. Early design factors are shown and the development of the modern K factor from the basic Hertz equations for surface compressive stress is indicated. This K factor is universally used in the United States for the establishment of gear size. It is shown that the *K* factor is a criterion for pitting failures in spur gears and an approximate one for pitting failures in helical gears. Two other types of failures, fatigue and scoring, are described. It is shown that, as gear materials are made harder, and tooth loads become greater, the tendency toward pitting failures is reduced but that fatigue failures become more probable. Scoring is a lubrication failure which can be avoided by proper design and lubricants. The fifth part is a quick look into the future. Gears of the future will operate at about present-day speeds but will transmit more horsepower while being smaller and lighter. Gear elements will be more highly loaded, material will be harder, probably case hardened.—*Paper by R. J. Hoard, R. C. Ferguson and F. N. Lamoreux, abstracted in Bulletin, The Society of Naval Architects and Marine Engineers, February 1956; Vol. 11, p. 54.*

British Ore Carrier

The first of a series of four ore carriers of 14,300 tons deadweight built by Lithgows, Ltd., for the St. Andrews Shipping Co., Ltd., has now entered service. This vessel, the *Dunadd,* completed her sea trials shortly after Christmas and left for Wabana, Newfoundland, on her maiden voyage to load iron ore for carriage to the United Kingdom. The *Dunadd* was launched on 7th October 1955. The *Dunadd* has been largely developed from the ore carriers *Gleddoch* and *Ormsary,* which were built for the purpose of carrying into Port Talbot as much cargo as possible. Experience gained from the *Gleddoch* and *Ormsary* showed that, from a navigational point of view and in practical working, it was better to have the navigation bridge amidships. In any case it has not proved any handicap to the shore appliances when discharging the vessels' cargo, and consequently the same position was used for siting the bridge on the *Dunadd.* With the bridge located amidships, bunker tanks are more easily arranged so that as the fuel on board is used the ship rises bodily, which is very important when sailing and arriving on port limits of draught, and there is, of course, the advantage of stowage beneath the bridge for the sliding hatches from Nos. 2 and 3 holds. An interesting feature of the *Dunadd* is the tunnel running fore and aft in the 'tweendeck which not only carries all the pipes normally laid on deck, but also gives covered access in heavy weather. Although by no means an unusual arrangement in the larger ore carriers, this is a useful adjunct to this type of vessel and one which could also be used in oil tankers, as it dispenses with the catwalk. The principal particulars of the *Dunadd* are as follows:—

Length, o.a.	505ft. 1in.
Length, b.p.	480ft. 0in.
Breadth, moulded	68ft. 9in.
Depth, moulded	36ft. 3in.
Draught on summer freeboard...	27ft. 6in.
Deadweight, tons...	14,300
Gross tonnage	10,682
Engine output, b.h.p.	4,500
Speed, knots	12



Ore carrier Dunadd

The *Dunadd* is powered by a Rowan-Doxford engine having four cylinders of 670 mm. bore and 2,320 mm. stroke, and developing 4,500 b.h.p. in service. This is understood to be the first diaphragm-type Doxford engine with oil-cooled lower pistons to be built by David Rowan and Co., Ltd. The lower piston coolant pump has a capacity of 79 tons per hour. A pump of similar capacity is installed as standby for either the main engine driven lubricating oil pump or the lower piston cooling oil pump. The propeller is of solid bronze having four blades cast with the boss and supplied by Bulls Metal and Melloid, Ltd. Electricity for power and lighting is supplied by two W. H. Allen steam driven generator sets of 80 kW 220-volts output, and one Ruston and Hornsby Diesel driven set of the same output. A 6-cylinder Lister emergency generator set of 25 kW output and having a clutch-coupled Megator fire pump is located in the steering gear compartment. Two horizontal multitubular type Scotch boilers, 15ft. diameter and 12ft. long, each with a heating surface of about 5,800 sq. ft., supply steam at a working pressure of 150lb. per sq. in. for the auxiliaries. The boilers are arranged for oil burning with cold forced draught. One boiler is also arranged to use in the two wing furnaces the exhaust gases from the main engine for raising steam when the ship is at sea.—*The Shipping World, 8th February 1956; Vol. 134, pp. 176-179.*

Polysulphide Synthetic Rubber

Protection of underwater surfaces of naval vessels has been a problem for years. This problem is aggravated by increases in speed. As the speed of the ship increases, the tendency toward cavitation damage also increases. The deterioration of underwater surfaces stems from a combination of electrolytic action of various metals in sea water and the mechanical phenomenon of "cavitation" or pitting. Various types of coatings are in use to protect underwater surfaces. Most of the promising types of coatings involve synthetic rubber. One of the earliest of elastomer coatings is a polysulphide synthetic rubber coating that comes in powder form. It is applied to underwater surfaces while the ship is in drydock by means of a flamespray technique that resembles gas welding. The flamespray technique was first used to apply metal powders, and in 1938 it was adapted for use with organic materials such as polysulphide synthetic rubbers. The newer types of polysulphide coatings are rubber-like and quite flexible. The main advantage of polysulphide is the tenacity with which it adheres to metals, even when they are subjected to severe cavitating conditions. A new technique recently developed uses special neoprene cements and tie gums applied to the metal surface. This process is followed by the application of thin sheets of vulcanized neoprene by means of the so-called cold bond method. The cement is allowed to dry until most of the solvent is removed, and then a thin sheet of neoprene rubber is applied, followed by a second and third layer of sheet neoprene. The unique feature about the process is the excellent adhesion obtained almost instantaneously. This process has been used satisfactorily as shaft covering. The cold bond method has been suggested for coating a number of other underwater surfaces. Satisfactory application on struts and on rudders of slow moving ships has been made; but no successful applications have been made to date on rudders of high-speed vessels or in coating the surfaces of high-speed propellers. Numerous other types of coatings have been used experimentally on underwater surfaces, but tests have not progressed sufficiently to warrant their use in regular installations.—*T. A. Werkenthin, Bureau of Ships Journal, February 1956; Vol. 4, pp. 13-15.*

Shipbuilding in Yugoslavia

In view of the orders that have been placed by London and other owners for sea going motor ships in Yugoslavia, it is of interest to record the development of the shipbuilding in the country. The three most important shipyards on the Yugoslav Adriatic coast are the 3 Maj, Split and Uljanik. The first mentioned is the largest, being situated at Rijeka, the most important Yugoslav centre of maritime trade. The growth of the shipyard may be indicated by the increase in the amount of finished steel used. In 1955, this totalled 18,000 tons, compared with approximately 7,000 tons in 1950. In 1955, welding equipment was installed in the yard on a substantial scale, and prefabrication was adopted. An agreement was entered into with Sulzer Bros. to purchase a licence for the construction of Sulzer engines. The yard has five slipways and can build ships up to 180 metres in length and 18,000 tons d.w., also steam and motor tankers up to 24,000 tons d.w. The Split shipyard is favourably situated and in 1948 a modern yard was established on the site of the existing yard. It is now practically completed. It covers an area of 385,000 sq. metres and is suitable for building ships up to 18,000 tons d.w. There are six building berths. A floating crane and a 7,000-ton floating dock are included in the equipment of the yard. About 3,000 workers are employed. At the Uljanik shipyard at Pula, 2,500 men are employed. There are three slipways, two graving docks and one dry dock. The yard is designed to build all types of ships up to 550ft. in length or 15,000 tons d.w. and tankers up to 20,000 tons d.w. Burmeister and Wain Diesel engines are now being manufactured under licence.—*The Motor Ship, February 1956; Vol. 36, p. 520.*

Canadian-built Passenger and Car Ferry

The Diesel-electric ferry *William Carson,* which commenced service during last summer between North Sydney, Nova Scotia, and Port-aux-Basques, Newfoundland, incorporates a number of features not usually fitted together in one vessel. The ship, for example, is strengthened for ice-breaking, has special arrangements for handling container cargoes, is fitted with Denny Brown stabilizers, and is provided with a bow propeller in addition to the normal twin screws aft. Built by Canadian Vickers, Ltd., Montreal, to the order of the Federal Department of Transport, the *William Carson* will be operated on her 93½-mile passage across the Cabot Strait by Canadian National Railways. She was built to the requirements of Lloyd's Register of Shipping and to the latest international regulations for an ocean going passenger vessel. The principal particulars are: —

Length, o.a.	350ft. 10in.
Length, b.p.	325ft. 0in.
Breadth	68ft. 0in.
Depth to upper deck	34ft. 9in.
Draught	19ft. 3in.
Gross tonnage	8,300
Number of passengers	262
Service speed, knots	15

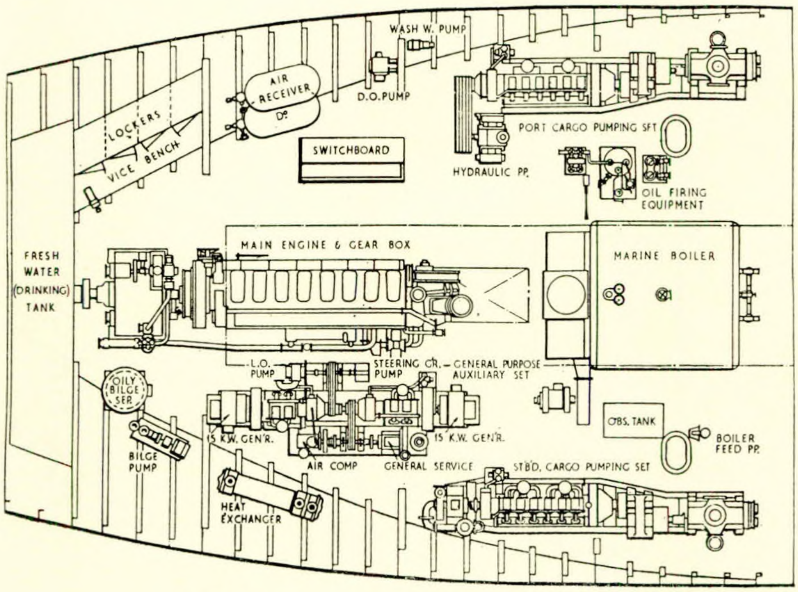
Designed for rapid loading and discharge of cargo, a modern system has been devised which incorporates arrangements at each of the terminal ports and on board the ship itself. Cargo is loaded into large containers prior to the ship's arrival in port and these containers are then towed into the vessel's freight deck through large ship's side doors. The main deck is largely occupied by the space required for stowage of these containers, while at the forward end of this deck 5,000 cu. ft. of refrigerated space is provided for frozen meat and fish cargoes. In addition, a cool space of 7,500 cu. ft. capacity has been fitted with sufficiently large access doors to permit the stowage of containers with perishable cargo. On the upper deck, stowage for motor cars, trucks and buses has been arranged. The main propelling machinery consists of a Diesel-electric system, driving twin propellers aft and a bow propeller which is employed during ice-breaking operations and while manœuvring. Three Canadian-Westinghouse propulsion motors are supplied, and are driven by six 1,375-kW, 925v. d.c. generators. Each after propulsion motor, of 5,000 s.h.p., 900v. d.c., operates at 170 r.p.m., and ensures the vessel's service speed of 15 knots with the bow propeller idling. When the forward propeller is in operation, the total power available is divided equally over the three propulsion motors, and thus the forward propulsion motor is designed to produce 3,330 s.h.p. at 900v. The Canadian Fairbanks-Morse propulsion generators are driven by six 12-cylinder opposed-piston oil engines, each rated at 2,000 b.h.p. at 750 r.p.m. These generating sets are arranged in one engine room in groups of two. The lubricating oil cooler, fresh water, heat exchanger, lubricating oil duplex strainer and bypass type lubricating oil filter for each machine are conveniently located nearby. Each Diesel engine drives a lubricating oil pump, a sea water pump and a fresh water pump, and one motor driven standby pump for each of these duties is also installed. The engine crankcases are of explosion proof design. As they can contain an explosion, no spring doors are fitted, thus making for a safer engine room. The temperature of the fresh water circulating in the engine jackets is thermostatically controlled and sub-cooled fresh water is used to cool the lubricating oil. The two after propulsion motors are separately excited and are capable of absorbing full power down to 136 r.p.m. and the torque can increase gradually as the r.p.m. drop to a maximum of 200 per cent at stalling point. Cooling is effected by an enclosed circulating air system, sea water being used to cool the air. All shafting is of forged steel and the propellers are of the four-bladed built-up type, material to D.O.T. specification for ice-breaking. The ship's service distribution system is 440v. 3-phase, 60-cycle alternating current, three-wire for power circuits and 115v., single-phase for lighting circuits.—*Shipbuilding and Shipping Record, 29th December 1955; Vol. 85, pp. 839-841.*

Tanker for Coastal Service

A coastal tanker, specially designed for bunkering the *Queen Elizabeth,* the *Queen Mary,* and other large liners arriving at Southampton Water, has been delivered to the Esso Petroleum Co., Ltd. This vessel, the *Esso Poole,* was launched from the Hessle shipyard of Richard Dunston, Ltd., in June 1955. A feature of the tanker is the high discharge rate of her cargo pumps which enables her to discharge a full cargo in about two hours. The cargo is carried in eight tanks, each of about the same capacity, and while the vessel is operating within the estuarial limits of Southampton she will be able to carry about 1,170 tons of fuel oil. Two cargo pumps, each having a capacity of 265 tons per hour, are installed in the engine room. The propelling machinery, an eight-cylinder Diesel engine, has been supplied by the English Electric Co., Ltd. The *Esso Poole* is one of the largest vessels to be built on the Humber. Her principal particulars are as follows: —

Length, o.a.	196ft. 0in.
Length, b.p.	185ft. 0in.
Breadth, moulded	33ft. 0in.
Depth, moulded	13ft. 6in.
Deadweight, tons	1,070
Gross tonnage	754
Draught, summer	11ft. 10in.
Speed in service, knots	9
Cargo capacity	46,230 cu. ft.

The *Esso Poole* is of all-welded construction and has been built in prefabricated sections, with a soft-nosed clipper stem and a cruiser stern. Sub-division is by one watertight and six oiltight bulkheads forming forepeak, cargo tanks, cross bunker, engine room and afterpeak water ballast tanks. Reserve feed water and wash water tanks are arranged in the double bottom in way of the engine room. The hydraulic deck machinery is of the Hyland type supplied by Vickers-Armstrongs (Engineers), Ltd., and comprises a windlass fitted with two cable lifters and warping drums, arranged on the forecastle deck, and a winch on the main deck, aft of the steel foremast, fitted with one 2-ton tubular steel derrick, and a capstan on the poop deck aft. Two steel lifeboats are stowed on the poop deck aft of the funnel in Schat mechanical davits the port lifeboat being equipped with a Diesel engine. The steering gear is also of the Hyland hydraulic type. The propelling machinery supplied by the English Electric Co., Ltd., consists of an eight-cylinder turbocharged Diesel engine, type 8SRKM developing 900 b.h.p. at 750 r.p.m., fitted with a 3:1 oil operated reverse reduction gearbox manufactured by Modern Wheel Drive, Ltd. The auxiliary machinery comprises a general purpose auxiliary set driven by two McLaren Diesels each flexibly coupled to a 15-kW 110-volt d.c. generator supplied by Hopkinson Electric Co., Ltd. It will be seen from the accompanying drawing that the engines are inter-connected and so arranged that either engine may drive the steering gear pump, standby lubricating oil pump, air compressor and general service pump.—*The Shipping World, 18th January 1956; Vol. 124, pp. 113-115.*



Machinery arrangement of the Esso Poole

Axial-flow Fan Applications

A company in Scotland has developed a new quick-freezer, to be built into fishing vessels. This allows the vessel to embark upon a long cruise without the necessity of frequent returns to port to discharge small catches while they are still fresh. The prototype unit was fitted in the fishing vessel *Fairtry.* It is a combined air-blast and contact freezer, the fish being frozen both by contact with the shelves, which are cooling elements, and by cold air recirculated at high velocity through the chamber by a 30in. contra-rotating axial-flow fan. The air speed is maintained at 40ft. per sec. through the freezer at a temperature of minus 40 deg. F., or 72 degrees of frost. The importance of fan efficiency will readily be understood. Any loss of efficiency would mean greater power consumption, higher heat input and therefore a greater load on the refrigeration machinery. Space conservation also is of utmost importance in a refrigerated chamber, especially in a ship. The choice of an axial-flow fan for this application was rather obvious. Ease of maintenance being important in a ship, special fan casings are now available to allow maximum accessibility of the motor and impeller. A more general marine application is that of supplying air to engine rooms.—*R. C. Dick, Journal of the Junior Institution of Engineers, March 1956; Vol. 66, Part 6, pp. 213-232.*

Ship Vibration Induced by Twin Propellers

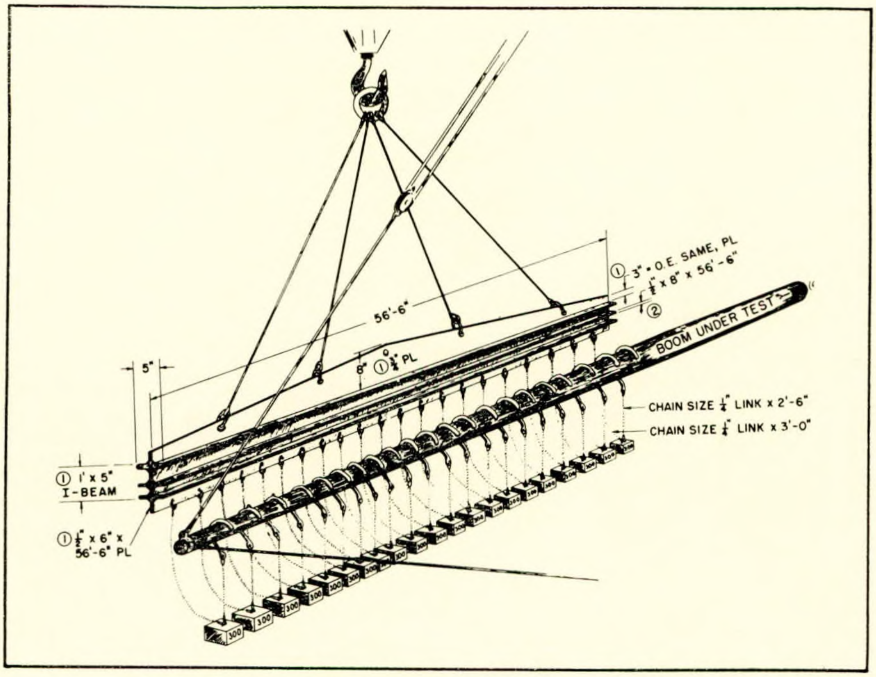
The character of vibration in fast turbine-driven ships depends partly on the magnitude and frequency of the forces imposed upon it by the propellers according to their geometry and location; and partly upon the elastic properties of the hull structure. These two aspects are discussed with particular reference to the author's experience in twin screw warships. The forces exciting vibration are believed to be predominantly hull pressure forces in the vertical direction and mixed forces in the athwartships direction. Some preliminary theoretical and experimental results are given with regard to the magnitude of the pressure forces. The response of the hull to such forces is discussed in the light of a vibration generator survey of a destroyer in harbour and calculations of the first five natural frequencies of vertical flexural vibration.—*Paper by J. W. Ramsay, read at a metting of The Institution of Naval Architects, on 22nd March 1956.*

Victory Model Tests

The Victory ship model tests carried out at the Netherlands Ship Model Basin have been supplemented by a series of similar tests at the National Physical Laboratory. The combined results have been analysed in relation to assumed viscous formulations and the tank boundary interference effects required to provide a balance have been deduced. It is shown that the interference effects which correspond to the viscous formulation proposed by the author from earlier work are consistent and reasonable, but further work of a similar kind is required to enable the viscous and interference effects to be separated out more accurately.—*Paper by G. Hughes, read at a meeting of The Institution of Naval Architects, on 21st March 1956.*

Test Equipment for Boat Booms

Use of a strongback for testing boat booms has been



Weights are held by strongback if the boom fails

suggested. The new testing equipment is shown in the accompanying figure. The weights are attached to a strongback by a chain and shackle. Each weight also has a second chain with a hook attached. The hooks are placed on the boat boom to be tested and the strong back is lowered until the weights are transferred to the boom. If the boom should fail under the test, the weights will fall only a short distance before they are suspended again from the strongback.—*Bureau of Ships Journal, March 1956; Vol. 4, p. 42.*

Still and Filter Unit for Reclaiming Used Oils

An interesting Still and Filter Unit for reclaiming used lubricating oil has just been completed for a foreign navy by Lubex Oil Refiners. This plant has been designed to re-refine 200 gallons of used oil per eight hours and at the same time to extract Diesel fuel diluent. It is claimed that when used at this rate it will repay its cost in less than a year, and that the re-refined oil will be physically and chemically equal to new. A plant used for more than eight hours per day would very quickly repay its initial cost. The plant has four distinct processes. (1) The used oil is fed by means of a positive-type pump (which can handle oil containing abrasive material) through a plate and frame filter press having a large filtering area and utilizing porous mats which are faced with disposable filter papers. (2) The clear filtered oil is now preheated, first in the steam heater and then in an electric heater and passed into the vacuum distillation column in which the volatile or diluent material is flashed over and removed. The oil is stripped of all traces of this material by passage over a number of distillation plates and finally passes into a vacuum vessel. (3) As soon as a small quantity of oil has accumulated in the vacuum vessel, a measured quantity of Fullers Earth is added through a vacuum trap, and an electrically operated stirrer is started. When the vacuum vessel is nearly full, the pump is stopped, but the stirrer continues to run for a period. (4) The filter press is meantime cleaned and made ready for further operation. The valves are changed over so that the pump will draw the treated oil with Fullers Earth in suspension from the vacuum vessel (which has now been vented to atmosphere). The pump is now started and passes the oil for its final filtration and removal of the Fullers Earth with absorbed gums, etc. The fully purified oil then passes direct to storage and requires only further small quantities of additives to ensure it having similar properties to the original unused oil. The unit requires only the part-time services of a man and is economical in steam and electric power consumption. Steam consumption is normally 150/200lb. per hr. with an increased consumption for a short while during starting up. Electrical consumption is 22 kVA for the initial part of the cycle, and thereafter only 1-2 kVA. The vacuum vessel is of welded steel construction, with a capacity of 250 gallons. The complete unit is of the "package" type, being complete on its own bedplate and requiring the minimum of installation. The main heat exchanger is arranged for alternative heating or cooling of the oil after filtration. It is of the extended surface type, utilizing a copper tube presenting a very large surface on the oil side to compensate for the relatively poor heat transfer on the water side. It consists of a number of horizontal members connected in series and each containing one extended surface tube. The vacuum distillation column is of welded construction and fitted with six high efficiency distillation plates of a special combined bubble cap and perforated type which permits a high throughput rate with maximum stability. The top section of the column comprises a centrifugal separator and flash chamber and is mounted on the vacuum vessel.—*Scientific Lubrication, December 1955; Vol. 7, pp. 31-32.*

Patent Specifications

Free-Piston Generator for Jet Propulsion

A liquid jet propulsion plant, according to the invention, comprises a free-piston gas generator, an injector to impel the liquid jet with a gaseous fluid and a pipe to supply the injector with gas tapped from the combustion gas outlet and with the scavenging air which escapes from the free-piston gas generator. As will be seen in the accompanying illustration, the air drawn

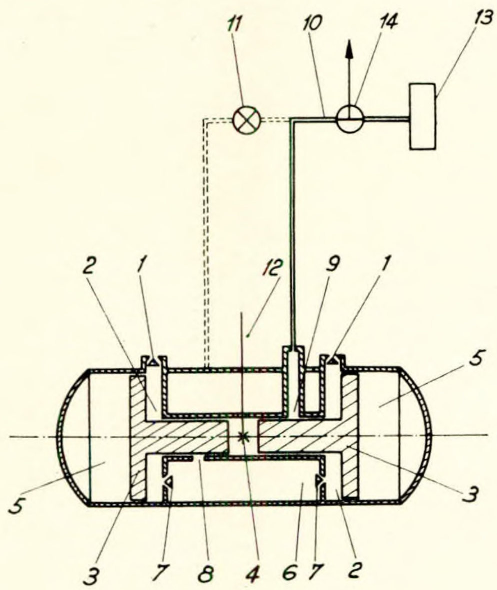


FIG. 1

in at atmospheric pressure through the valves (1) fills the chambers (2) on the inner side of the pistons (3). In the course of this suction stroke, which corresponds to the expansion of the combustion gases in chamber (4), the cushion of gas in the closed chambers (5) is compressed, whereafter it expands again, so that the pistons (3) are caused to compress the air previously drawn into the chamber (2) and force it through the valves (7) into the chamber (6). The air present in cylinder (4) is carburetted by a fuel-injecting device represented diagrammatically by a spraying nozzle (12). The compressed combustible mixture thus obtained in chamber (4) is ignited, then expanded. Towards the end of the expansion stroke the orifices (8, 9) are uncovered, and the air stored under a pressure in chamber (6) provides for the scavenging of the cylinder (4), and some of it will remain in it thereafter, upon which the cycle of operation is repeated. The combustion gases and the scavenging air escape through a pipe (10) through which the device (13) for the injection of the gases is supplied; the desired propulsion pressure is obtained by suitably dimensioning the injection device. A release-and-control valve (14) may be provided in the pipe (10), particularly with a view to make starting easier.—*British Patent No. 747,423, issued to Compagnie Electro-Mecanique. Complete specification published 4th April 1956.*

Reversing B. and W. Two-stroke Engines

A simplified arrangement of cams used for the fuel pumps and exhaust valves of two-stroke engines, is shown in Fig. 4. The fuel pump cam (2) and the exhaust valve cam (3) of each cylinder are keyed on the control shaft (1). The highest part of the exhaust valve cam is conventional, but the upper part (8) of the fuel pump cam is formed by an inactive circular portion which keeps the cam follower (5) stationary in its uppermost position during about two-thirds of a revolution of the control shaft. The chain wheel (9) is loose on the control shaft (1) and is driven from the crankshaft. Blocks (11) slide in radial slots (10) and each block is mounted on the end of a crank (12) keyed on the control shaft. Each of the journals (13) carries a planet wheel (14) engaging a sun wheel (15). A sleeve on the control shaft (1) carries a notched

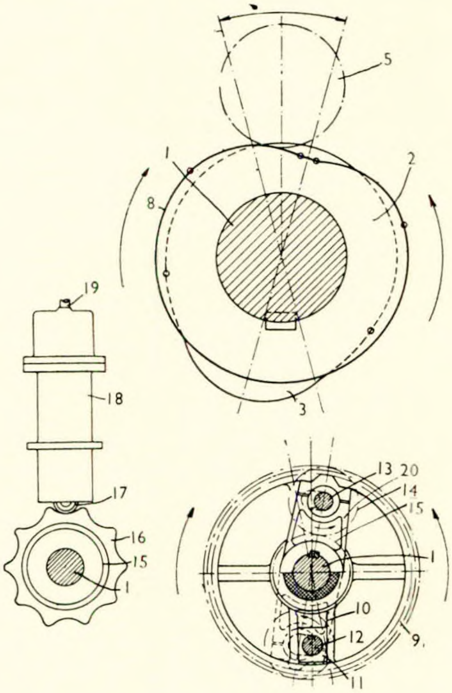


FIG. 4

wheel (16) arrested against rotation by a roller (17), which is pressed into the grooves by compressed air supplied to a cylinder (18) through a pipe (19). When it is required to run the engine astern, for example, starting air is supplied in the normal manner and the chain wheel (9) begins to turn in the reverse direction. The notched wheel (16) is prevented from turning by the roller (17) and the planet wheel (14) roll on the stationary sun wheel (15). Thereby the cranks (12) turn, causing an angular change between the chain wheel (9) and the arms (20) and, therefore, between the control shaft and the crankshaft. When this angular change has been completed, the cylinder (18) is vented and the roller (17) releases the notched wheel (16). The fuel supply to the engine is resumed and the unit continues to run in the new direction of rotation. —*(British Patent No. 734,398. Ove Petersen and Mads Lindberg-Nielsen, Burmeister and Wain, Copenhagen.) The Motor Ship, March-April-May 1956; Vol. 37, p. 49.*

Slack and Parr Variable-pitch Propeller Control

A form of variable-pitch propeller control gear intended to occupy a minimum amount of space in the engine room is illustrated in Fig. 1. The propeller shaft is coupled to the

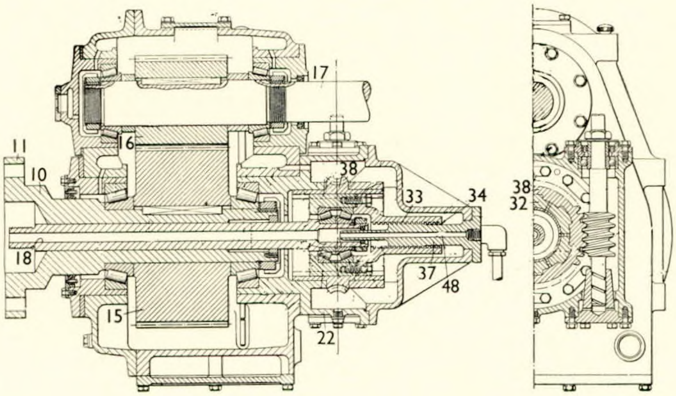


FIG. 1

flange (11) of a reduction gearwheel (15) and the pinion (16) is driven from the main engine shaft (17). When the bearing housing (32) and the nut (33) are rotated within the control gear casing (22), translatory movement, relative to the propeller shaft (10), is imparted to the housing (32) by the screw (34). This movement slides the control rod (18) which alters the pitch of the blades. The bearing housing and nut are turned by a wormwheel (38). Oil is fed to the propeller through a hole (48) in the screw (37).—*(British Patent No. 737,097. Slack and Parr (Marine), Ltd., Kegworth, Derby.) The Motor Ship, March-April-May 1956; Vol. 37, p. 49.*

Improved Hull Construction

It is an object of this invention to prevent, as far as possible, fractures caused by overstresses resulting from the superimposition of general hull stresses and local stresses to which certain elements of the hull structure are submitted. The invention shows how the continuity of a divided longitudinal (or transverse) girder passing through a transverse (or longitudinal) bulkhead is preserved by means of a connecting member connected to the two ends of the girder and passing through the bulkhead. The effective cross-sectional area of the connecting member, together with the part of the plating between the two ends of the girder, must be at least equal to or greater than the normal effective cross-sectional area of the girder and plating, while the effective centres of area of the two cross-sections are arranged to lie at approximately the same distance from the plating or deck. In the method of construction shown in Figs. 4, 5 and 6, the ends (21) of a T-section longitudinal, cut short on either side of a bulkhead (22), are curved or bevelled downwards so that a connecting member (26) of trapezium shape, fitted above the longitudinal, lies at such a height that the effective centre of area of the composite section is approximately at the same height as the effective centre of area of the longitudinal and associated plating at its normal section. The connecting element (26), constituted by a thick plate, passes through a flange (27) which is welded to it and to the bulkhead. Stiffeners (28) joining the flanges of the longitudinal to the plating may be provided.—*British Patent No. 747,886, issued to V. Albiach. Complete specification published 18th April 1956.*

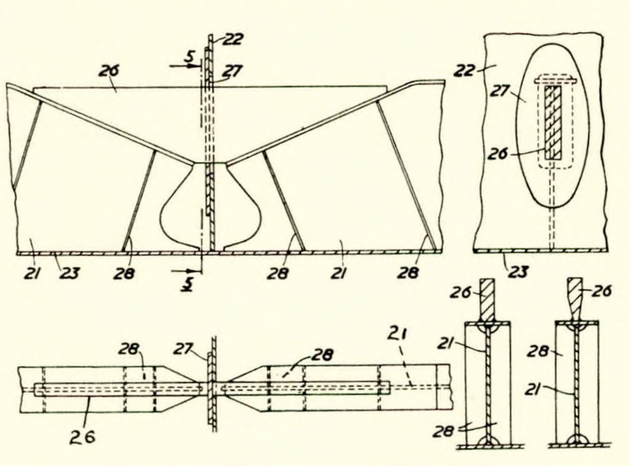


FIG. 4 *(above left)*, 5 *(above right)*, 5a *and* 5b *(bottom right) and* 6 *(bottom left)*

Covers for Ships' Hatchways

In accordance with this invention each cover member at or towards its shorter edge has projecting downward from its under surface a strong slide runner of metal. Thus each

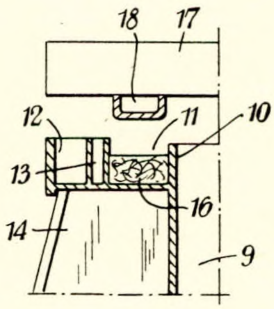
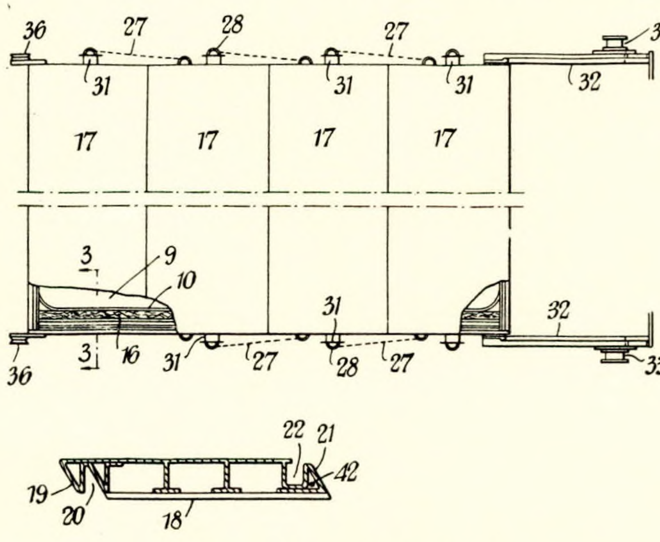


FIG. 3

member has two runners parallel to each other. As will be seen from Fig. 3, laterally of each coaming (10) there is formed a multiple channel member comprising a main channel (11), an outer channel (12) and an intermediate channel (13), the whole structure projecting laterally of the coaming (10) and supported by fishplates (14) from the deck. In the channel (11) there are located tallow-coated oak members (16) constituting the two parallel slipways. A number of cover members (17) taken together by their longitudinal cross joints form the complete cover. Each of these cover members on its underside, towards its narrow edges, is provided with a slide runner (18) which is of U-section steel and so positioned that when



FIGS. 2 *(above) and* 4 *(below)*

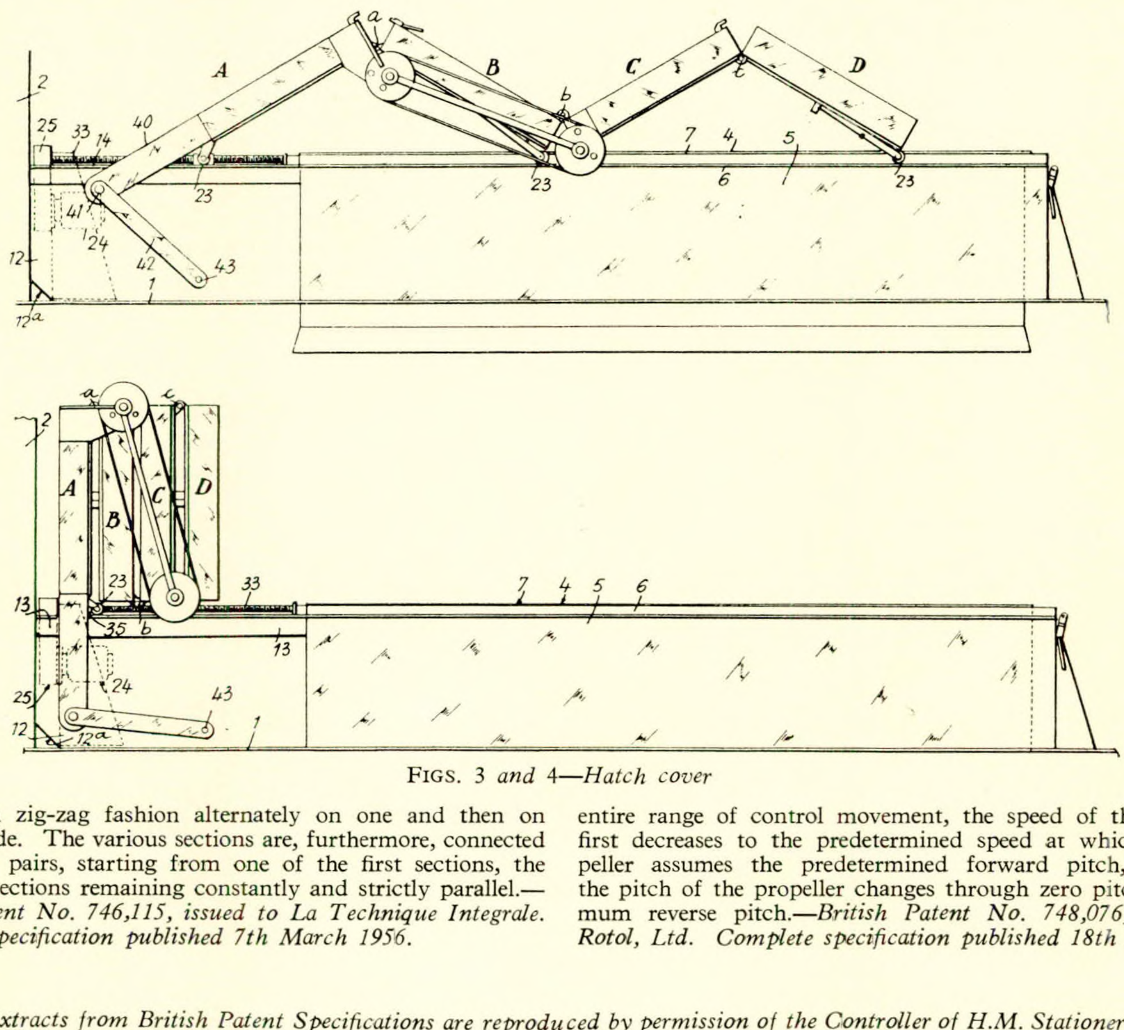
in position it projects into a channel (11) and makes contact with the upper surface of the tallow-coated slipway (16). These slide runners are of such length and position that the ends of the runners of one cover member make contact with the similar ends of the next adjacent members. Except for the two end members (17), Fig. 4 shows a diagrammatic cross-section of the intermediate members. Each of these has at its forward end a hook member (19) with a hook-like channel (20) to its rear and at its rear end a hook member (21) with a channel member (22) adjacent to it. At the base on each side there is a runner (18). It will be understood that when two such members are adjacent, the V formation (19) of one member enters the channel (22) of the next adjacent member, whilst the V member (21) of one member enters the formation (20) of the next adjacent.—*British Patent No. 748,068, issued to F. W. A. Laudan. Complete specification published 18th April 1956.*

Hatchway Cover

The invention envisages an improved cover for hatchways. This cover, which comprises several transverse sections, is characterized in that the first section at one of the ends of the cover is connected to a control device by means of which it is possible to pivot this section to its vertical open hatchway position and, inversely, the extreme transverse edge of this remaining constantly in a horizontal plane which substantially coincides with that containing the fixed support surfaces. The various sections are pivoted together by hinges disposed in zig-zag fashion alternately on one and then on the other side. The various sections are, furthermore, connected together in pairs, starting from one of the first sections, the connected sections remaining constantly and strictly parallel.—*British Patent No. 746,115, issued to La Technique Integrale. Complete specification published 7th March 1956.*

Variable Pitch Propeller

This invention relates to control systems for variable pitch propellers in which means are provided for selective and automatic (constant speed) control. The specification describes a control system for a hydraulic variable pitch propeller having a hydraulic pitch change motor. The system comprises a single manual control member which, over a first range of control movement, is arranged to control the supply of hydraulic fluid to the pitch change motor through a follow-up system responsive to the pitch of the propeller so that each setting of the manual control member corresponds to a particular pitch of the propeller. Each setting within this first range of control movement corresponds to a particular pitch of the propeller from maximum reverse pitch through zero pitch to a predetermined forward pitch substantially within the forward pitch range. Over a successive range of control movement, the control system is arranged to control the supply of hydraulic fluid to the pitch change motor through a follow-up system responsive to the speed of rotation of the propeller so that each setting of the control member in the second range corresponds to a particular propeller speed. The arrangement is so chosen that when the control member is moved in one direction through its entire range of control movement, the pitch of the propeller first changes from a maximum reverse pitch through zero pitch to a predetermined forward pitch at which the propeller is rotating at a predetermined speed, and then the speed of the propeller increases. When the manual control member is moved in its other direction through its entire range of control movement, the speed of the propeller first decreases to the predetermined speed at which the propeller assumes the predetermined forward pitch, and then the pitch of the propeller changes through zero pitch to maximum reverse pitch.—*British Patent No. 748,076, issued to Rotol, Ltd. Complete specification published 18th April 1956.*



FIGS. 3 *and* 4—*Hatch cover*

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Marine Engineering and Shipbuilding Abstracts

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Stepped Thrust-bearings

An experimental investigation into the operation of stepped thrust-bearings has been carried out using an experimental machine and measuring equipment specially designed for the purpose, but adaptable to other types of thrust bearing. The running oil-thickness and friction characteristics have been determined for a range of speeds, loads, and inlet temperature for several different angular positions of the radial step and for two curved steps. Results are given in the usual manner using ZN/P and also in non-dimensional form and are compared with theoretical predictions based on constant viscosity. The experimental results are compared with the corresponding results obtained on tests of a Michell bearing of identical size and they establish the stepped bearing as being superior to the Michell bearing so far as load capacity and friction are concerned.—*Paper by R. C. R. Johnston and C. F. Kettleborough, read at a meeting of The Institution of Mechanical Engineers on 10th February 1956.*

Smoke Detector System

In recent years there has been a large number of serious fires in ships, both at sea and in port, some of which could possibly have been avoided had an early enough warning been given. Many of the incidents occurring in port are due to delayed fires resulting from the use of burning and welding apparatus, either while the ship is undergoing repairs or during construction. The effect of these fires can, up to a point, be lessened by keeping an alert watch, but even then a considerable amount of damage may be caused before the fire is discovered and completely extinguished. The types of fire that can occur on board ship are many and varied, ranging from a fire in the galley to the more serious fire in the superstructure of a passenger vessel—and this is probably one of the most difficult and dangerous fire hazards to control. All fires start in a small way and it is reliably estimated that more than 70 per cent of the damage that they cause could be avoided if they were discovered and dealt with at an early stage. This is particularly true of fires which start in passenger and crew accommodation. A new system which is worthy of note is the Minerva smoke detector, a system of fire prevention which has been approved and adopted by the Admiralty, Air Ministry, Ministry of Supply and the G.P.O. The Minerva system, which is already in use in the French passenger liners *Liberté, Maréchal Foch, Lyautey* and *General Leclerc,* consists of a radioactive detector head which will detect the first trace of smoke before any flame is generated. The sensitive element in the detection system is an ionization chamber in which the air is rendered conducting by the alpha particles emitted from a small quantity of radium compound having a theoretical life of 1,000 years. A cold cathode gas-filled tube to which are connected two ionization chambers is mounted on a moulded base which plugs into the detector socket. One of these chambers is open to the air while the other is closed. The balance between them maintains the whole system in a quiescent state until the entry of the merest trace of smoke into the open chamber increases the effective impedance of that part of the circuit and causes the valve to trigger. The dimensions of the two chambers are carefully chosen to make the fullest use, under widely varying conditions of temperature and pressure, of the alpha particles streaming out from the radium elements accurately positioned in the assembly. Under the influence of the applied line voltage, and as a result of the ionization to which the alpha particles give rise, a minute electrical current flows through the two chambers. Smoke or other products of combustion entering the open chamber modify the ionizing effects of the alpha particles and therefore cause this current to decrease slightly. The voltage across the open chamber then rises sufficiently to raise the voltage on the trigger electrode of the valve above its critical value. The total voltage drop across the two chambers in series remains constant but the increase in the impedance of the open chamber which arises from the effect of smoke on the state of ionization therein, results in a larger proportion of the voltage drop occurring across this chamber. As a result, the potential of the trigger electrode of the cold cathode tube is raised and the tube then passes 10 mA., a current sufficient to operate the relay controlling the alarm bells and signal lamps. The number and positions of the detectors required vary with each installation and are established by a careful survey. In general, the detectors are wired in groups using a two-wire system, following normal electrical installation practice. Each group is connected to a warning lamp on the control unit, which lights immediately smoke enters any one of the detectors in the group. At the same time audible warning is given by bells or klaxons suitably positioned on board. There is no reasonable limit to the number of detectors in each group. To facilitate rapid identification of the locality of a fire, however, it is normal practice to keep the number to a minimum. In the case of a large vessel, the groups are arranged so as to divide the area into definite and readily identifiable zones. The control unit can be readily arranged to provide automatic alarm at a point ashore, when a ship is in port, and to operate CO_2, chlorobromethane, or methlybromide extinguishers, or sprinkler systems.—*The Shipping World, 15th February 1956; Vol. 134, p. 199.*

New Design for Steam Operated Distilling Unit

A distilling unit of the flashed vapour type with a capacity of 50,000 U.S. gallons per day has been built and tested by the Bethlehem Steel Company. It is composed of five stages, each made up of a flash chamber, a vapour separator, and a stage condenser. In addition, there is a salt water heater, an air pre-cooler, an air ejector after condenser, and a three-stage ejector. Salt feed water is pumped in series through the stage condensers beginning with the fifth stage in which the highest vacuum is maintained, the ejector after-condenser, and the salt water heater. The feed water thus serves as circulating water for the stage condensers and the ejector after condenser. The feed water is heated by the condensation of the flashed vapour in each stage and by the condensation of the steam from the second and third air ejector stages. The feed water leaves the ejector after-condenser at a temperature of approximately 150 deg. F. It is further heated to 170 deg. F. by low pressure steam in the salt feed water heater. After leaving the feed water heater, the feed is introduced into the first stage flash chamber in which an absolute pressure of approximately 8·8 inches of mercury is maintained. The feed being at a higher temperature than the temperature of saturated steam at the above absolute pressure, some of the feed flashes to vapour, passes through the vapour separator, and is condensed in the first stage condenser. The remaining feed cascades through a loop seal into the second effect flash chamber, in which an absolute pressure of approximately 6·3 inches of mercury is maintained, and where additional flashing occurs. Similarly, the remaining feed passes through other stages until in the fifth stage a part of the feed is flashed in an absolute pressure of approximately 2·2 inches of mercury. The remaining brine is pumped overboard at about 104 deg. F., having a density of 1·07/32 as compared with the 1·5/32 density normally found in the conventional submerged tube low-pressure distilling unit. The condensate from the condensed flashed vapour in each stage is cascaded into the stage of next lower pressure. The steam from the first stage air ejector is introduced into the third evaporator stage, where it is condensed. The conbined condensed flashed vapour is removed from the fifth stage condenser as distillate. The flash-type distilling unit has several advantages over the conventional low-pressure submerged tube unit. One advantage is economy in steam consumption. In conventional submerged tube evaporators, the heat transfer coefficient is a function of the temperature difference. Furthermore, with smaller temperature differences per effect, the loss due to hydrostatic head becomes increasingly important. It is, therefore, practically impossible to justify more than four effects in the submerged tube type, and because of weight and space considerations, three effects are used. In the multiple-stage flash type unit, there are no comparable losses in heat transfer coefficient with reduced temperature difference per stage, and no losses of temperature difference due to hydrostatic head. It is therefore possible to utilize a smaller temperature drop in each stage, the resulting pressure difference between adjacent stages being just sufficient to maintain flow. For this reason a five-stage unit is practical, with its economy of steam consumption as compared with a 3-effect submerged tube unit of the same capacity (5,000 pounds per hour against 6,200 pounds). Still another advantage is that the scaling problem is minimized. Scale forms rapidly on the tubes of the conventional submerged tube type, because of the salt water boiling in contact with the tubes. In the flash type, there is no boiling in contact with any heat exchange surface. The salt water is heated in the tubes of the various stage condensers, ejector after condenser, and the salt water feed heater under pressure; no boiling can occur. Under these conditions scale formation is a relatively slow process and, because of the temperatures, it is expected to occur in the salt feed water heater tubes only.—*C. B. Tuley, Bureau of Ships Journal, December 1955; Vol. 4, pp. 19-20.*

World's Largest Motor Tanker

The largest Diesel-engined oil tanker in the world ran trials in Sweden recently, this being the *Ferncrest,* of 34,800 tons d.w.c. built by the Eriksbergs Mek. Verks. Owned by Fearnley and Eger, Oslo, one of the largest of Scandinavian dry-cargo ship and tanker operating companies, the *Ferncrest* bears the added distinction of being the highest-powered single-screw motor ship, her turbocharged Eriksberg-B. and W. poppet-valve-type engine developing 12,500 b.h.p. at 115 r.p.m.; this corresponds to 13,900 i.h.p. with a mean indicated pressure of 7·9 kg. per cm.^{2} (112·3lb. per sq. in.). The ten cylinders have a bore of 740 mm. and a piston stroke of 1,600 mm. The main features are as follows: —

Length o.a.	681ft. 10in.
Length b.p.	645ft. 0in.
Breadth, moulded	87ft. 0in.
Depth, moulded...	47ft. 6in.
Draught, on summer freeboard	35ft. 5in.
Corresponding deadweight capacity, tons...	34,800
Gross register, tons	22,398·65
Net register, tons	13,230·85
Speed on loaded trials, knots...	16
Machinery, b.h.p.	12,500

Of all-welded construction and built to the highest class of Det Norske Veritas, the ship has two longitudinal bulkheads and longitudinal framing, the longitudinal and transverse bulkheads being of horizontally corrugated construction. There is a total of thirty-three cargo tanks, the tank capacity being 1,669,022 cu. ft. The cargo pumping arrangements are of especial interest, there being two steam turbines in a pit at the forward end of the engine room; these drive two centrifugal pumps through a forward bulkhead. Each has an output of 750 tons per hour against a head of 100 m., whilst in the forward pump room between tanks Nos. 3 and 4 are two Eureka compound steam pumps; these also are designed to deliver each 750 tons per hour against 100 m. All the deck machinery and most of the engine room auxiliary machinery are steam driven, and there are three oil-fired Scotch boilers. These do not utilize the exhaust gas after the turboblowers, which is, however, passed through a 350-m.^{2} Spanner boiler silencer fed with water circulated from the three Scotch boilers, the Spanner boiler then delivering to the steam side of the oil-fired boilers. One of the three Rateau turboblowers operates on exhaust gas from the forward four cylinders, the two remaining blowers utilizing in each case the exhaust gas from three cylinders. The main engine and the auxiliary machinery installations are fully equipped for operation on heavy fuel.—*The Motor Ship, February 1956; Vol. 36, pp. 486-487.*

Echo Sounding

When a sound wave is projected through water in a narrow beam, it will be reflected back to its point of origin on striking a surface of different acoustic impedance to that of water and normal to the beam direction. Since the passage of a sound wave requires a finite time for transmission and reflection, it is possible to determine the distance from the source to the reflecting surface by measuring the elapsed time interval. The frequency used is governed by the spread of the beam at low frequencies and the increasing absorption of energy as the frequency is increased. Generally, the frequencies employed lie between 15 and 50 kc/s. The velocity of sound in water is about 4,800ft. per sec. and it will be obvious, therefore, that the main essential of an echo sounder is an accurate method of measuring time intervals of less than one second. Indeed, most commercially produced echo sounders vary only in the means provided for time measurement and display, the method of generation being basically similar in all cases. One of the earliest forms of sounder used mechanical means for measurement and the same principle is still employed today with little modification. In this, a gas-filled discharge tube is fixed to a disc rotating at a constant rate. A stationary scale around the periphery of the disc is calibrated in terms of depth and, as the tube passes a point corresponding to zero, a contact is closed causing a capacitor to discharge through the windings of a magnetostriction transducer, or across the electrodes of a piezo-electric crystal. This produces a pulse of sound that travels to the sea bed and is reflected back to a second transducer. The electrical impulse generated by the conversion of acoustic to electrical energy is fed to the discharge tube where it produces a flash of light. However, the rotating disc has moved the tube to another position, the length of arc corresponding to twice the depth of water, and this can be read off the scale. Since the disc is rotating continuously, an apparently stationary image will be produced. The rotational rate of the disc may be varied to increase or decrease the distance corresponding to the depth. Most of the modern equipments incorporate a roll chart to give a permanent record of the depth, but the method is basically similar. A motor rotating at constant speed carries an arm on the extremity of which is a stylus or pen. This describes an arc as it passes over the recording paper and the initial pulse is triggered as the arm passes the edge of the paper. Since the stylus is continuously moving forward, a second position will be reached by the time an echo is received. At this point a mark is made on the chart, either by dropping the point into contact with the surface or by discharging a small spark through temperature-sensitive paper.—*A. E. Crawford, British Communications and Electronics, February 1956; Vol. 3, pp. 64-69.*

Sodium and Sodium-potassium Alloy as Heat Transfer Medium

The advent of the nuclear reactor as a heat source has stimulated the search for a heat transfer medium capable of operating over a wide temperature range with a good heat transfer coefficient. As a consequence, the use of liquid metals for this purpose has received much attention during the past few years. In the design of a reactor cooling circuit, many limitations are imposed by nuclear physics, and it is not necessarily the case that a good reactor coolant is also the best choice for an industrial heat transfer process. It appears, however, that sodium and sodium-potassium alloy are suitable for general application to heat transfer problems where high heat fluxes and high temperatures are concerned. In the paper the authors discuss briefly the relative merits of the various metals which, because of their low melting points, are suitable for general application as heat transfer media. The alkali metals suffer from the disadvantages that they oxidize rapidly and can react explosively with water; however, little trouble is encountered with corrosion by these metals in steel systems. On the other hand, the use of mercury or lead-bismuth-tin alloys raises serious corrosion problems, and both are much inferior to sodium or sodium-potassium as far as heat transfer properties are concerned. Mercury has the added disadvantage of a rather low boiling point, a highly toxic vapour, and a cost which is approximately two hundred times that of sodium for the same heat capacity. The experimental work which is described in the paper was directed mainly along two lines; firstly, measurements of heat transfer coefficients, and secondly, the development of handling techniques, such as pumping, flow measurement, level control, and the cleaning of plant before and after its use with the liquid metal. The work also included the investigation of cavitation, the performance of sodium-to-water heat exchangers, the calibration of electro-magnetic flow-meters, and methods of measuring and controlling the amount of oxide present in the apparatus. It has been possible to find solutions to most of these problems along the lines of well-established engineering practice; in some cases, the use of a liquid metal makes possible a simpler solution. Of the eight liquid-metal circuits which have been built and operated during the three years the work has been in progress, three typical examples are described in the paper. The first is a circuit of 4-inch-diameter pipe which is used mainly for the testing of electromagnetic pumps. The pumps have generally been of the flat linear induction type, and have proved very satisfactory. The important details in the design and construction of this and the following two circuits are given in a later section of the paper.—*Paper by W. B. Hall and T. I. M. Crofts, read at a meeting of The British Nuclear Energy Conference on 18th January 1956.*

Cargo Handling Appliances

For electrical machinery on shipboard d.c. has been used universally until very recently. The use of a.c., however, offers many advantages to a shipowner. Unfortunately, the inherent characteristics of d.c. machines are better suited for the requirements of cargo handling equipment than those of a.c. machines. It is probably this fact that has delayed the general adoption of a.c. installations for ships' electrical equipment. Many ships are, however, now in service with a.c. installations. The majority of these are fitted with some form of Ward-Leonard control for the cargo winches. Undeniably such winches have ideal characteristics for cargo handling, but they are expensive, and tend to defeat the object of installation of a.c. power, which is to make the electrical equipment of a ship more simple and durable. The simplest and most durable type of a.c. prime mover is the squirrel-cage motor, but this motor has one drawback, the high current peak at switching on, probably of the order of four or five times full-load current. As each cargo winch of an outfit may be switched on and off as often as six times a minute when working cargo, some form of automatic voltage regulation for the alternators is almost essential to prevent large variations in line voltage. Unlike a d.c. motor or a steam engine a simple squirrel-cage motor has no speed range. A cargo winch requires at least two speeds, a slow speed for breaking out and landing cargo, and a higher speed for lifting and lowering cargo, if not a third, higher again for the return of the light hook. These speed changes can be obtained by providing stator pole changing contactors, which, of course, complicate the equipment and require maintenance. Many such winches are now in service, and it will be of great interest to learn, after a sufficiently long period of service, how their performance is meeting requirements. The author's company has recently been granted the opportunity of sending to sea for trial under service conditions, a pair of the simplest possible type of a.c. driven winches. Each of these winches is driven by a simple robust squirrel-cage motor, and is fitted with a footbrake, the application of which operates a star-delta switch in the stator windings. These winches can be safely stalled with the footbrake for reasonable periods, and loads can be gently broken out and landed by judicious use of it. Although no light-hook return speed is provided above the full-load speed, the excellent acceleration obtainable from these squirrel-cage motors has proved, according to the shipowners' reports, that cargo can be handled equally fast as by the remainder of the winch outfit aboard the ship, which is composed of modern high-speed totally enclosed steam winches. In spite of the rapid acceleration provided in these a.c. winches, no reports of damage to cargo by "snatching" have been received. This is probably due to the fact that each winch is fitted with a d.c. operated magnetic brake, supplied through a rectifier, which provides momentary resistance to the motor starting torque if the operator switches directly to the hoisting position without use of the footbrake. The control equipment for these winches is so compact that it can be mounted on the winches, and no separate mounting space is required in deck houses.—*Paper by L. T. Morton, read at a meeting of The Institution of Engineers and Shipbuilders in Scotland on 10th January 1956.*

Experience with Costa Bulb

The Costa propulsion bulb was named after Dr. Leo Costa, the naval archcitect who designed it. Consisting of a pear-shaped bulb which is welded to the rudder abaft the propeller, the bulb fills the vortex cavity of turbulent water which is formed aft of every propeller. As the water from the propeller rushes aft, it is smoothed out by the bulb and continues its flow without disturbance. The propeller is thus given a solid wall of water to bite into, increasing the forward thrust and speed of the vessel and reducing both vibration and fuel costs. Furthermore it creates an area of solid water for the rudder to turn in, which further increases the service speed and manœuvrability, and decreases the fuel consumption. The Costa bulb is essentially intended for single-screw vessels, but it can be fitted to twin-screw vessels if twin rudders are also fitted. Today there are over 4,500 vessels fitted with the Costa bulb, the largest vessel so far fitted with a bulb being the oil tanker *Tina Onassis,* 45,000 tons d.w. It is understood that the cost of installation is moderate and that the bulb will pay for itself within four to five months. The following figures have been obtained from the log abstracts of three vessels owned by George Gibson and Co., Ltd. It should be noted that these are only average figures.

M.V. *Bucklaw*—British Polar M47 I two-stroke engine, bore 250 mm., stroke 420 mm.

	Before fitting	After fitting
Dates ...	4.5.55 to 2.6.55	2.7.55 to 20.8.55
Observed distance, miles ...	2,630	4,459
Engine distance, miles ...	3,074	5,014
Consumption, gal. ...	6,749	11,250
Time ...	529 hr. 43 min.	414 hr. 30 min. (17·25 days)
Average speed, knots ...	10·13	10·75
Average consumption per 24 hr. (main engine), gal. ...	624	652
Average slip, per cent ...	14·45	11·08
Average draughts forward ...	5ft. 6½in.	7ft. 5½in.
Average draughts aft ...	11ft. 11⅓in. mean	11ft. 9½in. mean
Fuel used ...	Gas oil	Gas oil
Average revolutions ...	338·8	346·6

M.V. *Durward*—British Polar M47 I two-stroke engine, bore 250 mm., stroke 420 mm.

Dates ...	30.4.54 to 25.11.54	5.3.55 to 29.8.55
Observed distance, miles ...	12,304	14,593
Engine distance, miles ...	14,562	16,972
Consumption, tons ...	161·27	166·37
Time ...	1,220 hr. 56 min. (50·8 days)	1,374 hr. 29 min. (57·3 days)
Average speed, knots ...	10·07	10·62
Average slip, per cent ...	15·5	14
Average consumption per 24 hr., tons ...	3·16	2·9
Average draughts forward ...	—	—
Average draughts aft ...	—	—
Fuel used ...	Marine Diesel	Gas oil
Average revolutions ...	341·5	353

M.V. *Melrose*—British Polar M48M two-stroke engine, bore 340 mm., stroke 570 mm.

Dates ...	16.4.54 to 12.8.54	28.2.55 to 11.4.55	12.4.55 to 10.10.55
Observed distance, miles ...	13,159	5,016	19,051
Engine distance, miles ...	14,293	5,276	20,403
Consumption, tons ...	296·28	113·29	366·94
Time ...	1,111 hr. 30 min.	403 hr. 47 min.	1,546 hr. 55 min.
Average speed, knots ...	11·85	12·42	12·32
Average slip, per cent ...	7·94	4·93	6·63
Average consumption per 24 hr., tons ...	6·4	6·73	5·69
Average draughts forward...	—	—	—
Average draughts aft ...	—	—	—
Fuel used ...	Marine Diesel	Gas oil	Gas oil
Average revolutions ...	266	271	274

Average
r.p.m. 273·1
12·32 knots
6·28 per cent slip
5·92 tons per 24 hr.

The effect of the Costa propulsion bulb on the propulsive efficiency of the propeller appears twofold:—(a) the slip is reduced as in the three cases observed, and (b) the revolutions increase for the same shaft horsepower. In the opinion of the shipowners this is caused by the streamlining of the flow of water away from the boss of the propeller and also by the reduction of turbulence in the propeller aperture. It will be noted in general that the improvement in the performance of the *Bucklaw* and the *Durward* is greater than that of the *Melrose*. This is probably due to the fact that the *Melrose* has a finer hull form, is a longer vessel and has a slower running engine than either of the other two. It may also be remarked that the advantages of the propulsion bulb appear to be reduced in heavy weather. From the purely financial side, taking the saving in fuel and ignoring the value of an increase in speed, the bulb on the *Durward* has paid for itself in about 130 days steaming.—*The Shipping World, 18th January 1956; Vol. 134, pp. 117-118.*

Diffusion of Air into Pulsating Cavitation Bubble

Although the phenomenon of cavitation has been of interest to hydraulic engineers for some time it is only in recent years that this subject has gained the attention of physicists to any great extent. The concern of the engineers arises from the attendant destructive action on hydraulic structures and the object of their research has been to find ways of avoiding cavitation and means of reducing damage when cavitation cannot be avoided. The approach has been mainly empirical, involving the close observation of the phenomena and study of the character of the destructive action. Various theories have been advanced to account for the extraordinary severity of cavitation damage. The theory that chemical corrosion is involved has been pretty well discredited by the evidence of damage to non-corrosive surfaces such as glass and concrete. It is generally accepted now that the destructive action is of a mechanical nature due either to direct blows of water or the occurrence of high pressures in the neighbourhood of collapsing cavities. There is, however, at present no theory that adequately describes the mechanism. Indeed, the problem of explaining the creation and subsequent pulsation of a cavitation bubble involves the complicated interaction of so many factors that only a rough approximation can be attempted by theoretical investigation. In fact, the fundamental laws governing some of the factors involved are not yet fully understood. The properties of inertia, compressibility, and viscosity of water are involved; also, vaporization and condensation of water, expansion and contraction of the gas-filled cavity, heat conduction, surface tension, and finally, diffusion of air into the cavity. Water free from impurities and gas nuclei can support considerable negative pressure without rupture. The inception of cavitation at low positive pressures, i.e. the vapour tension, indicates the presence of gas nuclei in the water. Experiments indicate that the noise attendant upon the pulsations of bubbles decreases with increasing air content. The bubbles which contain the least air make the most noise. In general, the acoustical properties of bubbles in water are related to the volume of air contained. It also appears likely that the damage caused by the collapse of a cavitation bubble is similarly related to the air content. Therefore, although the process of diffusion of air into the cavity probably has little effect upon the motion of the boundary of the cavity, the increase of the air content during the pulsation of a bubble is of interest; and for this reason the author has evaluated the extent to which a pulsing bubble can grow.—*L. Pode, David W. Taylor Model Basin, Report 804 (1955).*

New Supertankers

Details have been released of the two tankers which the Newport News Shipbuilding and Dry Dock Company are to build for the Esso Shipping Company. These two vessels will be the largest bulk-oil carriers in the United States Merchant Service, and are due to be delivered to the owners in 1957. The general dimensions are as follows:

Length overall, feet	715
Length b.p., feet	685
Beam, moulded, feet	93
Depth, moulded, feet	48·1
Capacity of cargo-oil tanks, bbls. ...	318,000
Speed, knots	18.3

In normal trade between the U.S. Gulf and Atlantic ports, these vessels will have a deadweight-carrying capacity of 35,420 tons on a designed operating draught of 35ft. 2in., and of 37,800 tons at their international summer freeboard draught of 36ft. 9in. The propulsion machinery will consist of a cross-compound double-reduction geared marine steam turbine driving a nickel-aluminium-bronze propeller. The high-pressure ahead turbine will be of the single-flow reaction type; the low-pressure ahead turbine of the single-flow impulse-reaction type; and the impulse-type astern-turbine elements will be embodied on the forward end of the low-pressure rotor, and within the low-pressure turbine casing. The double-reduction gearing will be of multiple-pinion double-helical articulated design, connected to the turbine rotor shaft by means of a flexible mechanical coupling. The unit is rated for superheated steam at a pressure of 825lb. per sq. in. and a temperature of 850 deg. F. Steam will be raised in two watertube boilers capable of supplying 182,000lb. per hr. normal and a maximum of 275,000lb. per hr. The condenser will be of the horizontal two-pass surface-condensing marine type. The four main cargo pumps will be capable of discharging about 34,250 barrels of seawater of 1·03 specific gravity per hour at a discharge pressure of 150lb. per sq. in. The electrical system will include two 750-kW a.c. turbine-driven generators, and an emergency Diesel-generator set rated at 100 kW will be installed in the emergency generator room on the boat deck aft.—*Ship's Bulletin, No. 5, 1955; Vol. 35, p. 2. Journal, The British Shipbuilding Research Association, January 1956; Vol. 11, Abstract No. 11,152.*

Norwegian-built Vessel for Mediterranean Service

The *Baghdad,* recently constructed by Akers Mek. Verk., Oslo, for Fred Olsen and Company's Mediterranean service to the requirements of Det Norske Veritas, is similar to the *Balkis,* delivered to the same owners by Oresundsvarvat A/B, except that she has a bipod mast. The main characteristics of the *Baghdad* are:—

Length overall	374ft. 5in.
Length b.p.	340ft. 0in.
Breadth moulded	50ft. 0in.
Depth moulded to upper deck	28ft. 10in.
Depth moulded to second deck	20ft. 4in.
Draught (summer)	22ft. 4⅞in.
Gross register, tons, about ...	4,200
Deadweight capacity, tons, about	4,525
Speed fully loaded (trials), knots	15¼

There are two continuous steel decks, forecastle and a long combined poop and bridge. Forward of the engine-room are two holds and corresponding 'tween decks, including a portable third deck; aft of the machinery space is a hold with 'tween decks. Between holds Nos. 1 and 2 from the tank top to the main deck, is a centre-divided deep tank for the carriage of vegetable oils. The two holds and 'tween decks forward of the engine room have the upper deck hatches with MacGregor single-pull steel hatch covers, incorporating rolling sections which carry the cranes. The 'tween deck hatches are fitted with steel covers of pontoon type, and each of the two upper hatches is served by a 3-5-ton travelling deck crane, the platform of which forms part of the hatch cover. On the forecastle deck forward of hatch No. 1 is a bipod mast carrying two 10-ton derricks, and aft of the hold No. 2 there are two self-staying posts, each of which carries a 12-ton derrick. A six-cylinder Akers-B. and W. engine is installed. It is of the turbocharged two-stroke type, developing 3,700 b.h.p. and has cylinders 500 mm. in diameter with a combined piston stroke of 1,500 mm. There are two Brown Boveri blowers, of the type VTR 400. At full power with the engine running at 145 r.p.m., the mean indicated pressure is 7·4 kg. per sq. cm. The engine is arranged to burn boiler oil. Three 185-kW B.M.V. Diesel-engined dynamos are installed for the supply of current throughout the ship, and for harbour use there is a 27-kW. Diesel-engined generator.—*The Motor Ship, February 1956; Vol. 36, p. 499.*

Recent Trawlers

The fishing industry has long been accustomed to criticism over its ultra-conservatism in its approach to new developments, but a brief survey of recently completed trawlers gives ready indication of the steady, if unpublicized, progress which is now taking place. The most notable development in trawler construction is the increased capacity and speed coupled with the relatively recent general acceptance of Diesel propulsion. An example of this trend is the m.s. *Zelande,* completed last month by the Société des Chantiers Réunis Loire-Normandie to the order of Pêcheries de Bordeaux-Bassens. This vessel has a length b.p. of 252ft. 8in., a breadth of 42ft. 8in. and a depth to the main deck of 21ft. 8in. The main details are:—

Fishroom, cu. m.	1,600
Fresh water (in ballast), cu. m. ...	328
Fuel, cu. m.	774
Service speed, knots	13
Deadweight, tons	1,720
Gross register, tons	1,900

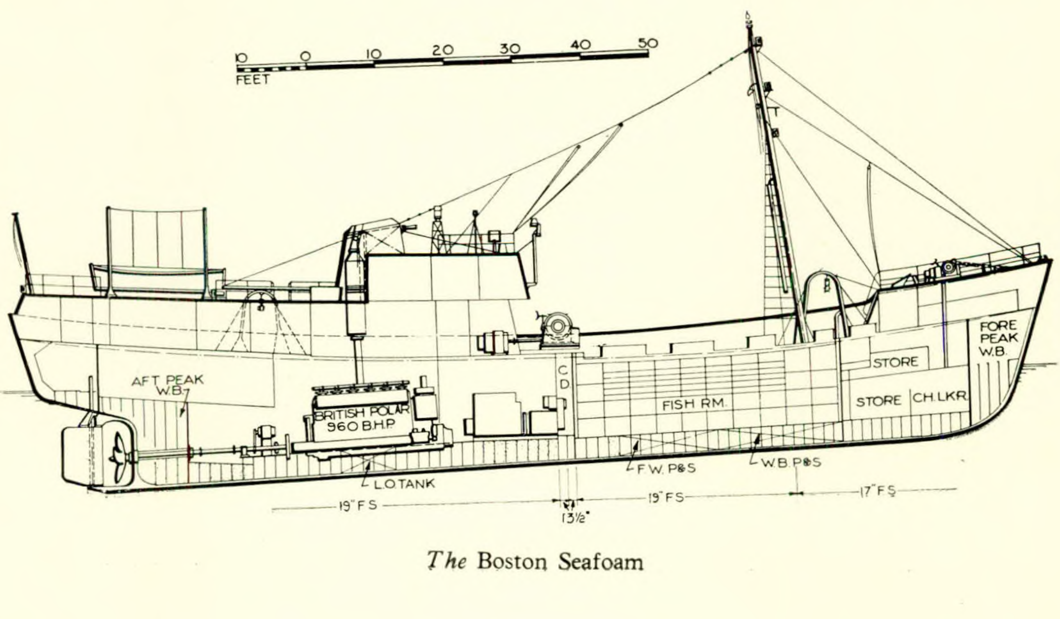
A point of note is the high machinery power of this trawler—2,050 b.h.p. (metric) at 200 r.p.m. The engine is a Penhöet-B. and W. five-cylinder unit. Despite the size of the vessel, no fish-factory or refrigerating plant is installed. A Spanner composite boiler is installed, also three 150-kW. generators, each of which is driven by a B. and W. four-stroke engine. What is probably the largest all-welded trawler built in Great Britain is nearing completion at the Hessle yard of Richard Dunston, Ltd. Owned by the Boston Deep Sea Fishing Company, this vessel, the *Boston Seafoam,* was constructed in fabricated sections away from the launching berth, which is used only for the final assembly. The principal characteristics are:—

Length registered	139ft. 6in.
Length b.p.	137ft. 0in.
Breadth, moulded	28ft. 0in.
Depth, moulded...	14ft. 0in.

Of 9,350 cu. ft. capacity, the fishroom is insulated with 2-in. Onazote, and wood-lined. Four hatches give access to this space. The Laurence Scott 1,200-fathom trawl winch is driven by an electric motor within the forward end of the deckhouse. Forward of the fishroom are two tanks, port and starboard, for the storage of livers and fitted with a scuttle to enable discharge through the ship's side. The main engine is a Polar six-cylinder unit developing 910 b.h.p. at 260 r.p.m. The winch generator is driven by a Mirrlees Diesel engine developing 315 b.h.p. at 600 r.p.m. Both engines are fresh-water cooled. An R.N. auxiliary set is fitted, this comprising a 17-kW. 220-v. d.c. generator, a Hamworthy air compressor and a Gilkes general service pump. Belt drives are taken from the intermediate shafting to a 30-kW. d.c. generator and a Carruthers bilge pump for use when at sea. The main switchboard is arranged so that either of the two generators supplies power to the mains while an independent Nife battery lighting system is installed.—*The Motor Ship, February 1956; Vol. 36, pp. 510-513.*

Protection of Condensers for Ships' Refrigeration Plants

During the war the shortage of copper, copper alloys and other non-ferrous metals resulted in the increased use of iron, even for those parts of a refrigerator which contain water, and, owing to the continued high price of non-ferrous metals, the practice has been maintained. All the greater, therefore, is the importance of adequate corrosion protection, especially in the case of plants such as ships' refrigerators which are exposed to sea water corrosion. This problem was reviewed by H. R. Hege in the German journal "Kältetechnik". In the case of condensers for refrigeration plants on board ship, the problem is not only one of corrosion but also one of erosion, as the water often carries sand particles. Frequent renewal of the surface protection is not practicable, not only for economic reasons but also for technical reasons, as the condensers are not easily accessible. Whilst the salt contained in the sea water is not in itself a cause of corrosion, the salt water acts as an electrolyte, causing a voltage difference which, in turn, leads to corrosion. Therefore, the greater the salt content of the sea water, the greater is the destructive effect of the water on the surface protection of the iron. Chemically, the most important factor governing the extent of corrosion is the oxygen content, which is particularly high in sea water. A special danger lies in the formation of local corrosion voltages. It follows, therefore, that corrosion protection against sea water must provide protection against moisture generally, and also against oxygen and the formation of local electric potentials. Such protection may be afforded by various means, including the use of suitable alloys, and phosphate, varnish, rubber or metal coatings. The use of suitable alloys is not generally considered economical as in order to be effective, the alloy must have a high chromium or nickel content. The



The Boston Seafoam

only non-metallic alloying constituent affording a reasonably good corrosion protection is silicon. In fact, cast iron with 15 per cent silicon content can be regarded as almost entirely proof against sea water. But such metal is so brittle and hard that it can only be worked by means of grinding, so that the possibilities of its application are strictly limited. Phosphate coatings afford a somewhat better means of protection, but the thin iron-phosphate film obtained by treating the iron surface with phosphoric acid and certain phosphorus salts merely affords a temporary protection against sea water carrying sand particles which are liable to damage that film. Similarly, paint coatings are strictly limited in their use, since the coat of paint must be renewed at intervals and, in any case, does not prevent the penetration of moisture when continually exposed to water. More promising is the application of rubber coating. A coating of, for example, chlorinated rubber can be applied without much difficulty and is completely proof against all constituents of sea water. The rubber can be satisfactorily integrated with the iron by means of vulcanization, but this is a highly specialized process which can seldom be carried out at the works of the refrigerator manufacturer. The use of synthetic rubber of the neoprene type signifies considerable progress in this respect, since it has made possible the application of self-vulcanizing coatings. One drawback, however, still remains, and that is the poor thermal conductivity of the material, which restricts its use to parts such as covers which are not required to transfer heat.—*Corrosion Technology, December 1955; Vol. 2, p. 374.*

Ore Carrying Steam Ship

After comprehensive loaded trials, which included a series of progressive speed runs over the Newbiggin measured mile, when the specified speed was attained under adverse weather conditions, the single-screw steam-driven ore-carrying vessel *Sept Iles,* built by the Furness Shipbuilding Co., Ltd., Haverton Hill-on-Tees, for the Iron-ore Transport Co., Ltd., of Canada, sailed on her maiden voyage to Chile. The vessel constructed at Haverton Hill is intended for the carriage of iron ore from the loading terminal at Sept Iles, Province of Quebec, Canada, principally to Philadelphia, but also to other Atlantic ports in the United States of America. The terminal port at Sept Iles, which is connected to the iron-ore mines by a railway some 360 miles long, is designed to handle, each season, 10,000,000 tons of ore. This season is limited to seven-and-a-half months, due to the cold climate freezing the ore in transit, on the railway, during the remaining four-and-a-half months of the year. The ship is of the single-deck, poop, bridge and forecastle type, with the machinery located aft. The hull lines terminate in a clipper-type plate stem forward and a cruiser stern aft. The vessel, which has been constructed under the special survey of officers of Lloyd's Register of Shipping, and to the highest classification of this society, is also in accordance with the requirements of the American Bureau of Shipping for the carriage of iron ore. The scantlings and arrangements are suitable for the vessel to have a tanker freeboard. The principal dimensions and other leading characteristics of the *Sept Iles* are given below:—

Length overall	661ft. 7in.
Length b.p.	630ft. 0in.
Breadth moulded	87ft. 0in.
Depth moulded	45ft. 6in.
Draught with summer freeboard	34ft. 0⅞in.
Corresponding deadweight, tons	31,100
S.H.P.	12,500
Corresponding r.p.m.	105
Designed speed, knots... ...	15½

The *Sept Iles* has been built on the longitudinal system of framing. Electric welding has been used extensively, the shell and decks being almost completely welded, while the longitudinal and transverse bulkheads are welded throughout. The propelling machinery consists of a single-screw set of Richardsons Westgarth-Brown Boveri double-reduction geared turbines, designed to develop 12,500 s.h.p. at 105 r.p.m. in normal service, and a maximum continuous output of 13,750 s.h.p. The h.p. ahead turbine is of impulse-reaction type, while the l.p. turbine is of all-reaction design. The h.p. turbine casings are of cast-steel, and the l.p. turbine cylinder is of fabricated construction, with cast-steel shells built into a mild-steel fabricated casing. At normal power, the h.p. turbine runs at 4,350 r.p.m. and the l.p. turbine at 3,000 r.p.m. The astern turbines, comprising an h.p. turbine of impulse design and an l.p. reaction element, are incorporated in the h.p. and l.p. casings, respectively, and are capable of developing 65 per cent of the normal ahead power. Suitable bled-steam tappings are provided for feed-heating and air-preheating purposes. Double-reduction articulated-type gearing is installed and the gearcase is of fabricated steel construction. Each turbine is connected to its primary pinion by a flexible claw-type coupling, the secondary pinions being driven through quill-drive shafts and flexible couplings from the primary gearwheels. The main gearwheel and the primary gearwheels have cast-iron centres, with pinned and shrunk forged-steel rims.—*The Shipbuilder and Marine Engine-Builder, February 1956; Vol. 63, pp. 105-111.*

Research on Paints for Ships' Hulls

The importance of an effective means of protection against marine fouling need hardly be emphasized. The drawbacks of marine fouling are not only to be found in the decrease in speeds of ships or the increase in fuel consumption; other disadvantages are that it hinders flying boats in taking off, reduces the efficiency of submarine signalling and sounding apparatus, fouls and chokes seawater piping on board ship (fire-extinguishing lines!) and in industrial installations ashore, destroys anti-corrosive coatings and increases the weight of buoys. The high cost of docking would be considerably reduced if anti-fouling paint had a longer life. The loss of sailing time caused by docking has also to be taken into account. It is remarkable to observe, however, that though numerous inventors and industrial organizations were concerned more or less successsfully with this matter before the war, real insight into the essential features of anti-fouling paints was only obtained during the war. Conventional anti-fouling paints contain copper or mercury compounds in various combinations. Arsenic compounds do not of themselves exercise an anti-fouling action. The action of anti-fouling paint consists in repelling larvæ when the latter are about to settle on the surface, or in killing them before they have been able to become firmly attached to it and start growing. In order to do this it is necessary that the poison should be liberated from the paint by solution in the sea water. The poisonous action takes place principally in the laminar layer of water on the hull surface. The thickness of this layer is about 10 microns. Since, therefore, an insoluble poison is inactive, and a soluble poison gradually disappears from the paint, the paint manufacturer is confronted with the problem of preparing paints from which the poison is liberated readily enough to prevent fouling, yet so slowly that the paint remains active over as long a period as possible. The anti-fouling action of paints is governed by the rate at which the poison is released from the surface into the sea water. It does not matter so much what amount of poison the paint yields to the sea water initially; it is more important that the rate at which this goes on should be constant over a long period (steady-state leaching rate). A distinction should therefore be drawn between the initial leaching rate and the steady-state leaching rate. The initial leaching rate is never a criterion of the behaviour of the paint in practice, but measurements of it are useful for investigations concerning the accumulations of poison or medium on the surface, and the formation of covering films. After the first few weeks of immersion, during which rapid changes occur in the leaching rate, this rate will either gradually decrease over a long period or remain almost constant. The poison present on the surface will be consumed in a few days. If the remainder of the poison is left confined in the medium the steady-state leaching rate will be zero. If, however, the poison present at a greater depth within the film becomes available there will inevitably be a steady-state leaching rate that is, at any moment, proportional to the area occupied by the poison exposed to the sea water.—*H. W. Talen, International Shipbuilding Progress, 1955; Vol. 2, No. 13, pp. 401-409.*

Propeller Interaction with Streamline Body of Revolution

This paper is the second of a series dealing with the calculation of the wake fraction and thrust deduction behind a body having a stern propeller. It is divided into two parts. In Part I the derivation of expressions for the fluid velocities in the propeller inflow are given, together with tables and curves of the velocities computed from these expressions. In Part II the potential flow about the stern of a stream-line body of revolution (U.S. airship *Akron*) is determined by means of a source-sink distribution, and the resultant surface pressures are compared with published experimental data. A hypothetical propeller installation is then specified, and the effect of the propeller inflow on the sink distribution, and the resultant propeller wake fraction and thrust deduction are computed using calculated data for the potential flow, and using published boundary-layer data for the frictional part of the wake fraction. The "nominal" and "effective" wake fractions are compared partly quantitatively and partly qualitatively. The effect of the propeller inflow on the sink distribution representing the body and on the potential wake fraction induced by this distribution is shown to be negligible. The predominating items of difference between the nominal and potential wake fractions appear to stem from the errors inherent in conventional computational and experimental practices, and in the case of an axisymmetric body, these can easily be accounted for. The signs of these errors are such as to cause good correlation between the values of the two wake fractions and to make both of them somewhat lower than the true wake fraction. The potential wake fraction is found to be 13 per cent, the total wake fraction 28 per cent, and the thrust deduction coefficient 17 per cent. Trial computations made with assumed resistances of 50 per cent and 150 per cent of the normal model resistance, and with the boundary layer thickness correspondingly adjusted, indicate that the thrust deduction is sensibly independent of resistance and of boundary-layer thickness. It is demonstrated that by far the largest part of the thrust deduction comes from parts of the hull in close proximity to the propeller. For instance, about 75 per cent of the thrust deduction is found to be generated within a radius equal to less than three propeller radii from the propeller centre. The present report, dealing with axi-symmetric flow, is considered as an introduction to the subsequent work which will deal with the propeller of a normal ship (*Victory*), including the broader aspects of circumferential non-uniformity of thrust distribution. The study was conducted at the Experimental Towing Tank, Stevens Institute of Technology, under Office of Naval Research Contract, sponsored by the Bureau of Ships.—*B. V. Korvin-Kroukovsky, International Shipbuilding Progress, January 1956; Vol. 3, pp. 3-24.*

Atomic Power for Tankers

Four companies—Babcock and Wilcox, Foster Wheeler, General Electric and Ingalls Shipbuilding Corporation—have given the Maritime Administration bids to build a modified Nautilus-type PWR for a 22·5-million dollar tanker to be in operation by June 1959. Nine companies offered to build, or to conduct research on, a more advanced power plant—probably a closed-cycle nuclear gas turbine using helium as system fluid—for a second atomic tanker to go into service in 1961. Only General Electric bid for both jobs. The other eight companies interested in the long-range project are American Turbine Corporation, AMF Atomics, Ford Instrument Company, General Dynamics (General Atomic division), General Motors (Cleveland Diesel engine division), North American Aviation (Atomics International division), Nuclear Development Corporation of America, and Stanford Research Institute. Conspicuous by their absence from these lists are Westinghouse and Newport News Shipbuilding and Dry Dock Company, the two firms hitherto most prominently identified with atomic merchant ship projects; the word is, however, that while both chose not to figure as would-be prime contractors, both are associated with bidders—Westinghouse with Ingalls, Newport News Ship with B. and W. and DeLaval Steam Turbine Company. Both projected ships would be in the supertanker class; about 38,000 tons displacement, 22,000 shaft h.p., 20-21 knots. The PWR-powered tanker, which could be used initially as an atoms-for-peace demonstration ship and then converted to commercial hauling operations, could easily be built for the 22·5 million dollars asked in the current budget; the gas-cycle ship would cost more to develop and build.—*Nucleonics, April 1956; Vol. 14, p. 17.*

Nuclear Reactors with Organic Coolant

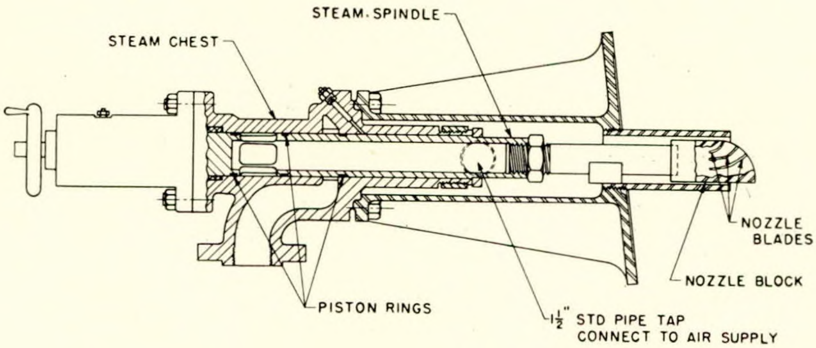
One of the first breakaways from the standard systems of graphite or water moderation has been announced by the United States Atomic Energy Commission. The reactor to be built will use diphenyl as the moderator and coolant. The reactor is of the heterogeneous type with enriched uranium as fuel. Stainless steel will be used in the construction and the coolant is expected to operate at a pressure of 300lb. per sq. in. The tentative proposal for the outlet temperature of the coolant is 500 deg. F. with the prospect of increasing this to 700 deg. F. Maximum fuel element temperature initially will be 500 deg. F. Neutron flux in the reactor will be between 10^{13} and $2{\cdot}6 \times 10^{13}$ n/cm^2-sec. Maximum heat generation is in the region of 15 MW. At this stage in the proceedings no attempt will be made to convert the heat to electric power. The idea of using organic compounds is not new but this reactor will be the first taking the important step of moving from the theoretical to the practical. Organic materials clearly have many advantages in that the basic components are hydrogen and carbon which combine good moderating powers with a reasonable cross-section. Pure diphenyl has a density between 1·18 and 0·99 at 0 deg. C., a melting point of about 70 deg. C. and a boiling point of 254 deg. C. at atmospheric pressure. The main difficulty in the past has been the risk of polymerization and the formation of decomposition products under irradiation. The U.S.A.E.C. has, however, confidence that these problems can be overcome and it must be inferred that the compound stabilizes under the working conditions without excessive formation of these deleterious substances.—*Nuclear Engineering, May 1956; Vol. 1, p. 51.*

Carbon Steel Promises Cheaper Reactor Systems

The Babcock and Wilcox Company, in the U.S.A., have carried out an investigation into the rates of corrosion of carbon steel in water at various temperatures and rates of flow in order to find out whether this material might safely be used in nuclear reactors as a substitute for stainless steel, which is both more costly and more difficult to fabricate. The results of the tests indicate that corrosion is highest for a clean specimen at the start of a test and that the corrosion rate decreases rapidly with time of exposure. After six months, the corrosion rates at 600 deg. F. are below about 0·0001in. per year. The specimens in semi-static water retain more scale and have a lower rate of total corrosion and loss of iron to the water than the specimens immersed in rapidly flowing water. The test data indicate the advantage of maintaining the pH value of the water at about 10 or more. Heat transfer test, metallographic examinations, and other observations did not disclose any insurmountable problems in the use of carbon steel in high-purity water. The problem of corrosion of carbon steel in reactor systems must be studied further, but it is believed that enough information is already available to permit the design of a reactor system using carbon steel as the structural material.—*R. U. Blaser and J. J. Owens, Nucleonics, 1956; Vol. 14, No. 1, p. 68. Journal, The British Shipbuilding Research Association, March 1956; Vol. 11, Abstract No. 11395.*

Retractable Soot Blowers

Retractable soot blowers are installed on most double furnace boilers in the United States Navy Fleet, and on some single furnace boilers of new design. The soot blower is usually located in the furnace roof so that, when it is placed in blowing position, it will clean the fire-row tubes of single furnace boilers, and also will clean the division wall tubes of double furnace boilers. The incidence of fireside deposit makes the soot blower very useful, but the blower must be kept in good condition to accomplish its purpose. The efficiency of the blower depends on the condition of the nozzle blades and block. If the blades are damaged or distorted, the steam flow will be distorted. The flow will damage the refractory baffles installed on the division wall or fire-row tubes, and will not clean the tubes. If the piston rings are worn, or the steam chest or steam spindle cut or gouged, the steam pressure will be reduced and the cleaning efficiency of the soot blower will be affected. The blower is in the hottest part of the boiler, and it is retractable to prevent the unit from being damaged by heat. However, the hot furnace gases can still attack the nozzle blades and block since these units are flush with the furnace roof and have no protection. For this reason, the unit is equipped with an air connexion to blow cooling air through the unit and prevent corrosion. A $1\frac{1}{2}$-inch air supply connexion is provided on the unit for this purpose. —*Bureau of Ships Journal, May 1956; Vol. 5, pp. 19-20.*



Retractable soot blower

Recent Developments in Lubricants

Extensive research over many years revealed that much of the wear of engine cylinders and piston rings could be accounted for by direct chemical corrosion. In the combustion of fuel above the piston, strong organic and inorganic acids are produced and a proportion of these condenses on and reacts with the cylinder wall. The products of these reactions are continuously removed by the rubbing action of the piston rings on the cylinder surfaces, exposing new metal to the chemical attack. Thus a process of "corrosive wear" is brought about which varies in its severity according to the conditions under which the engine is run. Low cylinder temperatures are conducive to acid condensation and aggravate the problem, as does a high fuel sulphur content, which leads to a more copious production of strong acid. Successful attacks on the problem of corrosive wear have been made in the oil industry, for it was discovered that alkaline materials could be added to the lubricant which could neutralize corrosive acids formed in the combustion process before they reached and damaged the cylinder surfaces. Accordingly alkaline materials which were oil soluble and satisfactorily thermally stable were developed and used as anti-wear additives in H.D. lubricants for high and medium-speed Diesel engines. In order to be successful in reducing wear there must be a chemical balance between the quantities of strong acid reaching the vulnerable cylinder walls and piston rings and the quantity of alkaline anti-wear additives supplied to that region by way of the lubricating oil. With most types of fuel normally used in high-speed Diesel engines the provision of this balance has presented but little difficulty, for the acid-forming propensity of this type of fuel could normally be readily matched with the aid of the oil-soluble additives of the type used in some of the more conventional H.D. lubricants. With bunker fuels, however, such was not the case because of the large quantities of corrosive acid formed during the combustion of such fuels. A novel and practical solution has been found in a lubricant which carries the required quantities of anti-wear additive dissolved in the water phase of a stable water/oil emulsion. Although developed with the primary objective of reducing wear, it was known that the new lubricant would reduce fouling of pistons and cylinders for, where acids formed in the combustion process go unchecked, in addition to causing wear, they aggravate deposit formation. Thus a further benefit obtained from the type of lubricant described is a considerable reduction in deposition on pistons and in the ports of two-stroke engines. The performance of this novel lubricant in extensive marine engine application provides ample confirmation of the soundness of its technical foundation.—*Paper by V. W. David and L. J. Richards, read at a meeting of The Institution of Engineers and Shipbuilders in Scotland on 24th January 1956.*

Defects of the Modern Marine Diesel Engine

The marine Diesel engine of high powers, as used in large ocean going vessels, is now a highly dependable prime mover which is taken for granted by shipowners in much the same way that they do not question the satisfactory behaviour in service of steam propelling machinery. The same cannot be said of the smaller marine engines—those in the 100 to 1,000 b.h.p. per unit range are particularly in mind. Bearing in mind the great numbers of engines in this field which are supplied every year, this state of affairs is not satisfactory. In many instances lack of real marine experience is the explanation; it is one thing to build a good Diesel engine, but it is quite another matter to turn out a *real marine* Diesel engine. As ship movement in a heavy sea, or through cargo loading, can be considerable, it follows that if the engine is rigidly attached to the ship's bearers it must tend to follow this movement. This may result in fracture of the engine structure or injury to the bearings. To obviate these dangers the engine, with its gearbox and thrust, should be rigid enough to mount on three points of suspension. The engine should be proof against water in any form—from dampness through long static periods to an engine flooded through leak, collision or a stove-in skylight. To guard against damp and dust from the quay or cargo loading, all moving parts of the engine should be enclosed, as is fairly usual today. The engine itself should be submersible, but what is of greater importance, the air intakes, either direct or through the turbocharger, should be arranged to avoid the possibility of water being drawn in. There are very few engines in operation that could not be stopped, even wrecked in some cases, by pouring a bucket of water through an open skylight; a leaking water pipe, in some instances has been sufficient. In bad weather there may be choked bilge strum boxes, ventilators may carry away, skylights stove in, etc., and enough water may accumulate to allow the flywheel to become partly submerged. In consequence, the whole engine could be subject to a continuous deluge of heavy spray, and there are cases where the air inlet is directly above the exposed flywheel. Gearcases should certainly be submersible; in some instances they are not even splash proof. It should not be essential, the writer holds, that high-duty oils are used in the engine, which should be able to operate in a satisfactory manner with "normal" lubricating oil. This is not recommended with some modern engines, which is not thought to be progress. There is too much money spent in scavenging an oil engine. In a four-stroke engine the cost is virtually 50 per cent of the cost of the engine, for inlet and exhaust strokes are parasitic ones. A two-stroke engine may expend 10 or 12 per cent of its power in pumping scavenge air. To obtain more efficient scavenging an exhaust valve may be added. This creates noise and costs money. The opposed-piston engine is the ultimate case. Three cranks for two pistons, in the best known marine example, a total height that is excessive for small vessels and a separate scavenge line in some models do not suggest the best solution for moderate powers, although such engines are very successful for big motorships. Some simplification of this is necessary when dealing with engines within the power range in mind and the twin-crankshaft opposed-piston engine is one way. In the case of smaller marine oil engines it is not only desirable but essential that the propulsion unit should be controlled directly from the bridge or wheelhouse. What is required with the oil engine is direct bridge control of starting, reversing, throttle, etc., through the agency of, in effect, an engine room telegraph that can be handled in the same way as the normal instrument and which may be termed panic proof. In an emergency, and with a stranger in the wheelhouse, it should be possible to pull over the instrument from "Full Ahead" to "Full Astern" as fast as the helmsman is able to operate it, without check and with an immediate response of the engine without any attendant being near. On this telegraph reaching astern position the engine should, within a period of two or three seconds, deliver full astern torque to the propeller shaft and hold that torque until the engine is able to turn the shaft astern, whether the time lapse is one or ten seconds. That is to say, the engine should respond exactly as would a two- or three-crank double-acting steam engine. In this arrangement the last sector of the control would be the throttle, increasing as the end of the sector was reached.—*A. F. Evans, Gas and Oil Power, January 1956; Vol. 51, pp. 23-25.*

Three-phase Ship's Supply Systems

In recent years more and more shipbuilders all over the world have been deciding in favour of three-phase supply systems for passenger vessels and tankers. The superiority of the three-phase system for shipboard installations becomes fully apparent when all the drives for both auxiliary machinery and deck machinery are equipped with squirrel-cage motors, since three-phase constant-voltage generators permit direct-on-line starting of these motors. The demands made on synchronous generators for frequent direct-on-line starting of three-phase squirrel-cage motors cannot be met if these machines are equipped with voltage regulators of the conventional type. The considerable voltage fluctuations occurring with great variations of load and caused by the reactance-voltage drop and armature reaction of the generators, must be regulated within a few cycles in order to keep the voltage of the ship's supply system constant and not to jeopardize the starting of direct-on-line started motors. Since generators are usually provided only for rated outputs which just cover the load imposed by the consumers, the rated voltage of the ship's supply system must be maintained even during short periods of overload, such as occur during the starting of large squirrel-cage motors. Nowadays these demands are met only by generators with magnetic regulators and by compounded synchronous generators. So far machines with magnetic regulators have been installed on board ship only for small ratings (port-duty generators), although the voltage recovers to its rated value after approximately 10 cycles even in the event of considerable variations of load, while compounded machines (constant-voltage generators), which do not require an exciter, have steadily gained in importance in the German shipbuilding industry during recent years. Exciter-less generators compounded over current transformers and dry-plate rectifiers, as designed by Dr. Harz, have no commutators, nor does their voltage depend on the temperature of the exciter winding. Since they are built mostly as internal-pole generators, the sliprings need not be dimensioned for the generator short-circuit current. The overall length of these machines is very short and it is this type which, in recent years, has found most favour in the German shipbuilding industry. The no-

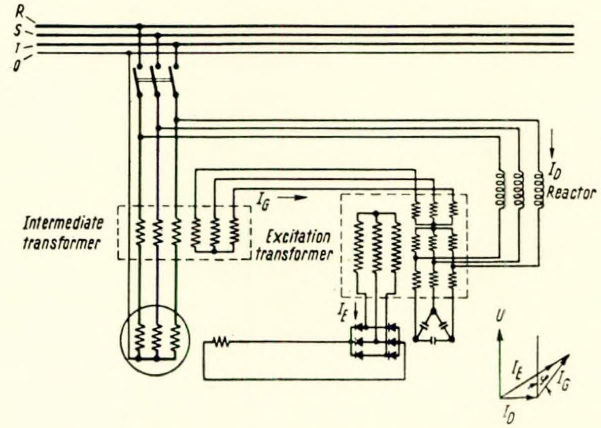


FIG. 4—*Basic circuit diagram of synchronous generator with load-sensitive excitation*

load exciter current is introduced over a reactor coil and passed to one part of the primary winding of the exciter-transformer (see Fig. 4). In order to ensure self-excitation, a capacitor has been provided which, at approximately 90 per cent of rated frequency, enters into resonance with the inductance of the reactance coil, thus increasing the remanent voltage of the generator to several times its original value. Proportional to magnitude and phase angle of the load current, the load sensitive component of the exciter current is applied to the second part of the primary winding of the exciter transformer. The geometrical sum of the two exciter currents is formed in the secondary winding of the exciter transformer. The secondary current is rectified by dry-plate rectifiers and passed on to the exciter winding of the magnet wheel. By varying the reactance value of the reactor, the magnitude of the no-load voltage can be adjusted. A separate reference-value adjuster is, however, unnecessary. The layout of the exciter circuit ensures that the generator voltage is unaffected by variations of resistance in the winding of the magnet wheel, such as might be caused by heating up or ageing. Since the exciter current of the magnet wheel is regulated by the current transformer almost without any time lag, the power-factor controlled compounding will cause rapid readjustment of the generator excitation and thus of the supply-system voltage. The voltage of the generator and thus of the ship's supply system is kept practically constant for all variations of load and power factor.—*A. Wangerin, European Shipbuilding, 1956; Vol. 5, No. 2, pp. 42-51.*

Controllable Pitch Propellers

With a fixed pitch propeller in combination with a multi-engine Diesel plant, each engine is designed to develop full horsepower (that is, full torque at full r.p.m.). However, it is obvious that the fixed pitch propeller cannot be designed to absorb full power at full r.p.m. with all engines in operation and also a third, a half, or two-thirds full power at full r.p.m., when only a third, a half, or two-thirds of the engines are in operation. It is possible, however, to accomplish this if we can change the propeller pitch when the number of engines in operation is changed. The flexibility of the controllable pitch propeller not only permits adaptation of the propeller characteristics to meet the engine and vessel characteristics to obtain full power engine output. It also permits, by changes in pitch, the operation of the combined propeller and engine at the optimum fuel economy point while the vessel is operating at partial engine loads. The characteristics of a fixed pitch propeller in combination with a multi-engine Diesel plant vessel can be described in a single diagram. Fig. 1 represents typical characteristics for such a vessel and shows how these characteristics limit the optimum operation of the engines. The representation of the characteristics of a controllable pitch propeller in combination with a multi-engine Diesel plant vessel is more complicated. Fig. 2 represents typical characteristics of such a plant. From these characteristics it can be seen that propeller pitches can be selected to obtain optimum operation of the engines. Although Fig. 2 was drawn to represent free route operation, similar representation could be made for the dead-pull condition or for any towing condition. It should be pointed out that controllable pitch propeller model tests have indicated that the controllable pitch propeller can be designed to have propeller efficiencies equal to those of a fixed pitch propeller for a given design condition, if careful attention is paid to the hub details. These features, combined with the ability of the controllable pitch propeller to perform the reversing function for a Diesel or gas turbine plant and the additional low speed manœuvring

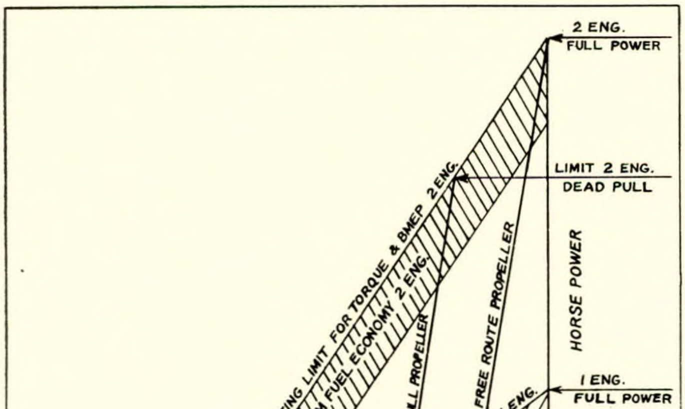


FIG. 1—*Typical propulsion characteristics of a fixed pitch propeller with two Diesel engines for each shaft*

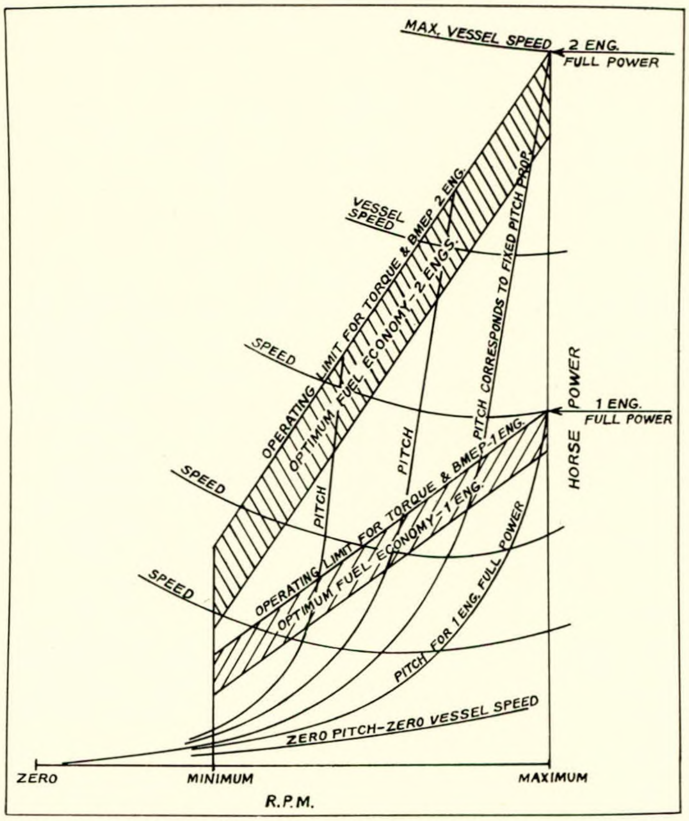


FIG. 2—*Typical propulsion characteristics of controllable pitch propeller with two Diesel engines per shaft and plant-free route. Similar curves can be drawn to indicate operation and choice of pitch for obtaining full power and optimum fuel economy for dead-pull and towing conditions*

characteristics that the controllable pitch propeller gives a Diesel plant, are the principal reasons why the controllable pitch propeller is being used and developed at this time.—*R. F. Desel, Bureau of Ships Journal, April 1956; Vol. 4, pp. 2-6.*

Crack Arresting by Overlays

Explosion-loaded, crack-starter tests of mild steel ship plate have demonstrated that the relative resistance of the steel to the propagation of brittle fracture is related to the development of surface shear (shear lip). At test temperatures such that the mild steel plates shatter completely, the unaided eye cannot discern evidences of surface shear (extremely fine fins, however, are present). At higher temperatures, such that the plates resist fracture to the extent of limiting the cracks to the plastically deformed bulge regions, easily visible shear lips of 0·020 to 0·050in. thickness are developed. The amount of shear lip increases rapidly at still higher temperatures to the point of developing complete shear across the section and completely ductile behaviour is exhibited by the steel. The development of surface shear in lip form results from the fact that free surfaces approach a condition of stress biaxiality compared with the stress triaxiality which may be developed in the inner regions of thick plates. Thus, if the steel is tested over a range of temperatures involving a transition from complete brittleness (fracture surface entirely shear), the first portion of the fracture face to show ductile behaviour is naturally the free surface region of lowest stress triaxiality. The important point is that a relatively minor thickness of surface shear lip imparts a large measure of resistance to the propagation of high velocity, brittle fractures. The finding that the propagation of brittle fracture was controlled by the energy absorption concomitant to the development of small amounts of surface shearing suggested cladding of mild steel plates with notch-ductile material for the purpose of providing an artificial region of surface shear. Overlays of highly notch-ductile weld metals were considered as a practical method of cladding. The results of tests demonstrate that the cladding of a brittle steel with notch-tough weld metal imparts a high order of resistance to the initiation and propagation of brittle fractures. The improvement in the properties of the steel is derived from the presence of a surface layer of metal which fractures in a shear fashion at temperatures at which the surface layer of the base plate otherwise would have fractured in a brittle fashion. The change in the fracture mode of the surface from cleavage to shear precludes the initiation or propagation of high-speed fractures (brittle fracture). General cladding for this purpose may be considered as practical in cases involving relatively small structures; however, it could not be considered economical for large structures. The major question raised by these tests involves the value of cladding when limited to small regions of large welded structures. If it is granted that high-speed fracture must terminate in regions of the structure involving steel of surface shearing quality, the question remains one of "how great a distance" of such a steel is needed in the path of the crack to prevent the fracture from crossing to the other side and then continuing to ultimate failure of the structure. The same question is faced in the use of notch-tough steel insert plates as welded crack arrestors in ships. There is no "one answer" to this question because the load characteristics of the structures must be considered. For example, the failure of the strength deck of a ship may so overload the remainder of the hull that a notch-ductile plate insert may be crossed in shear (due to high tearing forces) and the brittle fracture may continue on the other side of the insert. Obviously, an overlay of narrow width would not be expected to "hold the ship together" after the fracture has progressed across the strength deck. The value of notch-tough overlays (or inserts or notch-tough steels) lies either in the prevention of initiation of the fracture or in stopping the propagation following short runs of the fracture. With this view, the application of the overlay method should be aimed at protecting points of connexion or discontinuity, which are the usual points of initial failure in large welded structures. Over-all cladding of such positions should be used whenever possible with the aim of preventing initiation. In cases where this will be difficult or impractical, a ring-like cladding placed as close as possible to the point of possible initiation is suggested as a crack stopper. The method is considered practical for existing or new structures, and for emergency repairs in the field aimed at stopping the progress of short cracks.—*P. P. Puzak and W. S. Pellini, The Welding Journal, December 1955; Vol. 34, pp. 577s-581s.*

Electro-magnetic Pumps for Nuclear Reactors

Sodium, sodium-potassium alloy and lithium form a group of liquid metals which are likely to be used in nuclear-energy applications mainly as coolants where high rates of heat transfer at high temperatures are required. Bismuth is also likely to be useful, particularly in liquid-fuel reactors, due to its ability to dissolve uranium and its low neutron-absorption cross-section. These two classes of liquid metal—the low density, viscosity, and resistivity metals like sodium, and the high density, viscosity and resistivity metals like bismuth or mercury—usually require different methods of pumping. To meet these needs the British Thomson-Houston Co., Ltd., has developed various types of electromagnetic pump. The main advantages of electromagnetic pumps over mechanical pumps are: (1) The only moving part is actually the liquid metal, so there are no bearings or glands to maintain. (2) The length of the pump can be many times shorter than the equivalent mechanical pump without introducing cavitation or break-up of liquid; this is important where the length of mechanical pump is an appreciable fraction of length of circuit in an industrial process, thus leading to considerable saving in capital cost of liquid metal in the case of the EM pump. (3) The over-all efficiency of the EM pump is at least as good as that of the equivalent mechanical pump; in many cases it is better. In the case of the electromagnetic pump the current is established in the liquid itself and a pressure is developed directly within it. D.C. conduction pumps suffer from the great disadvantage of inconvenient electrode current requirements—thousands of amperes at a level of one volt. For example, a 100-h.p. pump recently designed required 100,000 amperes at 2·5 volts. An efficiency of up to about 40 per cent can be achieved at this size. A.C. excitation of the conduction pump (A.C.C.P.) eases current-supply problem, but efficiencies —particularly in large sizes—are lower; they are, however, very useful in small sizes, where an acceptable efficiency and power factor can be achieved and liquids of both sodium and bismuth type can be successfully accommodated. A further possibility in electromagnetic pumping is to induce the current in the liquid metal, and one of the most useful methods of doing this, particularly with metals like sodium, is to employ the induction-motor principle. The spiral induction pump (S.I.P.) operates on the lines of the induction motor. As can be seen in Fig. 2, the construction is virtually that of a standard polyphase stator with a fixed core and a large air gap through which is wound several turns of a rectangular pipe containing the liquid metal. End rings are necessary in principle in establishing the desired axial electric current. The field is of course radial, so the flow is circumferential, and the channel walls or guide vanes ensure that the liquid moves through the pump. Spiral induction pumps are specially suited to low-flow, high-pressure applications: 100lb. per sq. in. at 10 gal. per min., and 80lb. per sq. in. at 40 gal. per min. are ratings of pumps which have been designed, and it is in sizes such as these, say up to 10-h.p. output, where they have so far been most useful. The linear induction pump operates on the same principles as a spiral induction pump, but the channel is straight and the travelling waves of field, flux and current move axially. Two main forms of this pump exist. One is the flat form where the channel is rectangular with side bars on either side, performing the same function as end rings in the induction motor, and the winding is of the polyphase conventional type, though flat and on either side of the channel. An alternative form employs an annular channel enclosing a radially laminated central core and being itself enclosed by a polyphase winding.—*Nuclear Power, May 1956; Vol. 1, pp. 39-40.*

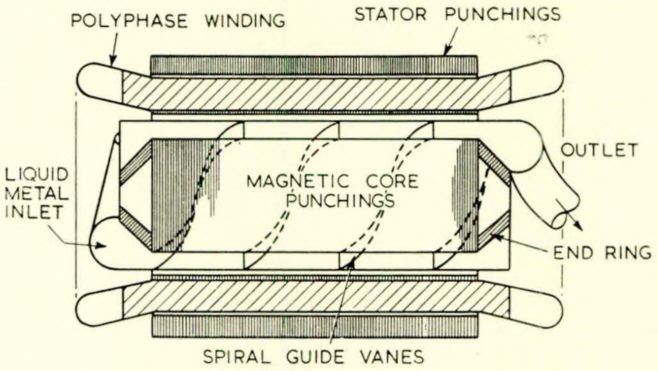


FIG. 2—*In the spiral induction pump the rectangular section pipe is wound spirally round the magnetic core. Such pumps are suitable for low-flow, high-head applications*

German Tankers for Gas Carriage

The first tanker specially built for the carriage of gas is believed to have been the *Rasmus Tholstrup*, a small vessel of 499 tons gross owned by a Danish firm, A/S Kosangas. This vessel, which was completed in the latter half of 1953, can carry 320 tons of liquefied gas in 12 cylinders mounted vertically in the centre part of the ship, the machinery being arranged aft. The upper parts of the cylinders project clear of the level of the well deck, and access to their upper ends is obtained from a central catwalk. The design of this ship was derived from that of an earlier converted vessel operated by the company, the *Kosangas*. Another specially-built ship of this sort, the *Elsa Tholstrup*, is at present fitting out. Two new German examples of the gas-carrying tanker are the *Neviges* and *Langenberg*, two sister ships built for the German owners Willy H. Schlieker and Company. These two ships are of 2,240 tons gross, and have been built by the Peute shipyard of Ottensener Eisenwork A.G., Hamburg. They are notable for the fact that—in contrast to other specially-built gas-carrying tankers—their tanks are arranged horizontally and not vertically. In addition to the transport of butane and propane, they are also suitable for the carriage of ammonia gas. With vertical tanks, the height and diameter of the tanks are limited by considerations of stability and space, respectively, and an appreciable amount of ballast may be needed if use is to be made of much of the deadweight capacity of the ship. It is, however, clear that as the size of the tanks increases, their weight decreases in proportion to their volume, so that a higher proportion of the total weight of gas and tanks consists of cargo. In addition, the use of larger tanks means that fewer of them are required, and this simplifies the piping installation and the arrangement of safety devices. For these reasons, it was decided in the case of the *Neviges* and *Langenberg* to mount the tanks horizontally in the ships, thus allowing a smaller number of larger tanks to be used and reducing the amount of ballast required. The propelling machinery is aft, and the tanks are arranged in three groups of three, one group being forward of the bridge and two between the bridge and the machinery spaces. In each group there are two tanks in the hold space, with a third centred above them. The length of the tanks varies, the longest (the lower forward tanks) being 67 feet in length and the shortest 60 feet. Their shape also varies according to their location in the ship. The midship tanks are cylindrical, but the lower tanks in the after group are slightly conical in shape, and the lower forward tanks distinctly conical. The largest tanks weigh nearly 100 tons when empty, this being the limit of the lifting capacity at the shipyard. The principal particulars of the ships are as follows:—

Length o.a.	310ft.
Length b.p.	285ft.
Breadth moulded	41ft. 6in.
Depth to upper deck	21ft.
Designed draught	14ft. 9in.
Gross tonnage	2,239
Net tonnage	1,466
Volume of gas tanks	91,300 cu. ft.

About 1,000 tons of gas can be carried. The propelling machinery in these ships consists of a pair of Diesel engines of the shipbuilders' own type, coupled through Lohmann and Stolterfoht gearing to a single shaft. Each engine develops 1,000 b.h.p., and the ships have a speed of 13·5 knots.—*The Shipping World, 25th January 1956; Vol. 134, pp. 132-134.*

Noise Problem on Board Ship

Important sources of direct air-borne noises in the engine-rooms of ships fitted with internal combustion engines are the engine air intake and the exhaust systems. The minimum frequency which the normal ear can detect as a continuous sound is about 30 cycles per second. Thus the suction noise from an engine-driven scavenge pump, which occurs at a frequency of one cycle per revolution of the engine, would not be heard as a continuous sound in engines running at less than 1,800 r.p.m. In the case of a rotary blower, with, for example, a three-lobed rotor the suction noise would be heard as a continuous sound in engines running at 600 r.p.m. or more. The exhaust impulses of two-stroke cycle engines occur at a frequency equal to the number of cylinders multiplied by the engine r.p.m. Thus, for a six-cylinder two-stroke cycle engine the exhaust note would not be heard as a continuous sound in engines running at less than 300 r.p.m. In four-stroke cycle engines the exhaust impulse frequency is one-half the number of cylinders multiplied by engine r.p.m., so that the exhaust note of a six-cylinder four-stroke cycle engine would not be heard as a continuous sound in engines running at less than 600 r.p.m. However, the intermittent nature of both suction and exhaust produces shock excitations which are heard as a low frequency throbbing noise which can be very distressing. In many cases the exhaust throb appears to have a frequency equal to the r.p.m. of the engine, because the impulse from the cylinder nearest to the exhaust outlet has a masking effect upon impulses from the other cylinders. An analysis of intake and exhaust noise shows that it contains both high and low frequency components, the latter generally predominating. The higher frequency components can be damped by lining the inlet and exhaust manifolds with sound absorbing material, a method which can be quite effective at frequencies above about 250 cycles per second. Other methods are required, however, for dealing with the lower frequency components, particularly noticeable in the larger engines. Sheer weight of material in the walls of exhaust manifolds is beneficial and for this reason cast iron manifolds with cooling water jackets are quieter than manifolds made from sheet steel, even when the latter are well lagged for heat insulating purposes. Where weight is an important consideration, however, the lower frequency components of the exhaust and intake noise can be reduced by connecting the interior of the manifold to one or more annular channels surrounding the manifold and forming enclosed air cavities. These act as resonators and are particularly effective at their resonant frequency, though they will also deal to some extent with noise components of higher frequency. If the manifold is connected to the atmosphere this is virtually the same as connecting it to an infinite cavity for which the resonant frequency is zero. This device has therefore proved effective for reducing the very low frequency noise from air intakes. Resonating cavities are principally of value for dealing with noise components in the frequency range of 30 to 300 cycles per second. Above 300 cycles per second absorbent materials are better.—*The Marine Engineer and Naval Architect, January 1956; Vol. 79, pp. 10-13.*

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Patent Specifications

Hub for Controllable Pitch Propeller

This invention relates to a hub for a propeller having blades with a controllable pitch. The object is to provide a hub having as small a diameter as possible in spite of the manœuvring forces being developed by hydraulic means located in the hub. This object is attained by providing two hydraulic servomotors, each comprising a cylinder and a piston, at opposite sides of the blades, the servomotor pistons being displaceable towards and from each other and both of them being connected to each of the blades for the purpose of turning them. Referring to Figs. 1 and 2, arranged in the housing are two hydraulic servomotors, one on either side of the propeller blade attachment discs (23). The servomotor located close to the shaft (11) comprises a cylinder (29) concentric with the shaft, and a piston (31) displaceable in it and attached to the piston rod (33). The ends of the piston rod are guided in the end walls (35, 37) of the cylinder (29). The servomotor located close to the point of the hub is similar to and is essentially a reflected image of the firstmentioned servomotor. It comprises a cylinder (39) coaxial with and having the same diameter as the cylinder (29), and a piston (41) displaceable in the cylinder and attached to the piston rod (43). The size and shape of the piston rod are essentially the same as those of the piston rod (33). The piston rod (43) is guided in the cylinder end walls (45 and 47). The cylinders (29 and 39) are hydraulically connected in parallel by means of fixed, always open communications between their ends. —*British Patent No. 750,079, issued to Aktiebolaget Karlstads Mekaniska Werkstad, Karlstad, Sweden. Complete specification published 6th June 1956.*

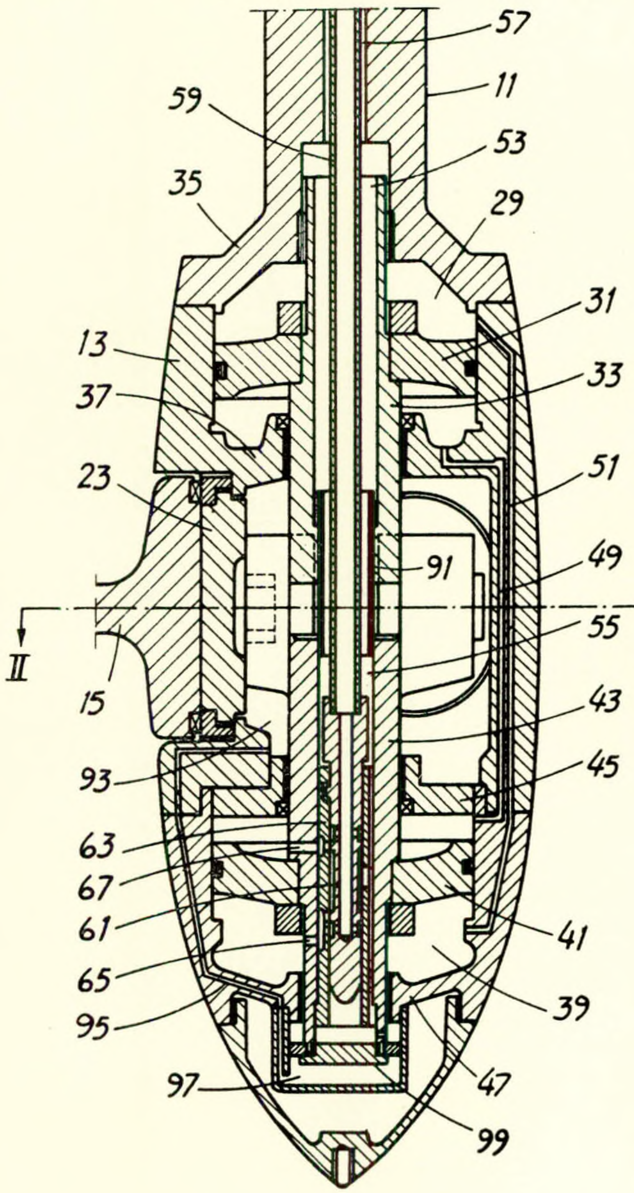


FIG. 1

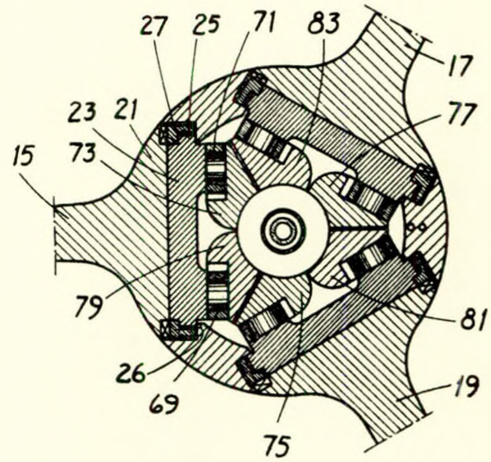
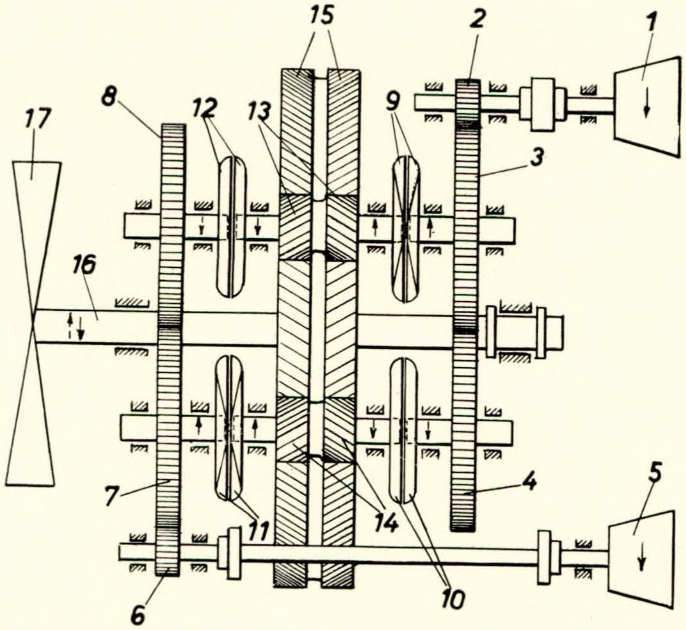


FIG. 2

Reversing Reduction Gear

A prime mover (1) which can only operate in one direction, for example a gas turbine, drives through a pinion (2) a reversing wheel (4). In similar manner a prime mover (5), which rotates in the same direction as prime mover (1), drives through pinion (6) a reversing wheel (7) and a unidirectional wheel (8). Wheels (2, 3, 4) form one first gear stage, and wheels (6, 7, 8) the other first gear stage. The unidirectional and reversing wheels of both these first gear stages are distributed on both sides of a large gear wheel (15) and are arranged concentrically with two large pinions (13, 14) of a second gear stage. On both sides of the large pinions there is a disengageable coupling (9, 10, 11, 12) respectively. With this arrangement the unidirectional gear wheels of one or the other first gear stage (4 or 8), and the reversing wheels of one or the other first gear stage (7 or 3) can be coupled as desired with one or the other of the large pinions (14 or 13). If for instance couplings (9 and 11) are engaged, then propeller shaft

(16) and propeller (17) will rotate in the same direction as the prime movers (1 and 5) as indicated by the full-line arrows; if, however, couplings (10 and 12) are engaged and couplings (9 and 11) are disengaged, the propeller shaft will



rotate in the opposite direction according to the broken-line arrow, whilst the direction of rotation of the prime movers remains unchanged.—*British Patent No. 749,422, issued to Aktiengesellschaft Brown, Boveri and Cie, Baden, Switzerland. Complete specification published 23rd May 1956.*

Fender

In Fig. 2 a fender suspended in the harbour installation (7) from the pivot point (4) acts on a weight in the form of a roller (6), which moves along a path (9). The counterweight (6) can be wider than the lever system and can be guided in lateral recesses. It can be prevented by stop means (8) from moving inwardly, or it can be rigidly but releasably connected to the lever if easy replacement of the weight, for example for cleaning, is not regarded as necessary. The backward movement is limited by a stop (10) provided in the landing installation or by a corresponding construction of the path

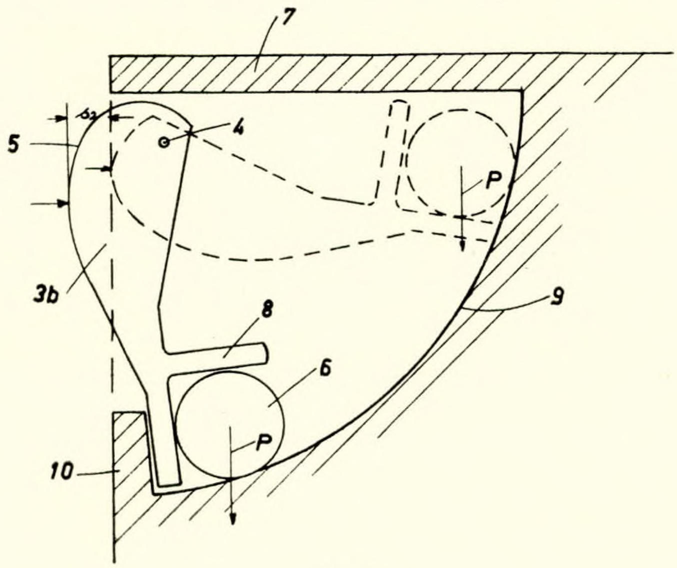


FIG. 2

of movement of the counterweight (9a), so that the tendency for backward movement decreases corresponding to the decreasing action of the weight (6).—*British Patent No. 749,283, issued to F. Spies. Complete specification published 23rd May 1956.*

Ship's Propulsion

One of the objects of the invention is to provide an improved construction of propelling means which aims at giving an increased efficiency over propellers of the type in which the

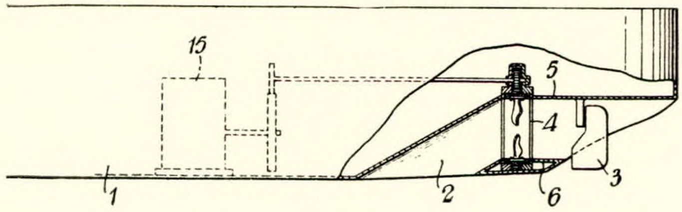


FIG. 1

blades are mounted on the boss fixed to the propeller shaft. This means provides, in combination, a screw or like propeller in which the inner ends of the blades are unattached, so that the usual boss is dispensed with, and the outer ends of the blades are secured on a rotatable ring having a toothed perimeter mounted in a housing of ring-like form, the latter being located in the hull of the craft. Referring to Figs. 1 and 3, the hull (1) of the vessel is chambered (as at 2). It is within this chamber that the screw propeller and its housing is located forward of the rudder (3). The housing (4) which is of ring-like form is secured and fixed between the upper wall (5) and the lower wall (6) of the chamber (2). The rotatable ring (7)

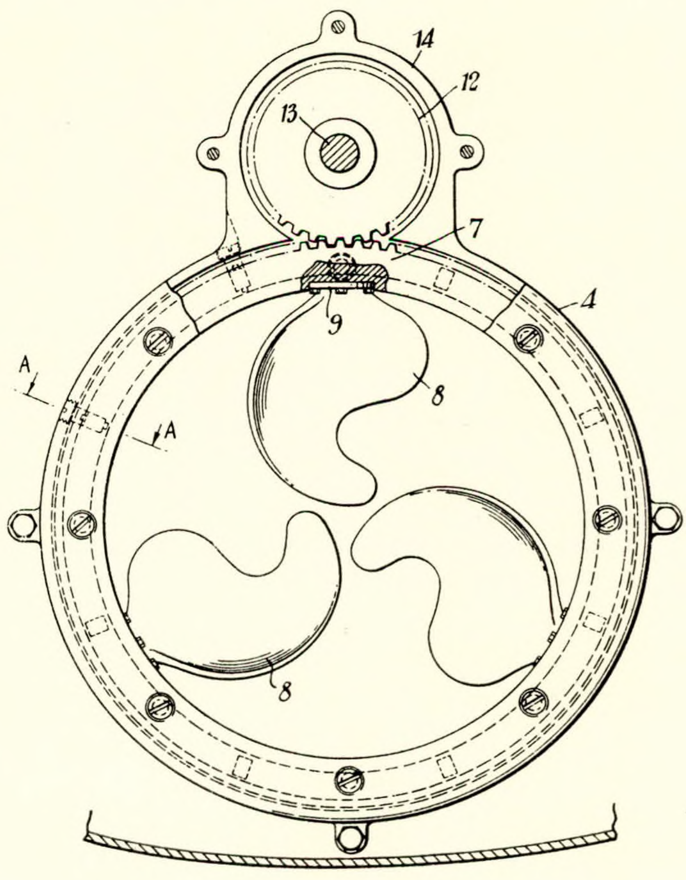


FIG. 3

is mounted and supported in this housing (4). The propelling blades (8) have flanges (9) which are bolted to the ring (7), so that the blades are detachable from the ring. Thrust bearings (10, 11) are provided for the ring (7). The ring (7) has a toothed perimeter which meshes with a gear wheel (12) on a driving shaft (13), the latter being driven from the power unit (15).—*British Patent No. 750,274, issued to E. Marcon, Monfalcone, Italy. Complete specification published 13th June 1956.*

Launching and Lowering Gear for Ships' Lifeboats

According to this invention a launching gear is provided for a ships' lifeboat which includes two davits with associated wire ropes for manipulation of the arms of the davits. A compensating device is provided whereby one or other of the ropes can be wound or brought in further, even although its davit arm is in the fully inboard position, without being subjected to undue strain. The operation of the compensating device shown in Fig. 6 is as follows. If, for example, the arm (32) of the davit (29) arrives at the fully inboard position before the arm of davit (30), then the lever (37) will swing in the direction indicated by the arrow. As a result undue tension on the fall wire or rope of the davit (29) will be avoided and more or less even tension will be maintained in both fall ropes until both arms are correctly in their fully inboard position. It will be appreciated that should the arm of the davit (29) lag and the arm of the davit (30) arrive in the fully inboard position first, then of course the compensating lever (37) will swing in the opposite direction from that indicated by the arrow.—*British Patent No. 750,329, issued to Marepa Trust, Ltd. Complete specification published 13th June 1956.*

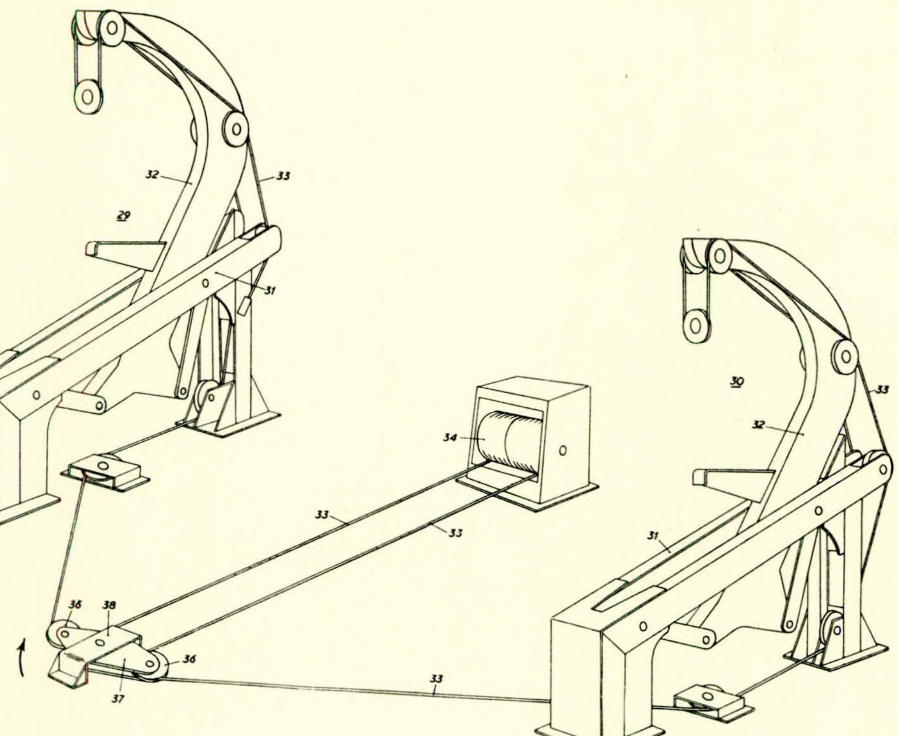


FIG. 6

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Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 7, August 1956

Canadian Vessel for Palletized Cargo

The unitized or so-called "pick-a-back" system of freight transportation which has lately made headway in the United States, and which has been adopted in one or two instances in some Danish ships, is employed in an interesting and unusual manner in the *Clifford J. Rogers,* the first Canadian vessel in which the arrangement has been utilized. The *Clifford J. Rogers* was recently completed by Canadian Vickers, Ltd., Montreal, for the British Yukon Ocean Services, Ltd., Vancouver, to operate on the West Coast of Canada and form part of a chain of transportation services which extend from the Yukon Territory to Vancouver B.C. Usually, general cargo is carried north from Vancouver to Skagway and the Yukon Territories, and asbestos ore and zinc concentrates on the return voyage. In order that the ship may utilize the "pick-a-back" system the vessel is designed to carry 168 containers, each of which is 8 feet wide and 8 feet long, the height being 7 feet. The containers are stowed two wide and three high throughout the centre part of each hold. Several are insulated with self-contained provision for heating or refrigerating the contents. General cargo northwards which cannot be packed in containers, and palletized lead and zinc concentrates moving southwards, will be stowed on each side of the loaded containers, in the wings of each hold, being retained by a series of rolling pillars which extend from the hatch coaming to the tank top, and which are spaced approximately 6 feet apart. The *Clifford J. Rogers* has the following principal characteristics: —

Length overall ...	336ft. 0in.
Length b.p. ...	316ft. 0in.
Breadth moulded	47ft. 0in.
Depth to upper deck ...	24ft. 6in.
Gross tonnage ...	2,999·87
Net tonnage ...	2,195·08
Draught	17ft. 9⅝in.
Deadweight at 17ft. 9⅝in., long tons ...	4,005

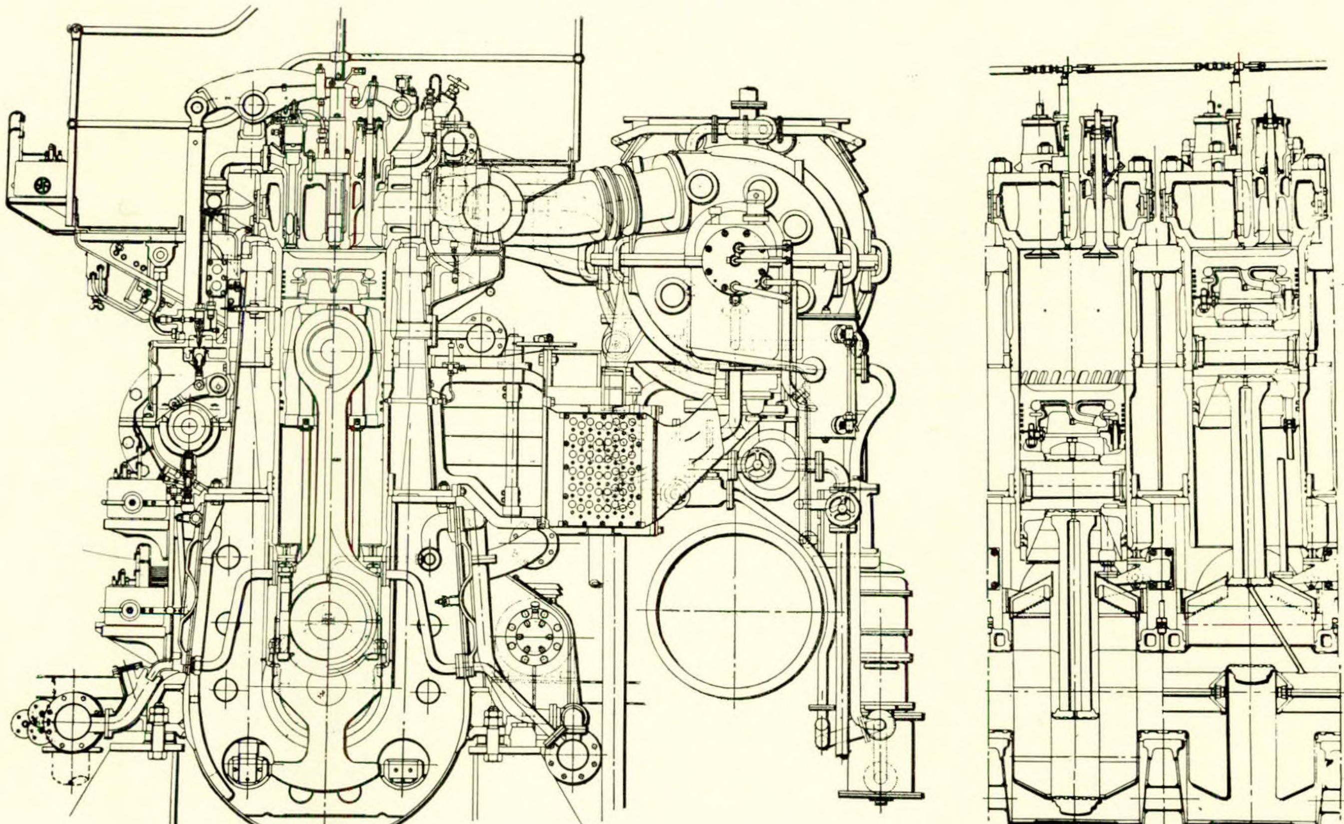
Bipod-type unstayed masts have been fitted, and each hold is provided with four derricks of 10 tons capacity; in addition, a 30-ton derrick is located at the after hatch of No. 1 hold. For cargo handling, eight Clarke Chapman electric winches are installed. An electric capstan is arranged aft and an electric anchor and a mooring windlass forward. The steering gear is of the electric-hydraulic type, having two motor pump units it is controlled from the wheelhouse by telemotor. For propulsion, two eight-cylinder Mirrlees engines of the J.S.S. four-stroke turbocharged type are installed. Each develops 955 b.h.p. at 800 r.p.m. and has cylinders 9¾ inches in diameter with a piston stroke of 10½ inches. They are connected through Vulcan Sinclair scoop-controlled type hydraulic couplings to a Hindmarsh-M.W.D. oil-operated twin-engine reverse-reduction gear having a gear ratio of 5 : 1, and giving an output of 1,806 b.h.p. at 155 r.p.m. The engines drive a single propeller. The speed of the ship on trials was over 13 knots.—*The Motor Ship, February 1956; Vol. 36, pp. 506-507.*

Corrosion of Aluminium

In general, aluminium is said to possess good resistance to corrosion. By this is meant good resistance to the atmosphere, to sea water, and to many fresh waters, chemicals, and foods. This good corrosion behaviour of aluminium is surprising in view of its high free energy content which usually means a strong tendency to corrode. Actually aluminium does corrode extremely rapidly until surface film forms which arrests further action. This surface oxide film is extremely thin—about 50 Angstrom units. When the film is damaged or removed under conditions where reformation or repair is not possible, corrosion results. Thus the corrosion resistance of aluminium depends on the resistance of the oxide film to attack, rather than on the metal itself. The oxide film on aluminium generally is stable in the pH range 5-8. There is a specific ion effect, however, since it is resistant to concentrated nitric acid at pH 1, to glacial acetic acid at pH 3 and to ammonium hydroxide at pH 13. It is well known that aluminium stands high in most galvanic series and hence provision must be made to avoid galvanic corrosion when using aluminium in contact with other metals. This is one of the most common practical corrosion problems with aluminium and one that can be eliminated if attention is given to joint design and care of construction. The further apart two metals are in a galvanic series, the greater will be the tendency toward galvanic action. However the amount or severity of galvanic corrosion cannot be predicted from the table alone, but depends on the following factors: (1) Electrical resistance of the joint. (2) Conductivity of the solution. (3) Relative anode and cathode areas. (4) Polarization. Galvanic corrosion is mild in most fresh waters, strong in sea water and strong in conductive chemical solutions. In the atmosphere it is negligible in rural locations, mild in most city atmospheres, and strong in marine atmospheres. It is extremely severe on exterior locations on board ship and very bad on piers in the ocean, but decreases rapidly with distance from shore. A mile from the sea, galvanic corrosion is mild, and five miles inland can be considered to be rural. In normal atmospheres, and in fresh waters, aluminium can be used safely in contact with stainless steel. In severe marine atmospheres stainless steels tend to corrode aluminium; because of this such joints should be protected. In sea water also galvanic corrosion will occur, especially where the area relationships are unfavourable. In marine atmospheres and in sea water, aluminium to steel joints should be electrically insulated where possible. Where direct contact must be made, as in the building of an aluminium superstructure on a steel ship, the steel portion of the contact should be galvanized or sprayed with aluminium. An inhibitive jointing compound should be used and a good overall paint system applied and maintained. Steel rivets are preferred and are a necessity if the joint is to be damp or underwater; where possible a galvanized washer should be placed under the rivet head on the aluminium side. Where this is not feasible the steel rivet head and the surrounding aluminium plate should be sprayed with aluminium and painted.—*H. P. Godard, Corrosion, December 1955; Vol. 11, pp. 54-64.*

Japanese Diesel Engine

About two years ago, after research carried out at intervals since 1940, the Mitsubishi Shipbuilding and Engineering Company developed the UEC supercharged Diesel engine. This engine, which is of the crosshead, two-stroke, single-acting type, has been installed in high-speed cargo vessels of Japanese construction, an outstanding example being the *Sanuki Maru,* which is propelled by a 9-cylinder engine developing 12,000 b.h.p. Since the successful development of the UEC engine, the company has been engaged in the production of a Diesel engine which will provide a large output with small bulk. This has now been achieved in the UET engine which is a highly supercharged engine of the trunk piston type and in its 9-cylinder version develops 6,000 b.h.p. at 380 r.p.m. Two engines of this type have already been installed in a destroyer escort of the Japanese Maritime Self-Defence Force. The B.M.E.P. of 9·44 Kg. per cm.^{2} (134lb. per sq. in.) at full load is much higher than existing two-stroke Diesel engines and the piston speed is high for the relatively large cylinder bore. The weight of the engine, only 11 Kg. (24·2lb.) per b.h.p., was achieved without using any special light alloy. Air for both scavenging and supercharging is supplied solely by the exhaust gas driven turbochargers. The engine frame is of welded construction with tie rods forming a strong box section. The cylinder cover is of special cast iron and is provided with three exhaust valves. Crankshafts are of high quality forged steel built in two sections (one with six and the other with three cranks) bolted together. The crankpin and journal are hollow, and balanced by the shaped counterweight at the opposite side of the crank. The exhaust-



Cross section and part longitudinal section gas turbocharger consists of a single-stage axial turbine and a single-stage radial blower; a turbocharger is provided for each three cylinders. An air cooler is fitted in the delivery passage of each blower. The fuel system is of the special accumulating type as in the UEC and MS type engines. It consists of a fuel pump, accumulator, fuel control valves, automatic fuel valves and a fuel valve spring control device. One of the difficulties confronting the designers was to obtain perfect combustion of a large volume of fuel within the small combustion chamber. The primary aim was to secure stability when running at a low output. At the beginning of the experimental development trials the temperature of the exhaust gas was comparatively high and perfect combustion could not be attained. Consequently a considerable amount of alteration was required to the size and shape of the induction manifold, air cooler, scavenging ports of cylinder liners, exhaust pipes, exhaust cams, gas turbine nozzles, etc., and trials were repeated until satisfactory results were obtained. From low output to overload, many tests such as progressive performance tests, constant torque tests, minimum power tests, governor tests, and vibration tests were conducted, following which a continuous endurance test for 100 hours at more than 100 per cent load including 110 per cent overload for one hour were also carried out.—*Shipbuilding and Shipping Record, 12th April 1956; Vol. 87, pp. 201-202.*

Aqueous Homogeneous Power Reactors

The paper deals with the general features of aqueous homogeneous reactors and then gives details of the reactor plant of this type. The attractiveness of aqueous homogeneous reactors for producing nuclear power is due to the fluid nature of the fuel and the unique quality of heavy water as a moderator. These features bring with them the following advantages:—

Aqueous homogeneous reactors can be designed for high power density while only a small stock of fuel is required.

Reactor fuels can be purified continuously to remove fission products and radiation-damage products. Fuel preparation, handling, and reprocessing are simplified, and a high degree of utilization of the fuel is achieved.

The reactors possess very high stability. Control rods or plates are unnecessary.

Simple mechanical design results from the use of a fluid fuel and moderator, and the elemination of control elements.

The absence of structural materials in the reactor core, the use of heavy water as the moderator, and the continuous removal of fission-product poisons make it possible to reduce the parasitic absorption of neutrons to a minimum.

These reactors also possess some undesirable characteristics, which include the following:—

High pressures are associated with the high temperatures required for producing power efficiently.

Large volumes of very highly radioactive materials are present in a fluid state at a high temperature and a high pressure. Provision must therefore be made for containing these materials if they should leak from the reactor vessel or piping. Also, pumps, piping, and heat exchangers become radioactive from contact with the fuel, and their replacement or repair can be difficult and expensive.

Uranium, plutonium, and thorium compounds, water, and materials of construction form complex systems, which impose limitations on the operating conditions by their physical and chemical characteristics and by corrosion and erosion effects.

Deuterium and oxygen are produced by radiolytic decomposition of the moderator. They must be recombined safely.

Although difficult problems remain to be solved, the aqueous homogeneous reactors appear to be among the most promising for producing nuclear power economically.—*Paper by R. B. Briggs and J. A. Swartout, read at the International Conference on the Peaceful Uses of Atomic Energy, Geneva, 30th June 1955. Journal, The British Shipbuilding Research Association, December 1955; Vol. 10, Abstract No. 11038.*

High Pressure Steam Piping for Marine Turbines

The greatest danger for ships' steam pipelines lies hidden in high amplitude, low frequency vibration (300 to 500 per minute). Although no results are known of tests in which actual operating conditions were approached, it is a fact that the resistance of the materials used is often considerably lower than the 100,000-hour failure limit which is generally the basis for the calculations. There are sound reasons for assuming that at the appearance of bending and torsional vibrations the resilience will be reduced to less than 50 per cent of the 100,000-hour failure limit. Experience gained during the past few years has shown that in a number of cases the methods used by some contractors of calculating and installing high-pressure steam piping have proved inadequate. It should be borne in mind that as a rule a safety factor of 1·5 with respect to the 100,000-hour failure limit is used when calculating marine high-pressure pipework. The permissible load will then be only slightly below the generally accepted creep limit of one per cent per 100,000 hours. Therefore, apart from extra loading resulting from vibration, slight inaccuracies in the methods of calculation and fitting could lead to stresses during operating conditions which are considerably higher than the one per cent per 100,000 hour creep limit. Generally speaking, this situation is not permissible for marine installations with a complex pipework system. It is true that transgression of the creep limit in many cases will, after a longer or shorter period, lead to a reduction of stress peaks, but sometimes this will not be the case, so that a rapidity of creep is maintained which is not permissible. In addition, the temporarily increased creep speed with ensuing permanent deformation is not permissible in some cases, since the stresses in the pipework in a cold condition will diverge from the calculated condition. Several cases are known in which, in all probability in consequence of this phenomenon, stresses in an idle pipeline (for example the astern turbine connexion) increased beyond the pre-set limit, after which, under the influence of vibration, the material resilience was exceeded, resulting in a failure in the cold pipe. During the past few years a number of installations have been built which, in consequence of inadequate methods of calculation or operation, must be considered as not sufficiently safe. A number of accidents, mostly of a serious nature, occurring through failures in high-pressure steam lines, has proved the correctness of this allegation. In order to eliminate all unknown factors in installations, a measuring method has been developed which enables the accurate measurement of the stress conditions in the pipework while fitting. This ensures that all values calculated for all points of the system are preserved. In this manner some empirical factors in the method of calculation could be verified by direct measurement. An investigation into the influence of the flange connexions on the elasticity of the pipework runs along parallel lines. Based on information received from the United States and Italy, N.V. Bronswerk, after prolonged experiments and extensive metallurgical investigations have succeeded in devising a simplified welding method. By making use of an Argon-arc welding method the root weld in high-grade carbon steel and low-alloy steel pipe welds is now of such a nature that internal grinding and polishing as hitherto required by Lloyd's Register of Shipping and the American Bureau of Shipping is no longer needed. The Argon-arc welding method produces a seam structure even in the stress-free annealed condition which is little different from that of the pipe material. In a normally annealed condition the structures are virtually identical. A similar result has not up to now been obtained with any other welding method. Though experiments have not yet been concluded, there are now sound reasons for assuming that the resilience of the welds obtained with the Argon-arc seam will be higher than that of connexions obtained with any other welding method. This means greater safety, especially in dynamically loaded pipelines. Careful investigation has shown that there is virtually no difference in the mechanical properties of the seam and pipe material.—*J. R. Olie, Holland Shipbuilding, February 1956; Vol. 4, pp. 24-25; p. 40.*

Finnish Cement Carrier

The single-screw cargo motor vessel *Pargasport,* 2,300 tons d.w., built by N.V. Scheepswerf and Machinefabriek "De Merwede", Hardinxveld, for Messrs. OY Semtrans, Pargas, Finland, is specially arranged for the carriage of cement cargoes. One of the features of the ship's design is that, although the whole of the living accommodation has been arranged aft, the master's quarters are in the bridge deckhouse amidships. This has been done in view of the difficulties of navigation in the narrow waters around the Finnish coast. The placing of the wheelhouse amidships is for the same reason. The principal dimensions of the m.v. *Pargasport* are as follows:—

Length overall, metres	86·45
Length b.p., metres	78·00
Breadth moulded, metres	12·00
Depth to maindeck, metres ...	5·68
Deadweight, tons	2,300

The *Pargasport* has been constructed to Lloyd's Register of Shipping Class 100 A1 with strengthening for navigation in ice and supplemented by the requirements of the Finnish Ice Class 1C. The shell plating is joggled and frames and seams are riveted. The side shell plating from deck to bilges is doubly riveted for the full length of the vessel. The butts are welded. The main propelling machinery consists of an 8-cylinder direct-reversible Werkspoor Diesel engine, and is capable of an output of 1,200 b.h.p. The engine has the following pumps built on to it: fresh cooling water pump, seawater cooling water pump, fuel injection needle cooling oil pump, lubricating oil pump and air compressor.—*Holland Shipbuilding, February 1956; Vol. 4, pp. 19-20.*

Dutch Steam Turbine Tanker

The steam turbine tanker *Vasum,* recently handed over by her builders, the Netherlands Dock and Shipbuilding Company, Amsterdam, to the N.V. Petroleum Maatschappij "La Corona" (Royal Dutch/Shell Group), is the first supertanker of this Group to be operated under the Netherlands flag. She is the first of two sister ships to be commissioned, and one of nine similar ships ordered by the Group. Of these, five were ordered from British yards, two in France and two in the Netherlands. The first of the French-built 31,000-tonners is the *Isanda,* the first of the British-built ships the *Vexilla.* The new ship incorporates several new features which show the intention of the owners to limit turnround in port to the minimum. The size of the centre tanks and of the wing tanks has been arranged so that the discharge of cargo and the loading of water ballast can be carried out simultaneously. The ballast is carried in tanks which will not normally be used for heavy petroleum products. The pumping and pipeline installation has been designed with a view to the carriage of crude and other black oils, the wing tanks being used for ballast. The principal particulars of the *Vasum* are as follows:—

Length overall	660ft.
Length b.p.	635ft.
Breadth moulded	84ft. 3in.
Depth moulded to upper-deck	46ft. 3in.
Draught	34ft. 9in.
Deadweight, tons	32,150
Gross tonnage	20,685
Block coefficient	0·78
Displacement, tons	40,600
Cargo capacity, cu. ft. ...	1,275,000
Horsepower: 13,000 s.h.p. at 105 r.p.m. and 14,500 at 109 r.p.m.	
Service speed, knots	16½
Steel weight at launch, tons...	7,600

The *Vasum* has been constructed on the combined longitudinal and transverse system of framing and is of fully welded construction. This vessel is propelled by a single screw, actuated by a geared Parsons turbine propulsion unit consisting of one ahead h.p. turbine of the all-impulse type and one l.p. turbine of the single-flow impulse-reaction type. The normal output of the propulsion machinery is 13,000 s.h.p. at 105 r.p.m. and the maximum output 14,500 s.h.p. at 109 r.p.m. The turbines, which were constructed by the N.D.S.M. under licence, work in conjunction with two Babcock and Wilcox watertube boilers of the integral furnace type, also built by the N.D.S.M. under licence. The boiler pressure is 42 kg. per sq. cm. and the steam pressure at superheater outlet is 850 deg. F. For astern working there is one h.p. astern turbine of the impulse type. It is arranged at the forward end of the h.p. ahead turbine. In addition, one l.p. astern turbine is incorporated in the l.p. ahead turbine casing.—*Holland Shipbuilding, January 1956; Vol. 4, pp. 29-32.*

Dutch-built Passenger Vessel for Brazil

The new building programme of the Serviços de Navegaçao da Amazonia e de Administraçao do Porto do Paré (SNAPP), of the Brazilian Ministry of Public Works, in addition to the passenger/cargo motor ships and sternwheelers, also comprised a passenger ship for which the order was placed with the Haarlemsche Scheepsbouw Mij., N.V., Haarlem. The ship was named *Presidente Vargas,* and the principal particulars are as follows:—

Length overall, metres	79·60
Length b.p., metres	73·20
Breadth moulded, metres	11·10
Draught loaded, metres	2·50
Speed on trials, knots	18

The ship has been built under the special survey of Lloyd's Register of Shipping, Class ✠ 100 A1 "for coastal service Brazil". Although the ship is designed for speed, its seaworthiness in a rough sea was especially noted during trials. A special feature of the ship is its all-welded steel hull. Extensive use has been made of automatic electric welding. With a view to the danger of excessive corrosion through heat and moisture in the Amazon region, all steel structural parts were sand-blasted by the yard before painting. Woodwork, also in consideration of the climate, received special treatment. All the linings of the cargo holds and the grounds of the linings of the accommodation have been pressure-treated with a solution of Wolman salts, to protect them against destruction by insects. The whole of the accommodation is fitted with forced-draught ventilation; the special class bar-restaurant, as well as the captain's and luxury cabins are air-conditioned. Deck machinery includes an electrically-driven van der Giessen windlass as well as a warping capstan placed aft. The steering engine is of the Hastie electro-hydraulic type. For the handling of cargo there is a Kampnagel/Schaerffe deck crane of 5 tons capacity with an outreach of 10 metres. It is placed forward of the bridge and permits the loading of motor cars and trucks. The main propelling machinery consists of two direct-reversing, two-stroke Sulzer Diesel engines, having an output of 1,330 b.h.p. at 300 r.p.m. in the tropics. Each of the 8 cylinders has a bore of 360 mm. and a stroke of 600 mm. The engines are cooled by fresh water in a closed circuit, with electrically-operated fresh water pumps, while the seawater for the inter-coolers is supplied by a piston pump attached to the engines. Each of the main engines has attached to it a bilge pump, and a double air compressor.—*Holland Shipbuilding, January 1956; Vol. 4, pp. 38-40; 50.*

Shipborne Wave Recorder

The desirability of a wave recorder which can be used from a ship at sea has recently been increasingly apparent, both for research into the generation and propagation of waves and for the study of ship motion. The main problem in designing such an instrument is that no steady platform is accessible for mounting it, though attempts have been made to use a drogue in the water below the action of the waves, say at a depth of 150 feet, for this purpose. Practical experience with this and similar methods has shown that no method of wave recording which involved stopping the ship and putting equipment over the side would be satisfactory, mainly because in bad weather handling such equipment is both difficult and dangerous. To give satisfactory results under all weather conditions the recorder must be simple to operate; it must also be reliable, since repair at sea may be difficult or impossible. A wave recorder which can be used from a ship under way enables the dominant direction of the waves to be measured, and is convenient in the study of ship motion. The instrument described measures waves from a ship at sea. It combines measurements of the sea pressure at a point on the ship's hull with the vertical displacement of this point obtained by double integration of the output of a vertical accelerometer. No equipment has to be put outboard. An instrument of this design has now been in service for more than two years, during which time several thousand records have been taken.—*Paper by M. J. Tucker, read at a meeting of The Institution of Naval Architects on 21st March 1956.*

Flame Plating with Tungsten Carbide

Carbide materials offer such unusual advantages for a wide variety of wear applications that it was inevitable that some means of utilizing this coating or "plating" material for metal surfaces would be developed. In the Linde detonation-gun combustion process of carbide plating, the plating applied is composed of tungsten, carbon, and 8 per cent cobalt. By nature of the process, the coating consists of layers, or laminæ, which are clearly revealed by etching. Each layer is composed of bodies which are flattened, spherical, or angular, large or minute, related to each other in a more or less periodic manner. Even though there is a distinct boundary between the coating and the base metal, there is no visible oxide layer. The exact type of bond between coating and base metal has yet to be determined; however, according to indications it is more than mechanical. The detonation gun used in the process employs a barrel and a mechanism for loading precise quantities of tungsten carbide powder, acetylene, and oxygen into the firing chamber, as illustrated schematically in Fig. 2. The tungsten carbide powder remains suspended in the explosive gases until a spark ignites the mixture, producing heat and pressure waves. The waves are concentrated by the shape of the barrel within a small area, producing tremendous heat and pressure. As the temperature reaches 6,000 deg. F. detonation occurs, with the flame front moving at supersonic velocities. The tungsten carbide powder is suspended in the burned gases, and the pressure inside the barrel reaches 10,000lb. per sq. in. in 0·003 second. After detonation, the shock wave dissipates into the air. The gases in the barrel burst out, carrying the tungsten carbide powder. The particles of tungsten carbide become partially molten and are deposited on the workpiece at a velocity of approximately 9,000 fps, the speed of the detonation wave. Though the frequency of detonation may be varied, it is usually several detonations per second for most carbide applications. The succession of blasts striking the surface of the part builds up the particles, fusing them together until the desired thickness is obtained. A clean surface is required for the process, preferably roughened as by grit-blasting, or thinly coated with a soft metal such as copper, nickel, or cobalt. The part to be plated is positioned about 3 inches from the open end of the gun. Under typical conditions, a layer of tungsten carbide, 0·020in. thick, can be deposited at a rate of about 1 sq. in. per min. Most metals can be plated, including steels, cast iron, aluminium, copper, brass, bronze, molybdenum, titanium, nickel, and magnesium.—*R. H. Eshelman, The Engineers' Digest, March 1956; Vol. 17, pp. 99-100.*

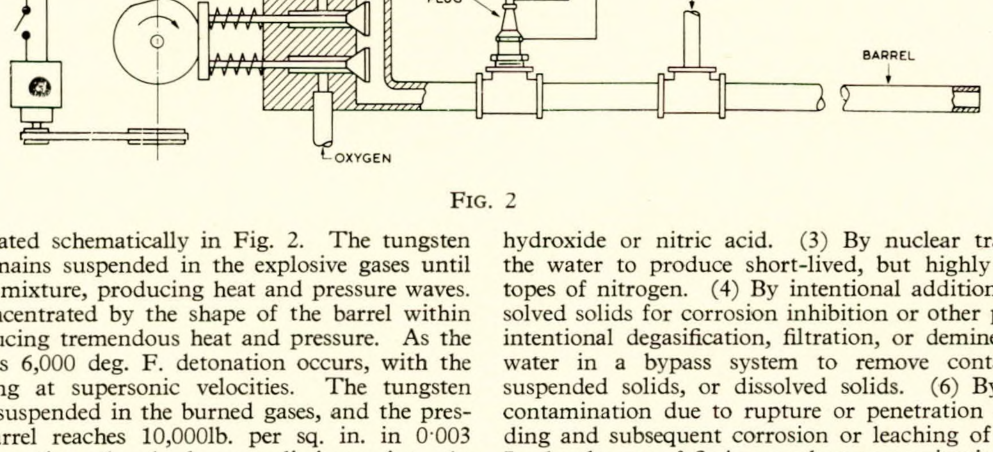


FIG. 2

Water for Primary Systems in Water-cooled Power Reactors

In sharp contrast to the evolutionary developments of water technology for conventional steam power plants, water technology for nuclear power plants of the pressurized light water type employing stainless steel systems is now based on a few years of development work and even fewer years of operating experience with full-scale plants. The water in the primary system of the pressurized reactor should be of high purity because radioactivity will be induced in impurities; it should also be non-corrosive and non-fouling in nature, for obvious reasons. Conventional water treating methods are employed and usually involve, at least as a final step, demineralization with a mixed bed of hydrogen-form cation exchange resin and hydroxyl-form anion exchange resin. The make-up water may also be (a) mechanically deærated, (b) deoxygenated with a sodium sulphite-regenerated ion exchange resin, or (c) used with no dissolved gas removal. After water has been added to the system and is being recirculated, its purity may be affected in several ways: (1) By contamination with corrosion products due to corrosion of any of the system materials in contact with the water. (2) By radiation-induced reactions of dissolved gases to form electrolytes such as ammonium hydroxide or nitric acid. (3) By nuclear transformations in the water to produce short-lived, but highly radioactive, isotopes of nitrogen. (4) By intentional addition of gases or dissolved solids for corrosion inhibition or other purposes. (5) By intentional degasification, filtration, or demineralization of the water in a bypass system to remove contaminating gases, suspended solids, or dissolved solids. (6) By fission product contamination due to rupture or penetration of the fuel cladding and subsequent corrosion or leaching of the fuel "meat". In the absence of fission product contamination, potential fouling problems arise almost entirely from the circulation of suspended corrosion products in the primary system. Soluble corrosion products and other soluble impurities (from the make-up water) are kept at very low concentrations due either to low solubility limits in high temperature water or to intentional removal by bypass demineralization. Concentrations of insoluble corrosion products are not, however, ideally transportable and tend to deposit or settle out at any point in a system where suitable conditions exist. Thus only a part of these insoluble products ever reach the bypass filter. Tests have indicated that radiation tends to promote deposition of corrosion products. Other factors having an influence on deposition appear to water chemistry, concentration of corrosion products in the water, and water velocity.—*Combustion, January 1956; Vol. 27, pp. 62-63.*

Largest East-German Motorship

The largest ship yet built in the shipyards of East Germany was launched at the State-owned VEB Warnowwerft, at Warnemünde, on 14th January. This vessel, the *Frieden*, 10,000 tons deadweight, is a fully welded, twin-screw cargo motorship, with accommodation for twelve passengers, intended for service in the BEV Deutsche Seereederei, the newly-established State-owned merchant navy of the East German Republic, in its service between Rostock and the Far East. A second vessel of the same class will be launched shortly, for export to Communist China and two more (for the same customer) are in an advanced stage of construction. The *Frieden* is constructed under survey to the highest class of the German Ship Revision and Classification, with plating of thickness suitable for a full scantling ship and welded seams, butts and joints. Her principal particulars are as follows:—

Length o.a.	517ft. 0in.
Length b.p.	566ft. 0in.
Breadth moulded	65ft. 7in.
Depth to main deck	42ft. 0in.
Depth to freeboard deck ...	31ft. 8in.
Draught (shelterdeck)	27ft. 7in.
Gross tonnage	6,600
Hold capacity (grain)	684,000 cu. ft.
„ „ (bale)	583,000 cu. ft.
Refrigerated space	15,800 cu. ft.
Speed on trials, knots	16·5
Crew	55

The propelling machinery, which is arranged aft with a bridge house amidships, consists of four direct reversible, single-acting, four-stroke turbocharged Diesel engines made by EKM Halberstadt. An entirely new section has been created specially for the making of such engines on licence at the State-owned VEB Karl Liebknecht Schwermaschinenbau (formerly Buckau-Wolf), at Magdeburg. The technical details of these engines are as follows:—

Power output, h.p.	2,400
Revolutions per minute	275
Cylinder diameter, inches	18·47
Piston stroke, inches	25·93
Number of cylinders	8
Overload capacity, per cent	10

The motors are geared to the twin shafts through electro-magnetic couplings. The twin propellers have a diameter of 14ft. 9in. and a pitch of 17ft. 6in. Electric power is supplied by a 350-kW turbogenerator and three Diesel-generators of 200 kW each, running at 500 r.p.m. There is also an emergency Diesel-generator of 12 kW. Steam is supplied at a working pressure of 14 atmospheres (199lb. per sq. in.) and a temperature of 446 deg. F. by two automatically-controlled boiler plants, each comprising two exhaust-gas boilers and one oil-fired auxiliary boiler. Electrically-driven pumps are provided for the usual purposes and there are three electrically-driven compressors, each with a suction capacity of 2,760 cu. ft. per hour.—*The Shipping World, 22nd February 1956; Vol. 134, pp. 210-211.*

Service Performance of Free-piston Generator Plants

The French coasters *Cantenac* and *Mérignac*, owned by the firm of Worms et Cie., Paris, are the first cargo ships to be equipped with propulsive machinery consisting of free-piston gas generators and gas turbines. On each ship there are two S.I.G.M.A. free-piston gas generators and two Alsthom gas turbines driven by the hot gases supplied by the generators. The turbines are coupled to a common propeller shaft through gearing which reduces the normal turbine shaft speed of 9,600 r.p.m. to 200 r.p.m. The *Cantenac* entered service on 6th February 1954, and by 1st January 1955 had covered a distance of 35,402 nautical miles at an average speed of 10·61 knots. During this period the total average consumption of Diesel oil, including the generators and all auxiliaries, periods of manœuvring, and periods in port, was 2,200 metric tons per 100 miles. At service speed, the total average consumption (main engines and auxiliaries) was 1,772 metric tons per 100 miles. In order to improve the fuel consumption, modifications were made on the *Mérignac* before she was put into service on 14th August 1954. These included a change of propeller; change of turbine blading; and the installation of a recirculation system to reduce fuel consumption at low ship speeds. In the period 14th August 1954-1st January 1955, the *Mérignac* sailed 13,536 nautical miles at an average speed of 10·84 knots; the total average consumption of Diesel oil at sea was 1,696 metric tons per 100 miles, and the total average for the whole period, which, as in the case of the *Cantenac*, included manœuvring and periods in port, was 2,085 metric tons per 100 miles. These figures confirm the efficacy of the modifications carried out as a result of *Cantenac's* performance during her first months of service, but exact comparison between the two ships is difficult owing to the fact that they did not sail under the same conditions. No major difficulties in running the ships were experienced, but lubrication of the free-piston generators proved somewhat troublesome owing to the tendency of the oil in the sump to ignite. This is thought to have been caused by an unsuitable lubrication oil, and recent tests by the S.I.G.M.A. have shown that by using the right oils the trouble can be completely eliminated. No trace of wear or blade fouling has been detected in the turbines. No piston ring sticking or cracking was reported. To lessen liner wear, chromium plated piston top rings were fitted on the *Cantenac* after examination of the generators, but the effectiveness of this measure will have to be assessed later. The following parts developed cracks and had to be replaced: (*a*) the central annular piece of the combustion cylinder in which the injection nozzles fixed (two failures); (*b*) compressor pistons (four failures). The S.I.G.M.A. has suggested two possible causes for the failures of the annular pieces; one is the corrosive effect of the cylinder cooling water and the other a possible defect of the cooling circuit whereby, owing to syphoning of the cooling water, hot surfaces might be cooled too rapidly. The failures of the compressor pistons are attributed to faulty fitting of the compressor cylinders. Suitable measures have been taken which, it is hoped, will eliminate these defects in the future.—*Shipbuilding and Shipping Record, 19th January 1956; Vol. 87, pp. 79-80.*

Survey of Dredges and Other Harbour Craft

A large modern port requires dredging and other harbour craft to ensure that it is kept open for shipping, to service the ships using the port, and for other purposes. The number and type of dredge craft required will depend on the size and situation of the port and its approaches, the nature of the tides and the soil of the sea bed in the area, and/or the size and character of the river on which it may be situated. In some cases it may be necessary to carry to sea for disposal some 15,000,000 tons or more of material annually in order to keep the water of the entrance channel, and in the harbour, at a depth suitable for the safe nagivation of the ships using the port. The most expensive harbour craft in terms of capital outlay and upkeep can, therefore, be those employed in dredging. To achieve this amount of dredging and provide the services mentioned above, a number of multi-bucket dredges, and/or suction dredges, and/or grab dredges, and/or dipper dredges, together with rockbreakers, hopperbarges, salvage or general purpose vessels, floating cranes, pilot vessels, sewage disposal vessels and tugs may be required. A small port, however, may need few, if any, craft and might have difficulty in employing even one small independent unit such as a self-propelled grab hopper dredge. It is not unusual for one small dredge unit to service a number of adjacent small harbours. This paper describes the many types of craft necessary for dredging and other harbour requirements, with observations on their design, construction, and the duties they perform.—*Paper by H. H. Hagan, read at a meeting of The Institution of Naval Architects on 21st March 1956.*

The Doxford Engine—Progress and Development

The principal developments in connexion with the Doxford marine Diesel engine in the past few years have been the development of supercharging and the extensive use of boiler fuel. The paper gives an outline of the development work undertaken in the supercharging of the Doxford engine and a brief survey of the experience at sea. The characteristics of the supercharged two-cycle opposed-piston engine are described, together with a resumé of technical and commercial advantages of supercharging. Similarly, a description is given of the employment of boiler fuels and of the advantages to be gained. A description is given of difficulties encountered and methods developed for overcoming these. The diaphragm engine and oil cooling of the lower pistons have been developed for the Doxford engine, particularly to enable boiler fuel to be used and to eliminate the troubles. A new fuel injection system has been developed, known as the "timing valve injection" system, and a description is given of the characteristics of this system together with a survey of the advantages. In conjunction with this new fuel system a new air starting system has been developed, which together enable reversing and manœuvring to be accomplished with a single lever. Prospects of improving the thermal efficiency and rating of marine two-cycle engines are reviewed together with proposed methods of achieving mechanical simplification.—*Paper by A. Storey read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 23rd March 1956.*

New American Bureau of Shipping Crankshaft Formula

The American Bureau of Shipping has included a new crankshaft formula in the section of its rules for internal combustion engines. The old rule was formulated over twenty years ago and during that time there has been considerable progress in the design and construction of Diesel engines. Better understanding and control of critical speed arrangements, stress concentrations, materials, bearing and lubrication arrangements, and other relevant aspects of crankshaft design have been developed from experience and research. This is not only true with regard to large slow-turning multi-cylinder propulsion engines, but a number of new types of higher speed engines with variations in cylinder arrangements have also been developed, such as the Vee, Deltic and radial types of engines. Advice and help in developing the new crankshaft formula were obtained from members of the Diesel Engine Manufacturers' Association in America and from most of the leading European engine builders. The new formula differs in several aspects from the existing rules and from traditional procedures. The rule is based on the assumption that vibratory torques will not exceed mean torque at full power. No distinction between two and four cycle engines is considered necessary. In the new rule, bending and torsional stresses have been combined in such a manner that the effect of bending is given increased weight. This increased emphasis on bending is believed to be desirable because bending is less subject to control under service conditions than torque. It is believed that the new rules reflect the actual technical development which has taken place and the quality of the materials now available.—*The Marine Engineer and Naval Architect, April 1956; Vol. 79, p. 104.*

Brittle-fracture-free Ship Plate

A recent research report summarizes the feasibility of special measures to make ship plate more resistant to the initiation and/or propagation of brittle fractures, which in so many cases have caused the complete loss of the ship affected. The three specific proposals dealt with in the report are (1) to inhibit crack initiation by the use of plates containing layers of weakness parallel to the plate surfaces; (2) to deter crack propagation by means of plates containing layers of notch-tough material; and (3) to arrest brittle cracks through the use of plates, within which rods of notch-tough material are incorporated at their edges parallel to the maximum tensile stress. Extensive study of the first proposal has led to the conclusion that layers of weakness in the thickness direction would not be effective in inhibiting the initiation of brittle cracks under the prevailing conditions in ships' operation. The second proposal was found to suffer from the limitation of the high cost which would be involved in using mild steel clad with stainless-steel sheet. Cladding with ferritic steel would lower the cost of the material, but would not avoid the high cost of the cladding process. With regard to the third proposal, it was concluded that if, at a suitable phase of rolling, one or more rods of a highly tough steel are placed on the plate and hot-rolled into it, they will form obstacles impenetrable to a brittle crack. If every plate had several crack arrestors rolled in, the chances for a brittle crack to penetrate into or across the plate might become very small. A method for producing a composite structure of this type is still lacking at present and pending its development the use of notch-tough beads in the longitudinal seam-welds of ships, to act as crack arrestors, is suggested.—*The Engineers' Digest, April 1956; Vol. 17, p. 127.*

Influence of Unfair Plating on Ship Failures

It was the primary purpose of this study to determine whether or not unfairness in deck or hull plates in transversely framed dry cargo ships may be substantial contributory cause to the loss of such vessels due to brittle fracture. Two essentially separate questions were considered. The first one concerns the effect of unfair bottom plating in compression, shirking its load and increasing the tensile stresses in the deck. The second one concerns the increase of tensile stresses in the deck due to unfair deck plating. An appreciable increase of tensile stresses due to either cause would, of course, contribute to the danger of brittle fracture. It is shown that the reduced effectiveness of warped or unfair bottom plating increases the tensile stresses in the deck only to an insignificant extent, less than 5 per cent. Unfair plating therefore cannot be considered a substantial contributory cause for brittle fracture. Using only the viewpoint of reducing the danger of brittle fracture, it does not seem appropriate to provide additional longitudinal stiffeners to decrease the unfairness of bottom plating. While such stiffeners might reduce the tensile stresses by an amount of possibly up to 5 per cent, it would seem that the same amount of material added to the deck would be more effective in reducing the tensile stresses. The question has also been considered whether a vessel may fail by brittle fracture of the deck due to unexpectedly large tensile stresses caused by dynamic forces during the jack-knifing of a vessel whose bottom plates have buckled. Such a failure, while due to weakness of the bottom plates, might not be recognized as such and ascribed to brittle fracture. The author shows that no such increase of tensile stresses occurs, and this possibility can therefore be dismissed. The increase of tensile stresses due to unfair deck plating was also found to be insignificant for the small unfairness to be expected at the time of construction. The effect of larger unfairness of some plate panels which might develop during the life of welded ships due to the combined action of operating stresses and residual stresses has also been studied. It was found that, in spite of gradually developing unfairness of deck plates, the maximum tensile stresses in the crucial longitudinal members of the deck do not increase above the value which the same loading combined with the initial residual stresses would have produced in the hull at the time of construction (when the unfairness was small). This result is due to the fact that the reduced effectiveness of the more unfair plating is overcompensated by a reduction of the residual stresses as unfairness develops. Summarizing, it was found that the unfairness of bottom or deck plating does not raise the tensile stresses to any significant degree. As any influence of unfairness on the danger of brittle fracture could be only through an increase of the tensile stresses, it is finally concluded that plating unfairness *per se* has no signficant bearing on the problem of brittle fracture.—*H. H. Bleich, Ship Structure Committee Report SSC-96, 1956.*

Design of Second Experimental Breeder Reactor

The Argonne Experimental Breeder Reactor II (EBR-II) is one of the five-prototype industrial power reactors selected by the United States Atomic Energy Commission for development and construction. It is a plutonium-fueled, unmoderated, sodium-cooled reactor with a power rating of 60,000 kW (heat). The plant consists of the reactor and heat removal system, the steam-electric power plant, and an integral fuel reprocessing facility. The plant is now in the engineering design and development stage, with construction scheduled to begin in 1956, and operation to begin in 1958. The heat produced in the reactor is removed by the primary sodium, and transferred to the secondary sodium system in the intermediate heat exchanger. The secondary sodium transfers its heat in the steam generator to produce a maximum of 200,000lb. per hr. of superheated steam which is delivered to the throttle valve of a 20,000-kW conventional condensing turbine at 850 deg. F. and 1,250lb. per sq. in. gauge. Five stages of feedwater heating are employed. The primary sodium becomes intensely radioactive in passing through the reactor, and a secondary, non-radioactive, sodium system is employed to isolate the radioactive sodium from the steam generator. The reactor consists of an enriched core of uranium-plutonium alloy, in the approximate shape of a hollow cylinder, surrounded on all sides by uranium breeding blanket. The average core power density is approximately 1,000 kW per litre, and the average core heat flux is approximately one million B.th.u. per sq. ft. per hour. The reactor is approximately 6ft. in diameter by 6ft. long and is divided into four main zones; central blanket, core, inner blanket, and outer blanket. Each zone is comprised of a number of right hexagonal subassemblies (2·3in. across flats of the hexagon) containing the fuel or blanket elements.—*Combustion, January 1956; Vol. 27, pp. 58-59.*

Fretting Wear in Mineral Oil

Experiments were conducted to determine the important factors of fretting in the presence of mineral oil. The results obtained with a hard steel ball vibrating in contact with a soft steel flat showed that, in the first few cycles, metal is transferred to the ball to cause galling and the softer metal is scored and plowed. The damage increases with the number of cycles. Wear fragments, which are generated at a constant rate, accumulate in the oil surrounding the contact area and cause the mixture to become a viscous paste that is physically displaced from the contact area. From this point on, fretting is "unlubricated"; and brown films and cocoa-coloured debris appear. In unlubricated fretting, the rate of wear depends upon the relative humidity of the surrounding air. Maximum wear occurs at approximately 30 per cent relative humidity. The physical properties of the debris change with humidity and apparently determine the rate of wear. In an investigation to evaluate lubricants for fretting, it is important to keep out of the "unlubricated" state and to hold humidity constant. Runs with a few representative additives show that certain additives do affect the area of the fretted spot and the occurrence of surface films.—*D. Godfrey, Lubrication Engineers, No. 1, 1956; Vol. 12, pp. 37-42.*

United Kingdom Atomic Energy Authority

The United Kingdom Atomic Energy Authority has three main Groups: Weapons, Industrial and Research. The Research Group carries out research and development directly relating to civilian application of atomic energy. The Industrial Group designs and operates factories for the production of uranium metal and the fissile materials uranium 235 and plutonium. It has also a design office for the design of pioneering type of nuclear power stations. The Industrial Group has also a Research and Development Branch which carries out experimental research into the operational problems of the factories and into specific development problems of new plant and nuclear power stations. The nuclear power programme of the future requires the development of new types of power stations as successors to the gas-cooled graphite-moderated power stations which are now to be constructed by industry in successively improved marks. The Research and Industrial Groups together explore the different possible types of future power stations and are carrying out design studies on the most promising types. During the last year, for example, a design study on the pressurized-water reactor has been carried out in collaboration with industry and the Central Electricity Authority. The comparative merits of this and other possible Stage-2 reactors are now being assessed. At the same time longer-range work is carried out on still more advanced reactors such as the homogeneous reactor and the fast reactor. This work combines with zero-energy reactor physics studies and is followed by construction of an experimental reactor. Each new reactor requires the development of specific technologies, particularly in the development of appropriate fuel elements and associated chemical-processing facilities for spent fuel elements. This development requires an intensive testing programme of reactor components, particularly fuel elements, and the Authority is now building three heavy water research and fuel-element-testing reactors to speed up such testing. These reactors require associated heavily shielded and remote-handling facilities for examining the highly radioactive components. These expensive central facilities are likely to continue to be provided by the Authority. It seems also likely that fuel-element fabrication and chemical-processing facilities will be held by the Authority. Industry will take an increasing share of the research and development work and construction work, for reactors and nuclear power stations, and the pattern of co-operation is being worked out by experience. —*Sir John Cockcroft, The Journal of The British Nuclear Energy Conference, January 1956; Vol. 1, pp. 3-12.*

Principal Types of Nuclear Fission Reactor

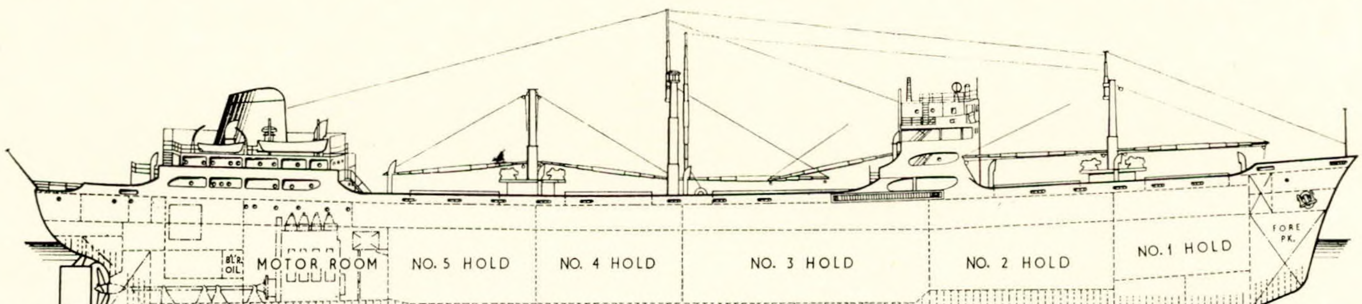
Of the dozen or so possible types of reactor the following six may be regarded as being of special importance and are being actively developed in different countries. *The graphite-moderated, gas-cooled reactor,* using natural uranium, is being built at Calder Hall and this type also forms the basis of the first stage of the United Kingdom power programme. Graphite-moderated gas-cooled reactors are physically of very large size but they offer the advantages of certain features of inherent safety and they can use ordinary natural uranium for their fuel. They may be expected to play a long and important role in the large-scale development of nuclear power. *The heavy-water-moderated and cooled type* has been actively pursued in Canada. It shares with the graphite-moderated gas-cooled reactor the advantage of being able to use natural uranium, but suffers from the disadvantage of the very high cost and limited availability of heavy water. *The light-water-moderated, water-cooled type* using slightly enriched uranium, known in America as the P.W.R. (pressurized water reactor), is probably the favourite runner for the first stage of nuclear power in the U.S.A. It requires enriched uranium, or a mixture of natural uranium and plutonium, for its fuel. Among the engineering problems involved are the use of high pressure plant and difficulties with corrosion. *The boiling-water reactor* may be regarded as a development from the pressurized-water reactor. The heat exchanger is omitted altogether and steam is generated directly by boiling the coolant water inside the core. Difficulties may arise with the possible contamination of the steam turbine plant in the event of a fuel-element failure and carry-over of activity with the steam. Nevertheless the boiling-water reactor is regarded as a promising development for the future and appears to offer a higher degree of inherent safety than was originally expected. *Graphite-moderated, sodium cooled reactor.* This is one of the possible types of liquid-cooled reactor which may play a prominent part in the second stage of the power programme. It will appear to the best advantage at very large power ratings and offers the possibility of higher temperatures and better steam conditions for the power plant. It again requires the use of slightly enriched uranium. *Fast reactor with sodium cooling.* The development of this type of reactor may be regarded as a long shot for the future. It holds out the prospect of the breeding of fissile material; that is, a rate of conversion of U238 to plutonium greater than the rate of fission of either U235 or plutonium. It requires a supply of highly enriched fuel and presents some very formidable engineering problems on account of the small size of the core. Experimental prototypes are being constructed at Dounreay in Scotland, and also in the U.S.A.—*J. M. Kay, Nuclear Engineering, April 1956; Vol. 1, No. 1, pp. 36-38.*

Italian Bulk Carrier

A new design of tramp ship has been developed by the Cantieri Riuniti dell'Adriatico, and the prototype vessel has now been completed. This ship, named the *Antonio Tarabocchia,* has been built to the order of the Societa di Navàgazione per Azioni "Lussino", Trieste. As the drawing shows this vessel has five holds and her Diesel propelling machinery aft. This type of ship with clear unobstructed holds and machinery aft has now become very popular on the Continent and is being taken up by British shipowners. The principal particulars of the *Antonio Tarabocchia* are as follows: —

Length o.a.	457ft.
Length b.p.	424ft.
Breadth moulded	60ft.
Depth to main deck	29·3ft.
Depth to shelter deck	38ft.
Draught fully laden	25·9ft.
Deadweight (metric), tons	10,002
Gross tonnage	5,851·6
Nett tonnage	3,204·3
Machinery output, b.h.p.	3,600
Service speed, knots	13·2
Trials speed (ballast), knots	14·66

She is of the shelter-deck type with a sunken forecastle, two tiers of deckhouses amidships, and two tiers of deckhouses aft. There are two mast houses, one arranged between Nos. 1 and 2 hatches, and one between Nos. 4 and 5 hatches, and goalpost mast carrying the heavy-lift derrick is fitted between Nos. 3 and 4 hatches. Suitable compartments have been provided for ballasting, some of which are arranged for ballast only, some for ballast or fuel oil and for fresh water or water ballast. The forward ballast tanks are the largest in view of the fact that the machinery is situated at the after end of the ship. The forepeak, trimming tank below No. 1 hold and the double bottom compartments in way of holds Nos. 2 and 3, are used exclusively for water ballast, having a total capacity of 69,258 cu. ft. The propelling machinery consists of a CRDA-Sulzer type four-cylinder, two-stroke, single-acting Diesel engine developing 3,600 b.h.p., and designed to operate on boiler fuel. Steam for ship's and engine room auxiliary services is obtained from two oil-fired and exhaust gas-heated Scotch marine boilers, each having a heating surface of 1,678 sq. ft. Electricity for power and lighting is supplied by two 150-kW Diesel-driven generators. An emergency generator of 20-kW output is installed in a separate compartment on the poop deck.—*The Shipping World, 9th May 1956; Vol. 134, pp. 447-448.*



General arrangement of the single-screw motor vessel Antonio Tarabocchia

Vibration in Boilers

A boiler that appears to be gasping for air is said to be vibrating or panting. The boiler flame increases and decreases in size with intermittent bursts of noise. A deficiency of air, excessive oil temperature, and poor air-oil intermixture causes the panting and vibration. The causes can be traced to improper burner cone angle, improper positioning of burner atomizer, diffuser plate deformation and clogging, and warping of burner parts. As a result of panting, the boiler brickwork may crack or fall out, particularly the plastic fronts, when there is severe vibration to the furnace walls. Vibration also may occur at different sections of the boiler installation, depending on the cause of the panting. Recently, a case of panting was reported in which serious vibration occurred in the boiler casings and uptakes at 15 knots and above. Inspection showed that the diffuser plate was distorted and cracked, and that the gap opening had been reduced to zero. New diffuser plates were installed, and the vibration and panting disappeared. Forces afloat should maintain the fuel oil burner installation in as nearly perfect condition as possible to avoid this difficulty in boilers. Burner refractory cones should be checked to make sure that the correct angle is kept during installation and use. Condition of the burner bladed cones and diffuser plate openings in the plate and shape and position of the plate should be checked whenever the boiler is inspected. These parts should always be located as specified on the burner plans. The position of the burner atomizer should be checked to see that it is in the position recommended by the boiler manufacturer. An incorrectly placed burner atomizer can cause fouling of the diffuser and bladed cone, and build up carbon on the refractory openings, tubes, and walls in the furnace.—*T. J. Lund, Bureau of Ships Journal, March 1956; Vol. 4, p. 23.*

High-temperature Fatigue in Presence of Thermal Stress

Thermal transients in large high-temperature machines represent a serious problem for the designer. Examples include temperature gradients in large steam turbines with rapid start-ups, welds between ferritic and austenitic materials, complex pipe assemblies, and many others. Here temperature gradients or mismatch in expansion of structural materials or expansion under conditions of constraint leads to thermal stresses which may be quite severe. Plastic deformation may occur in such situations, which, if cyclic conditions prevail, can lead to cracking by fatigue in an otherwise ductile metal. The situation can be particularly severe in nuclear-power equipment. The particular problem facing the designer is the evaluation of calculated stresses in excess of the yield stress of the material, these stresses arising from transient thermal conditions. Generally the part in question may receive only a limited number of thermal cycles during its life. The reduction in stress to values where conventional fatigue-design procedures are applicable may be difficult from a design point of view, or impractical because of the particular operating conditions imposed on the component. Thus a design procedure, which is based on a limited number of thermal cycles and which permits some plastic deformation, would have many applications in equipment operating at high temperatures. A criterion for fatigue failure is proposed, based on experiments carried out on test specimens subjected both to constrained thermal cycling and constant-temperature strain cycling. This criterion relates the number of cycles to failure with the plastic strain change per cycle. The application of such a criterion to design, where thermal-stress fatigue is the principal factor, is discussed from fundamental and practical viewpoints. From such a criterion it is possible to predict the life of a certain machine part for a calculated thermal stress, or conversely, the thermal stress permitted for a certain limiting number of cycles of stress.—*L. F. Coffin, Transactions A.S.M.E., April 1956; Vol. 78, pp. 527-532.*

Exhaust Gas Boilers in Supertankers

The arrangement of auxiliary machinery in Diesel-engined tankers with propelling machinery of from 8,000 b.h.p. to 15,000 b.h.p. lends itself to much ingenuity in planning. With this relatively high-powered machinery the available power derived from the steam supplied from an exhaust-gas-boiler plant becomes significant and, for instance, if it is desired to take the fullest advantage of the heat in the exhaust, it is possible to generate 0·9lb. of steam per engine b.h.p. at a pressure of 180lb. per sq. in. The case for the exhaust-gas boiler in a tanker differs from that in a dry-cargo ship because of the smaller demand for electricity at sea, so that the generating plant is of lower output in relation to the power of the propelling engine. Hence, the exhaust-gas boiler installation becomes of greater importance and its possible arrangement is, therefore, worthy of closer study. Broadly speaking, with a 10,000-b.h.p. propelling engine it is quite simple to raise exhaust steam equivalent to from 200 to 400 b.h.p., representing an economy of 2 to 4 per cent. This affords a saving of from 300 tons to 600 tons of fuel annually, the value of which is from £2,000 to £4,000. Even if it is not desired to raise the maximum amount of steam, the quantity is substantial and, for instance, in the *Champs Elysées*, a 26,000-ton tanker with machinery of 11,200 b.h.p., some 4,400 to 4,900lb. of steam at 180lb. per sq. in. is generated from 60,000-70,000 kg. of exhaust gas at a temperature of 320 deg. C., the feedwater temperature being 50 deg. C. This steam is supplied to a reciprocating steam engine driving a 90-kW. generator and, in addition, the necessary steam is available for heating the fuel and for other purposes. As a result, only a negligible amount of oil is required for oil firing to provide any further steam that is needed at sea.—*The Motor Ship, March-April-May 1956; Vol. 37, p. 4.*

Cargo Motorship for Mediterranean Service

Trials have recently been carried out, in the Firth of Forth, on the single-screw cargo motorship *Flaminian*, built by Henry Robb, Ltd., of Leith, for the Mediterranean service of the Ellerman and Papayanni Lines, Ltd., of Liverpool. The *Flaminian*, which is of the open shelter-deck type, with a raised forecastle forward and tonnage opening aft, has been constructed under the special survey of officers of Lloyd's Register of Shipping, and is in accordance with the requirements of the Ministry of Transport and Civil Aviation, the Home Office and the Factory Acts. The principal dimensions and other leading characteristics of the vessel are as shown. The propelling machinery is situated amidships, and there are three holds forward and two aft.

Length overall	351ft. 2¾in.
Length b.p.	325ft. 0in.
Breadth moulded	52ft. 0in.
Depth moulded to shelter deck	30ft. 0in.
Depth moulded to upper deck	20ft. 10in.
Draught loaded	20ft. 3in.
Corresponding deadweight, tons	3,500
Bale capacity, cu. ft.	186,900
B.H.P.	3,350
Corresponding r.p.m.	133
Speed, loaded in service, knots	12½

Water ballast is carried in the cellular double bottom under the forward holds, with fuel oil in the double-bottom tanks at the after end of the machinery space and under the after holds. Freshwater is carried in the port and starboard double bottom tanks under the engine room, while lubricating oil and distilled water tanks are provided in the centre compartments. Both the fore- and after-peak tanks are arranged to carry water ballast for freshwater. The deck machinery is all electrically operated, and includes a booster-type windlass, warping winch and twelve 5-ton cargo winches, two of which are of the regenerative control type, suitable for 35-ton lifts. The hatchways are served by eight 5-ton, two 10-ton, two 15-ton and one 35-ton derricks. The *Flaminian* is propelled by a Clark-Sulzer vertical, single-acting two-stroke cycle crosshead-type oil engine, capable of developing 3,350 b.h.p. at 133 r.p.m. in service. The engine has eight cylinders, each of 600 mm. bore by 1,040 mm. stroke.—*The Shipbuilder and Marine Engine-Builder, April 1956; Vol. 63, pp. 193-194.*

Dutch Cargo Liner for Europe-Great Lakes Trade

The Schelde yard has delivered the 7,200 tons d.w. open shelter-deck motor cargo liner *Kinderdijk* to the Holland-America Line. This ship is the first of three, the second of which (*Kloosterdijk*) has been ordered from Flushing and the third (*Kerkedijk*) from the Lubecker-Flenderwerke. They are to be employed on the cargo services to the United States Eastern seaboard for the time being, but have been specially designed so that when the St. Lawrence Seaway is completed they will be able to trade directly to the Great Lakes. The *Kinderdijk* has been built to Lloyd's Register of Shipping highest class and is strengthened for navigation in ice. She has the following principal particulars:—

Length overall	457ft. 6in.
Length b.p.	425ft. 0in.
Moulded breadth	61ft. 9in.
Depth to shelter deck ...	37ft. 0in.
Draught	24ft. 6in.
Net tonnage	3,152
Gross tonnage	5,634
Total cargo capacity, cu. ft. ...	413,180

There are five main cargo spaces served by twelve 5-ton, four 10-ton and one 40-ton derrick. The mainmast and foremast are of unstayed tubular pattern and there are two pairs of king posts at the corners of the superstructure, which is aft of amidships. No. 3 'tweendeck space (38,430 cu. ft.) is insulated and No. 4 lower hold takes the form of deep tanks for 17,200 cu. ft. of liquid cargo. An American type of humidity control apparatus is provided for the general cargo holds. The entire ship's company comprising fifty-six men is accommodated amidships and there is spacious accommodation for twelve passengers. The new ship has a 7,200 b.h.p. nine-cylinder Werkspoor-Lugt engine which gives her a service speed of 16 knots. The construction of ships for the coming Seaway and Great Lakes trade is one which is concerning many Dutch shipowners and the very fast *Prins Willem van Oranje* with the 12-cylinder turbocharged Werkspoor-Lugt engine was one of the first of these to be completed.—*The Marine Engineer and Naval Architect, April 1956; Vol. 79, pp. 100-101.*

Safety Precautions in Closed Spaces

A recent explosion in a waterbox of a main condenser indicates that personnel aboard ship are not paying attention to the requirements of the Bureau of Ships Manual, and are not being properly instructed in safety precautions. The explosion occurred while two crew members were inside cleaning the inlet waterbox and inspecting zincs. One member lit a cigarette, and was badly burned. Investigation revealed that the condenser had been left filled with harbour water for a month and had been drained just before the men entered through the lower manhole. The sea water side had not been adequately ventilated, and had not been inspected and declared gas-free by competent authority. Articles 46-50 of the Bureau of Ships Manual state that idle condensers with tubes packed at one end with fibre-metallic packing shall be kept empty unless they are to be used within the next 6 or 7 days. In this case, they should be kept entirely filled with water. In the case mentioned, numerous changes in sailing orders could account for keeping the condenser filled for a month. However, the water was not circulated daily with the waterbox vents opened, or a gas pocket would not have formed in the top of the salt water side. A film of fuel oil was found on water remaining in the discharge box after the explosion, which circumstance undoubtedly contributed to the formation of the gas pocket.—*Bureau of Ships Journal, March 1956; Vol. 4, p. 23.*

The Dall Flow Tube

Several new types of flow-metering devices have appeared in literature or on the market in the past few years. One of these is a device which is a modified venturi tube produced under the name "Dall Tube". Some claims made for this device seemed contrary to the performance that would be expected from theoretical considerations. The company by which the author is employed has made a comprehensive study of this new type of flow-metering primary element. An examination of the Dall Flow Tube gives the impression that a fluid flowing through it will be subject to a very high loss of head. Actually, the loss is lower than for any other known primary device which operates by developing pressures dependent on the acceleration of the fluid.—*I. O. Miner, Transactions A.S.M.E., April 1956; Vol. 78, pp. 475-479.*

Contra-rotating Propellers

After a brief description of the velocity field induced by a propeller, the results obtained from open water tests with systematically varied contra-rotating propellers of the B3-65 type are discussed. The results of these experiments are given in a $B_p - \delta$ diagram. With the aid of this diagram it is possible to derive a satisfactory survey of the efficiencies of contra-rotating propeller systems. This diagram also supplies data concerning the optimum diameters and the pitch ratios of the front and rear propellers. An analysis with the aid of circulation theory of the results of the experiments shows that with a distance of 0·37 D between front and rear propellers the axial induced velocity generated by the rear propeller is, in way of the front propeller, about 30 per cent of the value it has infinitely far downstream of the rear propeller. Finally, a method based on circulation theory is developed by which contra-rotating propellers can be rapidly designed, provided they are of optimum diameter.—*Paper by J. D. van Manen and A. Sentic, read at a meeting of the Institution of Naval Architects on 22nd March 1956.*

Effect of Roughness on Ship Resistance

This paper deals with the effect on resistance of hull roughnesses, including the effect of structural roughnesses on all-riveted and all-welded shells and of paint and other local roughnesses which frequently occur. It is shown that the calculated reduction in resistance due to the elimination of structural roughnesses is in good agreement with conclusions based on ship trial data. The paper also shows the marked variation in the effect of structural roughness on large ships compared with small ships and suggests that the modern flush-welded ship with a good paint finish on top of clean bare steel will have a resistance considerably above that of a perfectly smooth surface.—*Paper by J. F. Allan, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 12th March 1956.*

Resistance and Propulsion of Single-screw Coasters

The paper gives results of resistance and propulsion experiments for a second series of coaster models with a length: breadth ratio of 6½. The effects on resistance of block coefficient, position of L.C.B., midship area and draught have been investigated. The effects on propulsion characteristics of block coefficient, position of L.C.B. and speed have been investigated, one propeller being used at a constant loaded draught. Resistance and propulsion results have been combined, and optimum position of L.C.B. for overall performance are given. These positions are slightly aft of those indicated by the resistance experiments, but are well within the tolerances noted for optimum resistance.—*Paper by J. Dawson, read at a meeting of the Institution of Engineers and Shipbuilders in Scotland on 28th February 1956.*

Welding Grey and Nodular Cast Iron

The welding of grey iron castings has been an accepted practice for many years. With the inherent low strength and nil ductility of this material, not too much is expected of many weld repairs. Nodular or ductile cast iron has much higher strength and possesses a substantial amount of ductility. Nodular castings are replacing certain steel castings and hence more is expected of nodular iron castings than of grey iron castings. Weld repairs on nodular iron must also have better performance than repairs on grey iron. Many processes and filler metals are available for welding grey and nodular castings. A simple test is therefore desirable to rate the various filler metals and welding procedures. A small test block for this purpose is described in this paper. The test results show that a specific procedure can be reproduced and hence the block can be used to discriminate between various procedures. In the nickel base class of filler metals, the 55 Ni type is capable of producing a sound deposit whereas the 94 Ni type is not. Sound welds can be made in nodular iron with the 55 Ni electrode, but grey iron is susceptible to base metal cracking near the fusion line with this electrode. Satisfactory results will be obtained if the grey or nodular cast blocks can be preheated to over 1,100 deg. F. and a similar filler metal (grey or nodular iron) can be applied. It is possible to control the oxy-acetylene, inert-gas tungsten-arc and carbon-arc processes to give good results on casting repairs.—*W. A. Schumbacker and A. L. Schaeffler, The Welding Journal, February 1956; Vol. 35, pp. 91-s - 99-s.*

New Piston Ring Material

A new piston ring material is proposed for internal combustion engines, especially compression-ignition engines, in order to make the piston rings more resistant to corrosive conditions, such as those arising from the use of fuel of high sulphur content. The inventors claim that while it has been established that an aluminium alloy piston with a cast-in austenitic ring carrier reduces very considerably the rate of wear on both the piston and the cylinder liner under corrosive conditions, its use involves a substantial increase both in weight and cost. In particular, such a ring carrier would often require rebalancing of the engine, to avoid an increase in torsional vibration and loss of power. It is therefore proposed to make the piston rings of aluminium bronze containing 5 to 15 per cent aluminium, 2 to 8 per cent nickel, 2 to 8 per cent iron, and 0·25 to 8 per cent manganese, the remainder being copper, with or without small amounts of tin, lead, and/or silicon. After heat treatment and tempering, these rings are claimed to be highly resistant to wear and to corrosion attack from fuel oils of high sulphur content. They may be chromium plated either on the periphery or over the whole ring surface, and are said to have the advantage that they can be carried directly in grooves formed in a normal aluminium alloy piston, without excess wear being encountered when using sulphur-rich fuel or other fuels producing acid deposits in the cylinder. They are also suitable for use in compressors and pumps transmitting a variety of corrosive gases and liquids.—*The Engineers' Digest, March 1956; Vol. 17, pp. 85-86.*

Pumping of Sodium Hydroxides in Nuclear Reactors

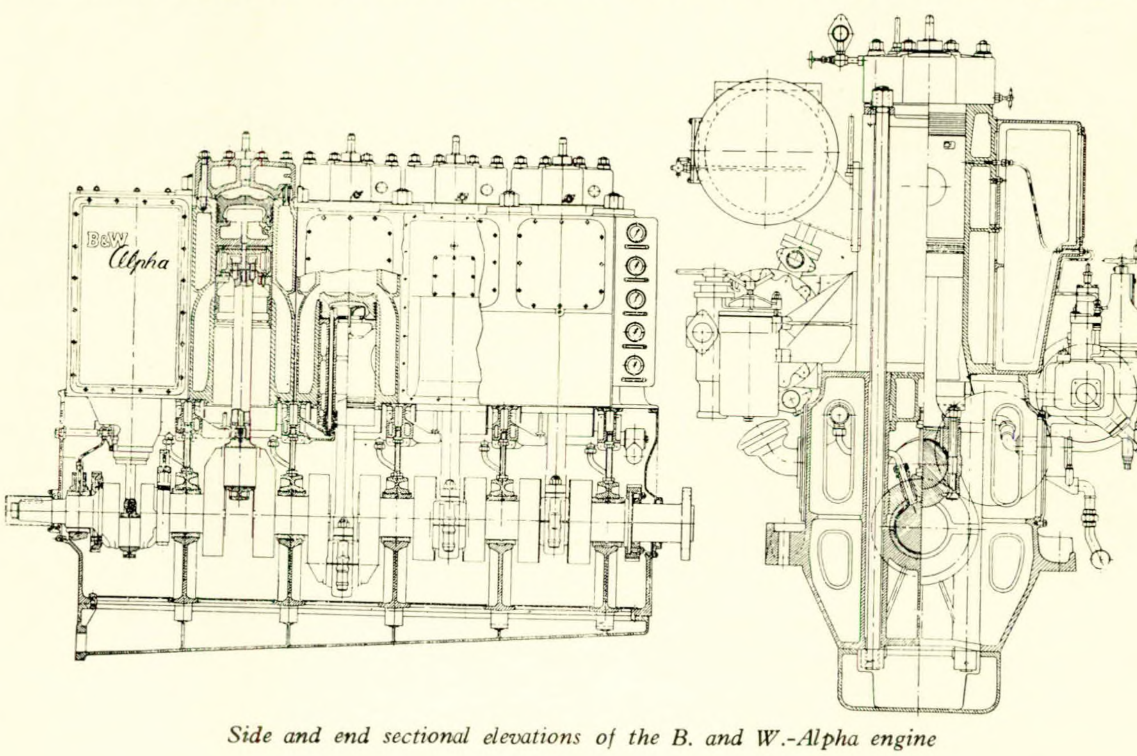
There is considerable incentive to find a suitable container material for the use of sodium hydroxide in nuclear reactors. In addition to its relatively low vapour pressure and favourable heat transfer characteristics, NaOH has attractive nuclear properties in the form of rather low neutron-capture cross-section and high hydrogen content for moderation. Furthermore, it is stable in the presence of radiation at elevated temperatures, as well as cheap and abundant. The authors described the design and operation of small laboratory loops for investigating the influence of temperature, thermal gradient, and flow velocity on the corrosion of nickel by circulating NaOH. Results of corrosion are given for the temperature range of 900 deg. F. to 1,500 deg. F. with thermal cycles from 70 deg. F. to 200 deg. F. Above 1,050 deg. F., with a practical thermal cycle of 1,000 deg. F., the cool section of the system may become completely plugged by nickel deposition in a relatively short time. From present knowledge, it appears that low maximum temperature and small thermal cycle are required for a reasonable lifetime of an NaOH-cooled reactor.—*Combustion, January 1956; Vol. 27, p. 65.*

Two-stroke Engines for Fishing Craft

The B. and W.-Alpha Diesel engine, manufactured by Alpha-Diesel A/S, a subsidiary of Burmeister and Wain, at Frederikshavn, Denmark, is designed essentially with a view to the propulsion of fishing vessels, coasters and tugs, the requirements for which include reliability in service, economy, ease of operation and simplicity and sturdiness of design. This engine is a two-stroke unit with loop-scavenging, having a piston-type built-on scavenging air pump. It is built with from four to eight cylinders, having a range of 480 b.h.p. to 960 b.h.p. The cylinder diameter is 290 mm., the piston stroke 490 mm. and the mean effective pressure 5·4 kg. per sq. cm. or nearly 77lb. per sq. in. The engine is available in three designs:—(1) directly reversible, (2) non-reversible, coupled to a reversing gear in which the friction coupling and reversing gear are hydraulically operated, and (3) non-reversible, coupled to a reversing gear for use in conjunction with a controllable-pitch propeller. The last-mentioned equipment, of Alpha design, comprises a friction coupling, hydraulically operated, and a double-acting pressure cylinder in which the piston—also hydraulically actuated—is attached to the rod (fitted in a bore in the shafting) controlling the variation of the propeller pitch. It is well known that in Scandinavia more interest is shown in the employment of controllable-pitch propellers than in other countries, because of the general belief in the advantages of this arrangement for fishing vessels which, in Norway, Sweden and Denmark, are almost exclusively fitted with variable-pitch propellers. The same arrangement is also preferred in many instances for coasters, and the Svenska Lloyd, for example, now operate the motor ships *Portia, Cordelia, Silvia* and *Hermia,* of 895 tons, all equipped with B. and W.-Alpha eight-cylinder 960 b.h.p. engines driving controllable-pitch propellers of the Alpha-Diesel design.—*The Motor Ship, March-April-May 1956; Vol. 37, pp. 6-7.*

American Passenger Liners

Designed for a cruising speed of 21 knots, the two new Moore-McCormack twin screw vessels will develop 25,500 normal and 28,000 maximum shaft h.p. Propulsion equipment consists of cross compound high and low pressure turbines with double reduction gears. The General Electric turbines will operate at 12,750 normal s.h.p. each with steam at 585lb. per sq. in., 855 deg. F. Three Foster Wheeler 70,000lb. per hr. oil-fired type "D" steam generators will furnish steam at 865 deg. F. and 600lb. per sq. in. gauge at the superheater outlets when supplied with feedwater at 281 deg. F. Any two of the three steam generators will operate the vessel at normal cruising speed plus furnishing steam for the normal "hotel load" of utilities and services. The two main condensers, each containing 10,000 sq. ft. of 70-30 cupro-nickel tubes, are designed to maintain vacuum of 28½ in. Hg. Cooling water, at the rate of 21,300 gal. per min. is introduced to the condensers through scoops in the hull. This feature, used for some time in United States Navy vessels, enables the operators to shut down



Side and end sectional elevations of the B. and W.-Alpha engine the main circulating pumps while the ship is cruising. The pumps (11,000 gal. per min. capacity) are operated only during slow-speed manœuvring, astern movement, or "in port" operation. The 617ft. 10in. vessels will include many novel features. The engine room is located in the aft third of the vessel to allow better arrangement of passenger facilities amidship. The boiler funnels, located port and starboard, are at the after end of the boat deck. The dummy stack amidship houses machinery and other equipment. An observation bridge is erected on the false stack for the use of passengers. Actuated fin-type stabilizers of the type installed on the *Queen Elizabeth* will limit the roll of the vessel.—*Heat Engineering, November/December 1955; Vol. 30, pp. 104-105.*

Corrosion of Cargo Ships and its Prevention

Sea water, which contains about 3 per cent of common salt and has a high electrical conductivity, is one of the most corrosive natural agencies. Under many conditions its corrosiveness is imparted to marine atmospheres in which considerable amounts of sea salts may be present in the form of a fine spray. It is not surprising, therefore, that the use of metals in ships and more particularly of steel, which plays a preponderating part in their construction, is accompanied by a number of corrosion problems that have to be solved if ships are to operate safely and efficiently. The purpose of this paper is to focus attention on the subject and to promote its discussion, by setting out briefly what has been learnt about the corrosion of iron and steel in ships and is prevention, through practical experience and as a result of research. No reference is made to the corrosion of oil tankers, which is a highly specialized subject. The problem of corrosion is not, of course, a new one, and has long been recognized in the Rules of Lloyd's Register of Shipping, which are summarized. It is interesting to note that even in their first form, 1888, they fully recognized the importance of the two major measures for preventing corrosion of the outer bottom: the removal of millscale before painting and the desirability of dry-docking new ships for repainting within a short time after launching.—*Paper by H. J. Adams and J. C. Hudson, read at a joint meeting of the Institution of Naval Architects and the Institute of Marine Engineers on 22nd March 1956.*

Heat Removal from Nuclear Power Reactors

The general problem is described of heat removal from nuclear-power reactors in which the fuel elements are in the form of solid rods or bars. The energy released in the fuel must be transferred to a coolant by forced convection and, for reasons of power cycle efficiency, it is desirable that it be transported from the reactor by the coolant at a temperature as close as possible to the maximum permissible fuel temperature. The influence of the coolant physical characteristics and of fuel element extended surfaces on the maximum coolant temperatures and on pumping power losses for a given heat removal rate are discussed, and gaseous and liquid coolants are compared. Simple methods are suggested for a first analysis of the heat transfer aspects of a reactor cooling problem and are demonstrated by an example in gas cooling.—*Paper by J. Diamond and W. B. Hall, read at the Symposium on Nuclear Energy held by the Institution of Mechanical Engineers on 28th March 1956.*

Nuclear Reactors for Power Generation

The paper is intended to be an educative introduction to the problems encountered when attempting to design nuclear reactors for power generation. It is based on five years' work in this field. Part I formulates various problems of reactor technology under the headings reactor physics, reactor materials, radiation and radioactivity and engineering design. In Part II an attempt is made to show how various kinds of reactor—fast, pressurized and boiling-water, and graphite-moderated—arise naturally from application of the elements of reactor theory and reactor technology. Part III deals with the running control of nuclear power plant. The Appendix on reactor theory is an attempt to summarize, in language comprehensible to engineers, the basic physics on which reactor operation depends. —*Paper by B. L. Goodlet, read at the Symposium on Nuclear Energy held by The Institution of Mechanical Engineers on 28th March 1956.*

Whale Catcher

The newest and largest of the Norwegian whale catcher fleet, the *Nortreff,* built by A/S Fredriksstad Mek Verksted, Fredriksstad, Norway, has a net tonnage of approximately 287 tons and measures 215ft. in overall length, 33ft. in breadth and 18¾ft. in depth. A Fredriksstad steam motor develops 3,400 i.h.p. to give the *Nortreff* a speed of 17½ knots. Steam is furnished by two Foster Wheeler "D" type watertube oil-fired steam generators. Each steam generator evaporates at normal load 18,000lb. of steam per hour. Pressure at the superheater outlet is 225lb. per sq. in. and temperature 570 deg. F. The feedwater temperature is 240 deg. F. The steam drum is 42in. diameter, the water drum 32in., and both drums are approximately 11ft. in length. The superheater is a convection type U-bend bare tube unit expanded into square carbon steel headers. The *Nortreff's* rigging is somewhat different from the usual whale catcher. The foremast is made in the form of a trestle, with the legs located a little way in on the deck in order to leave the whole gunwale free from shrouds and stays and to permit free outlook from the bridge to the gunner's platform. The aft masts have been omitted and replaced by a combined radar and signalling mast at the rear of the chasing bridge. The chasing bridge is located on the roof of the wheelhouse. The vessel is provided with modern navigation instruments including radio, radar, short wave transmitter, gyrocompass and direction finder.—*Heat Engineering, January-February 1956; Vol. 31, pp. 121-123.*

Electromagnetically Operated Pilot-injection System

Pilot injection has been recognized as a means of eliminating combustion knock in Diesel engines by the control of ignition delay. As a recent report points out, a satisfactory system can be expected to reduce fuel sensitivity, to increase power and fuel economy, and to reduce stresses in engine parts. These advantages would result in a reduction in operating cost and would be sufficiently attractive to adopt the principle of pilot injection, provided that the initial cost of the installation is not prohibitive. In order to investigate the influence of pilot injection on fuel sensitivity, the conventional jerk-pump fuel system of a precombustion-chamber single-cylinder Diesel engine was replaced by a common-rail system, and magnetically actuated fuel injectors and pilot valves were installed. Independent operation of the two injectors was effected by energizing the solenoids by timed condenser discharges. Experience with this system indicated that the magnetically actuated fuel-injection valve operating on a common-rail fuel system is not influenced by the surge in the fuel column experienced in a jerk-pump system. It is therefore possible to repeat accurately successive sprays at extremely close time intervals, or to control each spray independently of the other. This flexibility permits control in such a manner that a small initial fuel charge may be injected into an engine cylinder ahead of the main charge to act as a pilot and eliminate to a large extent fuel sensitivity. The investigation showed that a precombustion chamber type of engine may be operated with pilot injection on 20 cetane fuel as successfully as when using 50 cetane fuel.—*The Engineers' Digest, April 1956; Vol. 17, p. 128.*

Two Million Pounds of Weld Metal in Naval Vessel

Building the U.S.S. *Forrestal*, the first in the class of the largest and most powerful ships ever designed, was a pioneer effort for one of the most experienced shipbuilders in America, the Newport News Shipbuilding and Dry Dock Company. Her keel is 45 feet below sea level and the flaring stem curves 97 feet into the sky above the keel. The total area of her flight deck is nearly four acres. Her 1,039-ft. length and 252-ft. width make her longer and wider than any naval vessel afloat. Because the size and weight of everything connected with the ship is greater than in previous vessels, every item of equipment had to be designed especially for the job. Since the ship's estimated weight of 59,900 tons in the standard condition and over 70,000 fully loaded would snap any chain ever cast, engineers designed a special chain. It was 2,160ft. long and weighed 246 tons. Each link is 28½in. long by 17¼in. wide and weighs 360lb. Its breaking strain is 2,500,000lb. Almost 52,000 tons of steel of twelve different kinds was used in the construction of this great ship. This steel, plus aluminium, copper and many other metals, required 2,000,000lb. of weld metal, enough to make a weld ¼-in. wide and 2,400 miles long. The ever-growing importance of welding and cutting is well demonstrated aboard the *Forrestal*. A million-and-one fabrication jobs were accomplished with the help of oxy-acetylene flame-cutting machines and electric welding equipment and supplies. —*J. B. Davenport and L. M. Wood, The Welding Journal, March 1956; Vol. 35, pp. 248-249.*

Standard Gas Turbine for Variety of Fuels

In this paper two aspects of gas turbine and operation are dealt with. First, an account is given of the development of special types of "kinematic" construction suitable for accommodating the very large temperature changes encountered when a gas turbine is started and put on load rapidly. Examples are given of the application of this type of construction to representative components of a 750-1,000 kW. gas turbine. Secondly, a description is given of the development of combustion chambers to burn fuels ranging from natural gas and gas oil to residual fuels, coal tar fuel and peat. A range of chambers to burn these fuels has been designed to fit interchangeably on the basic components of the standard turbine. A detailed description is given of the development of a combustion chamber of elbow type which takes advantage of the fact that a number of changes of direction through 90 degrees or more are necessary in the ducting of nearly all industrial gas turbines. Development of this chamber is described from early atmospheric test models to the final pressurized combustion chambers which have been fitted to production gas turbines. With only slight adjustments, this type of chamber has shown itself capable of burning hydrocarbon fuels, ranging from natural gas to residual fuel oils, and a modified form of chamber has also successfully burnt low calorific value gases.—*Paper by G. B. R. Feilden, J. D. Thorn and M. J. Kemper, read at a meeting of The Institution of Mechanical Engineers on 6th April 1956.*

Steam Cycles and Nuclear Power Plant

The use of several reactor core coolant media is considered, and suitable single- and multi-pressure steam cycles for various reactor systems are discussed. Where the coolant circulating power consumption may be appreciable, the selection of the optimum operating condition for certain power reactors is illustrated. Methods of avoiding excessive moisture in the turbine exhaust which are particularly applicable to water-cooled reactors are suggested and discussed. It is recommended that with those reactor power plants limited to low coolant temperatures, the use of separately fired superheaters be given careful consideration, in view of the high utilization efficiency of the oil fuel and the very low initial capital cost of the resultng additional station capacity.—*Paper by R. E. Zoller, read at the Symposium on Nuclear Energy held by the Institution of Mechanical Engineers on 28th March 1956.*

Research Reactors in Nuclear Power Development

The rapid development of reactor technology is of vital importance for the achievement of economic nuclear power; the nuclear engineer has no broad background of past experience to guide him in the design and specification of nuclear power reactors but has to rely very largely on the results of theoretical calculations and laboratory experiments. The purpose of research reactors is to provide both the radiation-field and test bed facilities to enable the behaviour of reactor materials and components to be studied and tested under simulated operating conditions and to obtain fundamental information in the fields of reactor physics, chemistry and metallurgy. Not all these research and development activities can be performed in a single reactor; the present tendency is to design research reactors for fairly specific duties and the United Kingdom Atomic Energy Authority have in operation or under construction reactors for the study of shielding, core geometry, materials testing and fundamental measurement.—*H. J. Groot, The Journal of The British Nuclear Energy Conference, January 1956; Vol. 1, pp. 35-47.*

Torque-control Impact Spanner

An air-operated torque-control impact spanner, which will run a nut to any desired torque and then automatically shut itself off, has been developed. It is claimed that the new tool incorporates the first application of the torsion bar principle to torque control. While the nut is being run to required torque, the tool operates at normal power and speed but, when the required torque is reached and nut running resistance is equal to the stress present in the torsion bar, the impact mechanism rebounds instantly and trips a rubber-faced shut-off valve. Besides combining precision control of torque with power and speed, the following advantages are claimed for the new tool: torque adjustment is simple, and the tool can be set easily and quickly by using a jig, which turns a torsion bar and calibration collar to the desired reading against rigid splines on the torque bar adjusting sleeve. The torque setting remains constant for any nut running operation until the adjustment is changed. Releasing the trigger resets the tool automatically to the same torque for the next nut. There is said to be no need for pressure regulation, since the tool operates at full power and speed, over-torque being eliminated by the provision of an automatic shut-off. Operation of the tool is stated to be reversible, with full power available in either direction. Since the tool does not incorporate a clutch subject to wear and slip and requiring adjustment, maintenance should be low. The tool is made in two sizes, the smaller with torsion bars for 60ft.-lb. and 90ft.-lb., and the larger adjustable between 320ft.-lb. and 550ft.-lb.—*The Engineers' Digest, April 1956; Vol. 17, p. 128.*

Protective Lining for Cargo Oil Tanks

The internal corrosion of cargo oil tanks caused by the effects of alternate oil cargoes and salt water ballast is a matter of concern for shipowners and a number of palliatives have been tried with varying success. To these must now be added Prodorfilm, a cold setting material which polymerizes by chemical action and can be applied without stoving. The application of Prodorfilm, which is a polyurethane resin, involves the thorough cleaning of the metal surface by shot blasting, not only to remove all particles of corrosion, but also to provide a key for the adhesion of the lacquer. Subsequently the Prodorfilm is applied in a series of coats, commencing with a rust inhibiting primer, and finishing with the lacquer coats, to give a final thickness for fuel tank linings of some five-thousandths of an inch. The fuel tanks of H.M.S. *Grey Goose* and H.M.S. *Bold Pathfinder* are lined with Prodorfilm and in order to provide a practical test for more general cargoes the upper surfaces of two cargo tanks in the *Athelmere* were lined. These tanks are mainly used for the carriage of warm molasses or sea water ballast and provide an exacting test for the protective coating.—*Shipbuilding and Shipping Record, 12th April 1956; Vol. 87, p. 199.*

Patent Specifications

Supercharging Arrangements for Six-cylinder Doxford Engines

The diagrams in Fig. 4 refer to one of the patents taken out in connexion with the application of turboblowers to Doxford opposed-piston engines. In this instance a six-cylinder unit has reciprocating compressors (40, 41, 42) driven by means of links. The turboblower (43) is mounted at the back of the engine in the centre and is driven by exhaust gas supplied through pipes from the cylinders (44, 45, 46). Air discharged from the blower through a pipe (47) passes through an intercooler (48) to a manifold (49), from which the reciprocating compressors take their air. The size of the manifold is such that it damps out any pressure fluctuations. The engine-driven compressors discharge into the casing (5), which forms a reservoir for the air supplied to the cylinders. A by-pass pipe (50) may be fitted between the air manifold (49) and

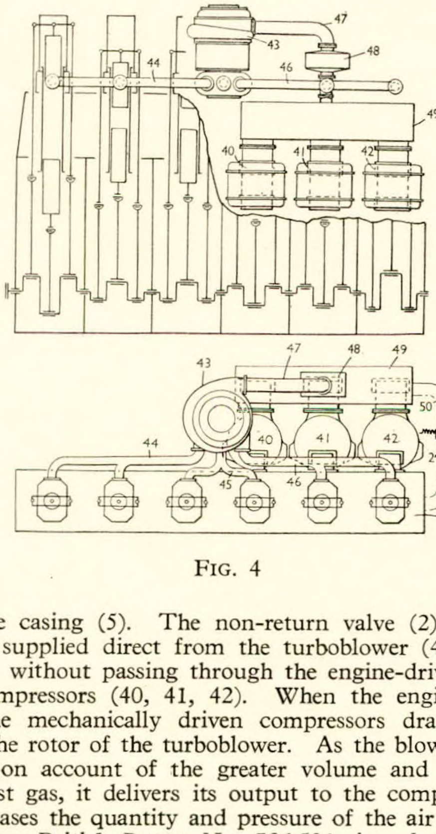


FIG. 4

the engine casing (5). The non-return valve (2) allows the air to be supplied direct from the turboblower (43) into the casing (5) without passing through the engine-driven reciprocating compressors (40, 41, 42). When the engine is being started the mechanically driven compressors draw their air through the rotor of the turboblower. As the blower increases its speed on account of the greater volume and pressure of the exhaust gas, it delivers its output to the compressors and thus increases the quantity and pressure of the air supplied to the engine.—*British Patent No. 736,581, issued to W. Doxford and Sons, Ltd., W. H. Purdie and P. Jackson, Sunderland. The Motor Ship, July 1956; Vol. 37, p. 148.*

MacTaggart Scott Steering Gear

With the mechanism illustrated in Fig. 2, the control wheel (29) moves a spring-loaded roller (26) along a lever (24), so that one of the reducing valves (11) allows fluid supplied under pressure through a hole (15) to bleed through an orifice (31). The greater the movement imparted to the roller (26), the greater the turning movement applied to the lever (24) and the higher the pressure built up on the discharge side. The orifice (31) of the second reducing valve is simultaneously placed in communication with the sump (19). The pressure is transmitted through the pipe (21 or 22, as the case may be) to act on the corresponding distributing valve (32), oil thus passing to the hole (37) connected to one end of the servo-motor cylinder (39). The second distributing valve places the other end of the cylinder in communication with the sump (42). The servo-motor is thereby operated to move the rudder,

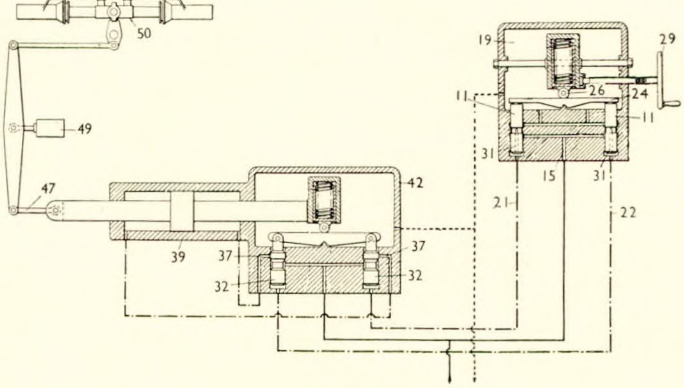


FIG. 2

through a link (47) and a control valve (49) supplying power to the steering unit (50), in the direction determined by the particular reducing valve opened. Both valves are returned to their balanced position as soon as the supply of oil under pressure is interrupted.—*British Patent No. 734,621, issued to MacTaggart Scott and Co., Ltd., and R. C. Russell, Edinburgh. The Motor Ship, July 1956; Vol. 37, p. 148.*

Cockburn-Cammell Laird Engine Control

An engine control apparatus is shown in Fig. 1, the device being adapted in this particular instance to stop the engine when the speed reaches 510 r.p.m. or if the lubricating-oil pressure falls below 12lb. per sq. in. Oil contained in the cylinder (5) is controlled by two devices (3, 17), the former varying the position of the piston (4) and thereby the amount of fuel supplied to the engine. In the event of overspeed, the valve (21) opens fully by centrifugal force and lowers the pressure

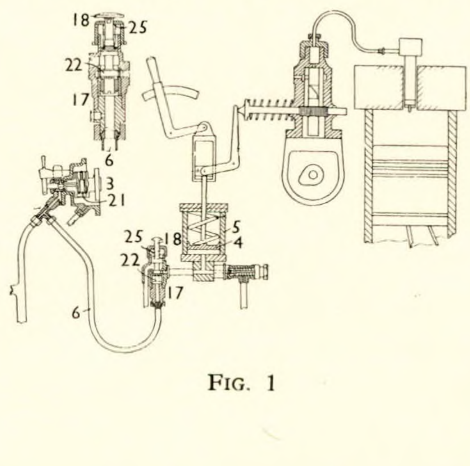
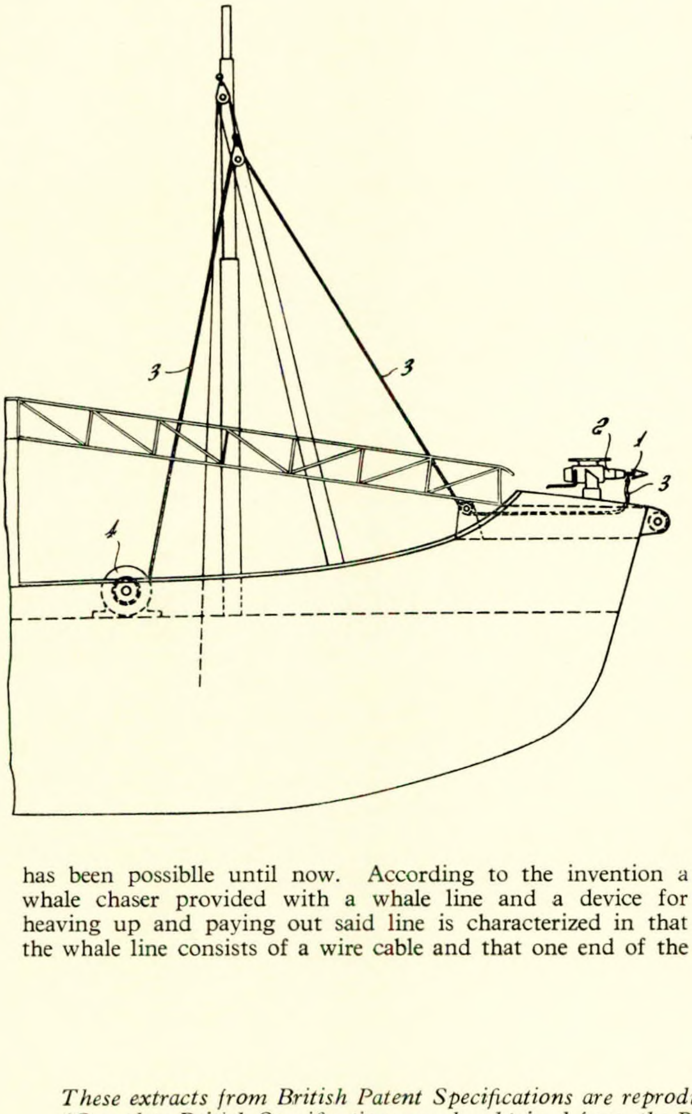


FIG. 1

in the pipe (6). The piston valve (22) descends and allows the oil to drain from the cylinder (5), causing the piston (4) to cut off the fuel. Likewise, the piston valve (22) drains the oil from the cylinder (5) when the pressure drops, the valve being supported by the oil pressure against the action of the spring (25). An emergency stop (18) is also provided. —*British Patent No. 734,009, issued to Cockburns, Ltd., Glasgow, and Cammell Laird and Co. (Shipbuilders and Engineers), Ltd., Birkenhead. The Motor Ship, July 1956; Vol. 37, p. 148.*

Whale Chaser

It is an object of the invention to provide a whaler fitted with suitable means whereby the whale line can be paid out and heaved in a much simpler and less dangerous manner than



has been possiblle until now. According to the invention a whale chaser provided with a whale line and a device for heaving up and paying out said line is characterized in that the whale line consists of a wire cable and that one end of the whale line is secured to the drum of a winch having a free wheel coupling, the drum having such dimensions that it can accommodate the entire, or substantially the entire whale line. According to the accompanying drawing showing a diagrammatic side view of the stem of a whale chaser the harpoon (1) which is to be fired by the gun (2) is secured to the one end of the whale line (3) consisting of wire cable. At its other end the cable is secured to the drum of winch (4).—*British Patent No. 750,381, issued to Werf de Hoog N.V., Rotterdam. Complete spcification published 13th June 1956.*

Liquid Jet Propulsion

This invention is concerned with the combination of an internal combustion turbine plant with a liquid-jet ship propelling plant. It is designed to avoid the necessity of providing at least two independent turbines and two independent compressors, by combining the circuit, through which the injection

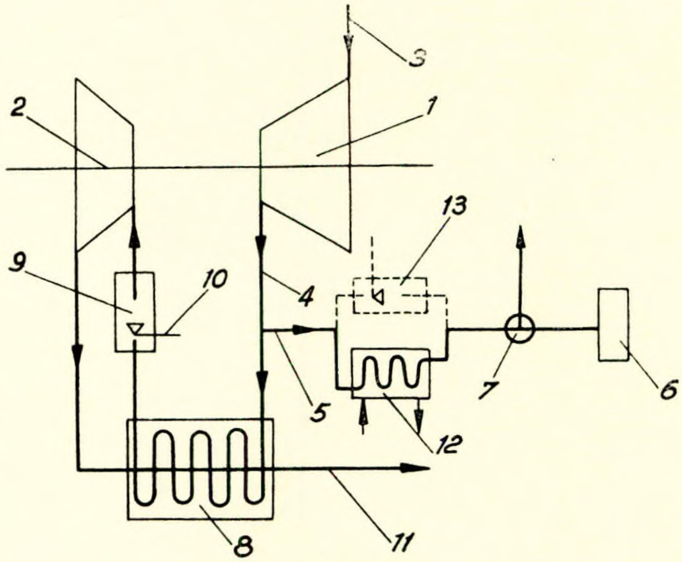


FIG. 1

device is supplied with the gaseous fluid, with the circuit of the internal combustion plant. The invention is characterized by the feature that the compressed gaseous fluid supplied to the injection device is tapped directly from the circuit of an internal combustion turbine, the elements and/or the cycle of which are modified to comply with the conditions involved by the feeding of the jet device. As shown in Fig. 1, the air for the injection device (6) is tapped from the delivery side of an internal combustion turbine compressor (1), a relief valve (7) being provided in this connexion.—*British Patent No. 750,511, issued to Compagnie Electro-Mecanique, Paris. Complete specification published 20th June, 1956.*

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Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 9, September 1956

Singing Propellers

The most difficult and elusive noise problem so far posed by the propeller was the phenomenon known as "singing", which first appeared about twenty years ago, with the general adoption of high-tensile alloys in propeller manufacture. Though the phenomenon never really grew to epidemic proportions it was sufficiently serious to initiate research work which has continued to the present day. This is not surprising when it is remembered that a "singing" propeller can produce a phenomenal amount of noise, mostly in the middle range of the audio-frequency scale, which can generally be heard throughout the vessel. Even today the mechanism of "singing" is not fully understood, though there appears to be no doubt that it is due to excitation of a complex mode of vibration of the blade regarded as a vibrating diaphragm. Various theories have been put forward to explain the mechanism of excitation, including onset of cavitation which subjects the blade to a series of impacts due to the formation and collapse of cavities in the water, formation of trailing edge and tip vortices, shock excitation when the blades pass through a varying wake, and self-excited vibration due to interaction of torsional and flexural modes of vibration. It is also likely that the phenomenon is specially liable to occur when the mode of vibration is a reactionless mode for the propeller as a whole so that there is little or no motion at the boss and therefore damping is confined to the blades themselves. The magnitude of the impulses acting on the blade as it passes through a varying wake can be reduced by applying the same measures as are necessary to reduce mechanical vibration, namely, adequate aperture clearances in single-screw vessels and adequate blade to hull clearance in multi-screw installations; combined with an after-body design which provides the smoothest possible flow of water through the propellers. In addition, the design-characteristics of the propeller blade itself can be adjusted to some extent to match the wake conditions; to delay the onset of cavitation, and by controlling the thickness of the blade edges and the plan form of the blade, to reduce the severity of vortex formation and increase hydrodynamic damping. During recent years a great deal has been learned about the vibration characteristics of propeller blades. This knowledge can be applied to assist in tuning a given design so that modes of vibration favourable for "singing" can be removed from the operating speed range. In this connexion, it is possible that the introduction of some dissimilarity between the vibration patterns of the several blades might be beneficial in preventing reactionless vibration of the propeller as a whole. The result of all this effort has been to make "singing" of propellers a rare occurrence, and from accumulated experience designs can now be prepared with reasonable assurance that this trouble will not occur.—*W. Ker Wilson, The Marine Engineer and Naval Architect, February 1956; Vol. 79, pp. 58-62.*

French Diesel-electric Trawler

Under construction at the Ateliers et Chantiers de la Seine Maritime, the Diesel-electric trawler *Cap Fagnet III* is to the order of the Pêcheries de Fecamp. The overall length is 245ft., the moulded breadth 37ft. 9in., the depth 19ft. 8in. and the maximum draught, aft, 19ft. 4in. The generating plant comprises three 750 b.h.p. Ruston-Paxman vee-type engines, running at 750 r.p.m., each driving two Sautter-Harle constant speed generators, supplying two propulsion motors. The passage speed will be 13-14 knots and by shutting down one of the generating sets the trawling speed can be maintained. The two generators driven by each engine are mounted in tandem, one being for propulsion, whilst the other supplies either the trawl winch motor or auxiliaries. The two propulsion motors are in series, each being rated at 950 b.h.p. The final drive to the propeller is through a double-reduction gear. Automatic governors are fitted to the engine; the controls for the generators and motors are arranged on the bridge, and all manœuvring is carried out from a control desk in the wheelhouse. The *Cap Fagnet III* is one of the world's largest fishing vessels and the design has drawn the attention and the interest of the fishing industry. It can be expected that the trawler's performance at sea will be closely studied. Among the many attractive features of the machinery arrangement is the high degree of operational flexibility permitted by the fast passage speeds to and from the fishing grounds and the satisfactory power output while trawling. As there are no separate auxiliary generators to be maintained, it will be possible to reduce the number of spare parts required to be carried.—*The Motor Ship, March-April-May 1956; Vol. 37, p. 18.*

Free-piston Gasifier Tests

The first free-piston gasifier of S.I.G.M.A. type G.S.34 to run in this country has been in operation recently at the South Bank works of Smith's Dock Co., Ltd. This French-built machine, which has been in operation on the specially constructed test bed at the South Bank yard since the beginning of the year, is the prototype of identical machines being built by Smith's Dock under licence from Alan Muntz and Co., Ltd. It is understood that since starting operation the output characteristics of the machine have been investigated in detail and confirmed to be in good agreement with results obtained from earlier tests carried out on the S.I.G.M.A. test bed in Lyons. These show a maximum continuous service output of 1,250 gas horse power with a discharge pressure of 45·5lb. per sq. in. and gas temperature 440 deg. C., at which rating 1,000 s.h.p. per gasifier would be available at the propeller shaft of the average marine installation, assuming turbine and gearing efficiencies equal to those actually obtained in installations of medium power now in industrial service in various parts of the world. The G.S.34 has also been shown to be capable of developing 1,400 gas horse power on the test bed with a discharge pressure of 50lb. per sq. in., which output may be regarded today as the maximum trial rating.—*The Shipping World, 16th May 1956; Vol. 134, pp. 469-470.*

New British Ore Carrier

The first of two ore carriers of 15,400 tons d.w. has been delivered to her owners, the North Yorkshire Shipping Co., Ltd., by Smith's Dock Co., Ltd. This vessel, the *Redcar*, was launched from the South Bank shipyard on 31st October 1955. The *Redcar* is powered by a Hawthorn-Doxford Diesel engine, and on her trials reached a speed of 14·5 knots. On her maiden voyage to Conakry, where she loaded iron ore for the United Kingdom, an average speed of 12·36 knots for the entire run was obtained. A feature of this vessel is the pipe and cable passage which runs along the starboard side of the ship the full length of the cargo holds, and which is also accessible from the engine room. The principal particulars of the *Redcar* are as follows:—

Length, o.a.	505ft. 0in.
Length, b.p.	480ft. 0in.
Breadth moulded	68ft. 9in.
Depth moulded to upper deck...	36ft. 3in.
Deadweight, tons	15,400
Gross tonnage	10,746
Net tonnage	5,473
Draught	28ft. 11in.
Service speed, knots	11½
Machinery output, b.h.p. ...	4,450

The *Redcar* has been specially designed for the carriage of ore cargoes, having her machinery aft, a long poop, midships structure and forecastle. The hull is constructed with four main cargo holds, with wing tanks and deep double bottoms. Longitudinal framing is employed and there are six corrugated transverse bulkheads. The double bottom in the holds is subdivided into six tanks, with Nos. 1, 2, 3, 5 and 6 arranged for water ballast. No. 4 tank is arranged for the carriage of oil fuel, and between Nos. 5 and 6 tanks there is a feed water tank. The side tanks in way of the cargo holds are subdivided into eight tanks for the carriage of water ballast. This, coupled with the fact that the vessel is longitudinally framed, allows her to be loaded to tanker freeboard limits, and thus enables her to carry about 1,000 tons more deadweight than a vessel of similar type and dimensions, but with only four ballast tanks on each side. The propelling machinery in the *Redcar* consists of a Hawthorn-Doxford Diesel engine of latest design with diaphragm and oil-cooled lower pistons, having four cylinders each of 670 mm. diameter and 2,320 mm. combined stroke. This engine has been designed to develop 4,450 b.h.p. at 115 r.p.m. Apart from the engine-driven service pumps the auxiliary equipment consists of independent steam-driven units which are supplied with steam at 150lb. per sq. in. from two Scotch marine boilers. The boilers are of the three-furnace type arranged to burn oil and are each of 14ft. 3in. internal diameter, and 11ft. 6in. long. The boiler oil burning unit has been supplied by the Wallsend Slipway and Engineering Co., Ltd., and the forced draught fan by J. Howden and Co., Ltd. A Spanner waste heat boiler is fitted in the funnel. A feature of the engine room is the large amount of platform space available at the top of the main engine, which enables upper piston maintenance to be carried out with considerable ease.—*The Shipping World, 16th May 1956; Vol. 134, pp. 463-465.*

Empress of Britain

The *Empress of Britain* is powered by steam turbines giving her a speed of over 21 knots. A feature of the propelling machinery is the use of a boiler which reheats the exhaust steam of both high-pressure turbines to the required operating temperature. The ship is completely air conditioned and the temperature of each room and the flow of air may be separately controlled by the occupants. To maintain steadiness Denny-Brown stabilizers have been fitted. In rough weather this equipment will reduce a roll of 18 degrees to less than 6 degrees. The principal particulars of the *Empress of Britain* are as follows:—

Length, o.a.		640 feet
Breadth, moulded		85 feet
Depth, moulded		48 feet
Draught		29 feet
Tonnage, gross registered		26,000
Machinery output, s.h.p.		30,000
Average speed, knots		20
Passengers:	First class	150
	Tourist	900
	Total	1,050
Total crew		464
Cargo:	Holds	6
	Total space	380,650 cu. ft.
	Refrigerated space ...	80,000 cu. ft.

The structural design of the *Empress of Britain* is more advanced than that of any previous large passenger vessel built in Britain for the North Atlantic trade, involving a combination of longitudinal and transverse framing and employing welding to a far greater extent than is general for a vessel of this class. In addition the keel, sheerstrake and two strakes of plating about the waterline are of special welding quality steel, and the scantlings of the frames and the shell forward have been increased for ice stiffening. All butts are welded and there are only four riveted seams on each side, frames in all cases being riveted. All decks, with the exception of the promenade and boat decks, are welded, the beams being angles with continuous full welds. Special attention has been given to the pillaring arrangements and the stiffeners of all main bulkheads are toe-welded angles, having continuous full welds. The propelling machinery and boilers in the *Empress of Britain* have been constructed by the Fairfield Shipbuilding and Engineering Co., Ltd., and employ a system of gas reheat developed by them. It is the first marine gas reheat system to be applied to a twin-screw steam turbine-driven passenger liner. The *Beaver*-class turbo-electric vessels which were equipped with gas reheat were fitted, of course, with unidirectional turbines. A thermal gain of about 5 per cent is obtained with this system of reheat. The propelling machinery consists of two sets of Fairfield/Pametrada double-reduction geared turbines designed for a combined output of 27,000 s.h.p. in service and 30,000 s.h.p. maximum. Each main engine consists of an h.p. and i.p. turbine in tandem and an l.p. turbine driving their own pinions at 4,195 r.p.m. and 3,452 r.p.m. respectively. The turbines are designed to take steam at 600lb. per sq. in. pressure, at 850 deg. F. and to operate on the reheat cycle, whereby the h.p. exhaust is reheated in a Foster Wheeler boiler to the initial temperature of 850 deg. F. before it enters the i.p. stage. Steam to the h.p. turbine is admitted through two groups of nozzles and there is also an overload port, which bypasses the first three stages. One of the two groups of nozzles is controlled and the arrangement is such that steam is not available at the overload valve unless the nozzle control valve is open. The h.p. and i.p. ahead turbines are of the all-impulse type having a suitable number of single-row wheels. The l.p. ahead turbines are of the reaction double-flow type with radial clearance blading. For astern running each set of machinery has an h.p. astern impulse turbine overhung at the forward end of the i.p. ahead rotor contained in a separate casing, and one l.p. astern impulse turbine incorporated in the l.p. casing. The tandem h.p. and i.p. turbines and the l.p. turbines both drive the main gear wheel through double-reduction, double-helical gearing, the rotors being connected to their respective pinions by means of a small tooth type flexible coupling. The gearing arrangement is of the articulated type in which the primary gearing is housed in a separate box external of the main gearing. A quill shaft drive is arranged between the primary wheel and the secondary pinion. The main boiler installation consists of two Foster Wheeler controlled superheat boilers and one Foster Wheeler reheat boiler. Each boiler is arranged with a superheater, economizer, and steam air heater. The steam condition at the superheater outlet is 650lb. per sq. in. and 850 deg. F. The reheat boiler in addition to its normal evaporation of 50,000lb. per hr. is designed to reheat the exhaust steam from both port and starboard h.p. turbines to 850 deg. F. Saturated steam is taken direct from the steam drums of the controlled superheat boilers to the coil of a steam to steam generator, and at reduced pressure to steam whistle and air conditioning plant, etc. The controlled superheat boilers are fired by ten burners, four normal size and one small size burner to each of the two furnaces. The reheat boiler has one furnace which is also fired by four normal size burners and one small burner. Quick-closing valves are arranged in the oil fuel supply line to the reheat boiler which automatically shut off the fuel to the burners at a predetermined drop in the steam pressure to the reheaters, and which have to be opened manually when the steam pressure is restored. The boilers work on the balanced draught principle, the air intake to the forced draught fans being taken from the boiler room and discharged to the furnaces through steam air heaters. The three boilers are each fitted with a Weldex bled steam air preheater. Each heater will raise the temperature of 87,500lb. per hr. of air from 90 deg. F. to 225 deg. F. when supplied with bled steam at a pressure of 15lb. per sq. in. gauge. This is the normal rating of the heaters; under maximum horsepower conditions a bypass is used to limit the draught loss through the heaters. One Weir single-effect evaporating and distilling plant having a capacity of 130 tons of distilled water per day is installed and comprises the following units in addition to the evaporator-feed pump, brine extraction pump, condensate extraction pump, air ejector, sea water circulated distilling condenser, main feed circulated distiller, evaporator feed preheater and a distilled water cooler, also a polythene lined mixing tank for ferric chloride treatment of the evaporator.—*The Shipping World, 25th April 1956; Vol. 134, pp. 401-405.*

Russian Prototype Tanker

The first Soviet oil tanker for mixed sailing in seas and rivers both, a motor-driven ship of 4,000-ton cargo capacity has been launched at a Russian shipbuilding yard and is reported to have been put through satisfactory test navigation in the Caspian Sea. The new tanker is the prototype for a fleet of new vessels the Russians are building to improve oil shipments along the country's immense internal waterways linking the Volga and other rivers with five great seas—the White, the Baltic, the Azov, the Black and the Caspian. Direct shipments between sea and river ports without reloading to barges at roadsteads are made possible by the new oil carrier. Under the name of *Oleg Koshevoy,* the prototype vessel has been put into service on the Caspian oil route from Baku to Astrakhan and other ports, according to Russian advices, which describe the new tanker as a "single deck, twin-screw motor ship of shallow-draught, with fuel tank, midship deckhouse and poop, with engine compartment admidships". The vessel's technical specifications are:—

Overall length, feet	405
Rated length, feet	377
Rated width, feet	52
Rated height of side, feet	18
Water displacement, empty, tons ...	1,795
Corresponding mean draught, feet...	4·3
Maximum capacity at sea, tons ...	4,000
Corresponding mean draught, feet...	13·1
Cargo capacity on river, tons ...	2,600
Corresponding mean draught, feet...	10·5
Self-contained voyage, days ...	10
Complete store of fuel, water and oil, tons	128
Crew	44
Full water displacement at sea, tons	6,030
Full water displacement on river, tons	4,660
Total power of main motors, h.p. ...	1,600
Speed with full stores and cargo, under 10·5ft. draught, knots ...	10·5

The tanker's hull is made of high strength steel—with limit yield given as 3,500 kg. per $cm.^2$ (about 49,000lbs. per $in.^2$)—which permitted 26 per cent reduction in weight. Ordinary carbon steel is used in the superstructure and deckhouse. Installed in the tanker are two Diesel motors of 800 horsepower each at 300 r.p.m. The screw shaft has rigid connexion with the engine drive shaft. The tanker's boiler installation consists of two auxiliary watertube steam boilers with heating surface of 303·5 square feet each. The productivity of each boiler under forcing reaches 2,200lb. per hr., operating pressure is 11lb. per hr. The installation uses liquid fuel and is also employed to warm the cargo, steam the tanks and heat the crew service quarters. The evaporating system has a productivity of seven tons a day.—*Marine News, February 1956; Vol. 42, p. 17; p. 30; p. 38.*

Cathodic Protection

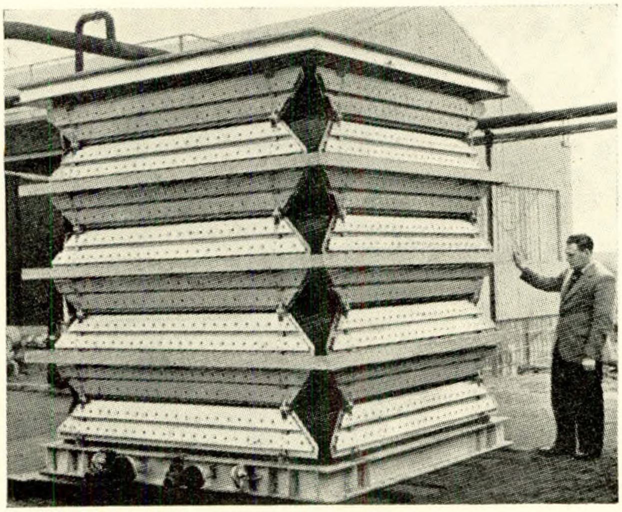
An account is given of work done by the Navy Bureau of Ships with cathodic protection of active and reserve ships. Because it is difficult to dissociate costs for maintenance and corrosion protection it is impossible to say whether or not the cost of cathodic protection of active ships is merited. Because corrosion damage to hulls seldom is considered except when perforations occur, or in destroyers and submarines where plates are thinner and original dimensions more critical, there is some belief that cathodic protection for all ships cannot be justified on a cost basis. With inactive ships, however, the reverse is true. Indefinite extension of drydocking times, the interval contingent on the exhaustion of anti-fouling paints, is anticipated. Initial cost of cathodic protection of active destroyers, submarines, and five types of reserve ships is tabulated. Details of cathodic protection systems for reserve ships are given. Criteria of protection differ somewhat from the accepted standards. In polluted waters inactive ships may require a potential in excess of 1 volt, while in other high resistivity waters 0·85 to 0·95 volts are sufficient. Some data are given on the cathodic protection of active ships. Merits of sacrificial anodes versus impressed current are listed. Extensive further activity in cathodically protecting active ships is contingent on the outcome of trials now under way.—*I. D. Gessow, Corrosion, March 1956; Vol. 12, pp. 18-24.*

Brittle Fracture Strengths of Welded Steel Plates

An account is given of a series of tensile tests on wide mild steel plates of 1in. thickness, where the plates contained central, notched butt welds parallel to the direction of pull. The notches consisted of fine, shallow saw cuts made in the plate edges prepared for welding, and were intended to simulate weld flaws. The tests were conducted within the temperature range ± 15 deg. C., which was below the fracture appearance transition temperature of the parent material. At temperatures above 4 deg. C. the plates sustained yield point average static tensile stresses before brittle fractures occurred. Below 4 deg. C. brittle fractures across the weld residual stress zones started from the saw cuts, either spontaneously after welding, or with small external loads. With continued loading, complete fractures were obtained only after general yield of the remaining plate cross-sections. At 4 deg. C. a single-stage fracture was produced at half yield point stress. In further tests between ± 15 deg. C. no residual stress zone fractures could be produced at less than yield point stresses in welded plates previously stress relieved by stretching at 40 deg. C. Considerable importance is attached to the critical temperature, at which alone complete fracture could be obtained at half yield point stress. The Charpy V-notch energy of 7ft. lb. at this temperature matches the energy range identified by Williams for casualties in American welded ships. Evidence is presented to show that the behaviour in these tests may be explained mainly in terms of the mechanical effects of weld shrinkage and residual stresses, and metallurgical damage over the narrow weld-hardened zone.—*Paper by A. A. Wells, read at a meeting of The Institution of Naval Architects on 22nd March 1956.*

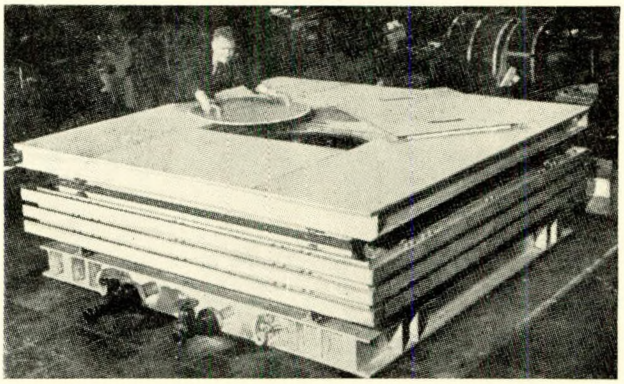
Collapsible Tank for Fluid Cargo

A scheme for a possible means of carrying bulk liquids in the holds of dry cargo vessels while at the same time providing facilities for carrying solid cargoes without having to remove the containers for the fluids, originates from the firm of R. and H. Green and Silley Weir, Ltd., who hold the patents, and has particular advantages for ships at present sailing under ballast due to lack of suitable cargo for the return voyage. An 8ft. cube prototype tank has now been designed and manufactured by Marston Excelsior, Ltd., who are a subsidiary of Imperial Chemical Industries, Ltd., and has completed static trials prior to more extensive seagoing tests. The tank has a



The collapsible tank when loaded, showing the light alloy shuttering

capacity of 2,900 gallons and is 9ft. 4in. in height when open, and 2ft. 11¼in. closed. The top of the tank is 8ft. 9¾in. square and can be loaded to 400lb. per sq. ft., and weighs 2 tons 10 cwt. The structural design of the unit is based on an angle of roll of 20 degrees on each side of the vertical, and a periodic time of eight seconds. The flexible bag is made of four-ply fabric synthetic rubber to a Marston specification MM.250. Shuttering, bag ties and beams are of Kynal M.39/2 light alloy, and the hinges and pins are made of mild steel. The tanks in question are square in section and so constructed that only upward and downward movement is possible. The flexible inner containers are like a concertina and are encompassed by light alloy telescopic frames, each connected to its immediate neighbour by equal sets of hinged links offset by stops to prevent them from opening too far and so failing to close again. These hinged links are made with a simple bearing surface at the pivot in order to prevent side wracking. When the containers are filled with fluid, all air is driven out so that there is no room for swashing at the top of the tank and all movement of the fluid within is thus prevented. The tank becomes more rigid as the head of fluid approaches its designed maximum, thereby increasing its self-supporting characteristics. The weight of the dry cargo carried on top of the tank when it is collapsed is transferred through the top cover to a supporting frame built within the tank, thus preventing damage to the container. The partial side frames situated between the main square frames are, on closing, forced inwards by means of the hinged links, and automatically control the



A view of the tank when empty, showing the manhole for cleaning

folding of the container, as fluid is discharged. Delivery, suction and air vent connexions are all brought to the bottom channel frame. Each tank is a separate but standard unit and is secured at the base by quick-release clips so that a tank in need of repair or overhaul can be quickly replaced without delaying the ship. Cleaning the containers is simple, and the work may be undertaken on the spot, or exchanged for a set of clean tanks, thus avoiding delay in sailing. When installed in ordinary cargo vessels, the carrying of bulk liquids in dry cargo holds or deep tanks can be undertaken, with the alternative facility of carrying dry cargo without expensive cleaning and without fear of contamination by fumes from the previous liquid cargo.—*The Shipping World, 2nd May 1956; Vol. 134, p. 427.*

Sheaves and Rollers for Fishing Vessels

Most fishing vessels employed on different kinds of trawling are equipped with quite a number of sheaves and blocks for paying out and hauling in the trawls. These sheaves must rotate freely and be made of wear-resisting material, since otherwise grooves are worn in their tracks and the galvanizing on the trawl wire becomes damaged. Unfortunately, conventional sheaves often have a tendency to seize in spite of frequent lubrication, the wires and chains sliding instead of running smoothly over free-running gear. This tendency has not been helped by the more intensive operation of modern fishing vessels, with the consequent increase in the power of the haulage equipment used, as a result of which the sheaves are subjected to extremely heavy stresses, the most heavily loaded being those mounted in the gallows, one forward and one right aft. Over recent years, SKF, the ball- and roller-bearing manufacturers have gone into the problem of free-running gear for fishing vessels and as a result have produced a number of different types of sheaves, including blocks for gallows, deck blocks, spinning guide bars for winch drums, steering chain sheaves and rollers, all of which are fitted with ball bearings and are manufactured from a special cast iron with high wear-resisting properties. The single forward gallows sheave is fitted with two deep groove ball bearings and sealing is effected by three sets of labyrinth sealing washers fitted at the outer side of each bearing. Re-lubrication is effected through the spindle. The stern gallows requires a double block, one of whose sheaves is larger than the other. The larger one is of the same type as that used in the forward gallows. In order that the spindle may be fitted either way round, the lubricating ducts of the spindle are drilled exactly alike from both ends. After the trawl lines have passed over the sheave in the gallows, they are led through deck blocks to the winch drums. Because of space limitations, labyrinth sealing washers cannot be used for sealing in the case of these 9in. deck block sheaves. They have, therefore, been fitted with a simple labyrinth seal at each side of a double bearing. Since lubrication is effected at both sides of the bearing any dirt that may enter is forced out through the gaps. In the case of both the single and double block steering gear chain sheaves, sealing is by labyrinth sealing washers and re-lubrication is effected through the spindle. A number of other sheaves may also be fitted with ball bearings. For instance, the blow or cathead sheave mounted on the stemhead of the boat for hauling up the anchor cable and the pivoting roller fairleads mounted on the gunwale, over which the sweep lines run, can both be fitted in this way. The latter consists of two vertical rollers and one horizontal roller. Two deep groove ball bearings are fitted to each vertical roller and two to the horizontal roller. Labyrinth sealing washers are again used for sealing and re-lubrication is carried out about once a month.—*Scientific Lubrication, March 1956; Vol. 8, pp. 20-21.*

New Fire Extinguishing System

The first shipboard fire protection system employing inert gas generated from the combustion products of Diesel oil was demonstrated in Liverpool in the newly delivered Elder Dempster cargo motorship *Oti*. Known as the Pyrene-E. D.-Hol system, it has been developed by close co-operation between the Pyrene Co., Ltd., Elder Dempster Lines, Ltd., and W. C. Holmes, Ltd., Huddersfield, manufacturers of the gas generating plant. The idea of using the combustion products of Diesel oil to reduce the oxygen content of cargo spaces on the detection of fire came originally from Mr. J. H. Joyce, chairman of the shipowners, after one of the company's ships had used up all its available supply of conventional carbon dioxide cylinders in extinguishing a fire at sea. The new system involves the installation of a small gas generating plant, which

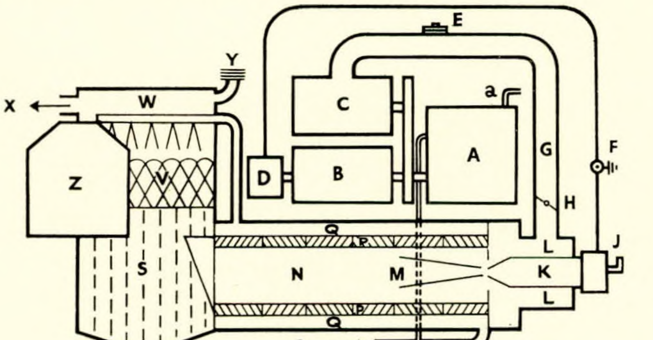


FIG. 2—*Operation of gas generator unit*

(A) Power unit; (a) Cooling water outlet for power unit; (B) Alternator for driving remote water pump; (C) Air blower; (D) Oil pump; (E) Air relief valve; (F) Oil fuel governor valve; (G) Air duct; (H) Air regulator; (J) Oil fuel regulator; (K) Burner; (L) Air space; (M) Flame; (N) Combustion chamber; (P) Fire brick lining; (Q) Water jacket; (R) Cooling water inlet from pump; (S) Cooling chamber; (T) Controlled water drain; (V) Lessing ring labyrinth; (W) Sprayer; (X) Gas outlet; (Y) Gas relief valve; (Z) Control panel.

will produce a virtually inexhaustible supply of inert gas which is distributed to the affected spaces by a system of pipes which also acts as a smoke detecting system. The inert gas has the effect of lowering the oxygen content of the spaces more than is possible either by steam or carbon dioxide, and it is entirely harmless to the cargo. All ships building for Elder Dempster Lines will be fitted with this equipment. Fig. 2 shows diagrammatically the principle of operation of the gas generating unit. On receipt of indication of a fire in a cargo hold the engine is started. The appropriate main and distribution valves are immediately operated. The starting of the engine automatically circulates cooling water round the combustion chamber water jacket, the engine and to the sprayer at the top of the cooling tower. At the same time, Diesel oil and air are supplied under pressure to the burner. The gases pass from the combustion chamber to the cooling tower and thence to the distribution pipework at a temperature slightly above that of the cooling water. There is no carry-over of water droplets; should any moisture separate out of the gas, drains in the pipelines are provided to prevent it reaching the cargo. The control panel of the generator is designed to give automatic warning should the system become out of balance thus providing warning of flame or water failure. There is also a continuously recording CO_2 indicator which allows the operator to keep the carbon dioxide content at the maximum, as well as pressure gauges to indicate fuel, air and gas outlet pressure. The total consumption of Diesel oil to meet Ministry of Transport requirements for a ship, the largest hold of which has a "grain" capacity of about 115,000 cu. ft., for example, would be approximately 25 gallons per hour. A separate fuel supply of gas-oil is provided in the *Oti* for the power unit of the generator. The gas distribution system comprises a main pipe from the generator unit outlet to manifolds fore and aft, thence through diverting valves by individual pipelines to discharge points in each protected space. The gas is conveyed through this system at low pressure and tubing of medium gauge is employed, with condensate traps and drains at suitable positions. The gas may continuously be produced for many hours, so that after dealing with a fire in a particular space it may immediately be diverted to adjacent spaces to prevent fire spreading. An almost unlimited supply of inert gas will still be available for dealing with any other fire that may occur. The gas generated is heavier than air and is shown by standard tests to be composed of:—

	Per cent
Oxygen	0-1
Carbon monoxide	Nil
Carbon dioxide	15-14
Unburnt hydrocarbons ...	Less than 0·1
Oxides of nitrogen	0·01-0·015
Nitrogen	Remainder 85

The effect of the gas is to dilute the oxygen content of the air in the affected space until combustion ceases. The generator has an hourly output of gas sufficient to meet existing regulations concerning fire extinguishing equipment for holds and other spaces of a given volume. At the correct rate of generation the continuous discharge of the new inert gas into the largest hold half full of cargo reduces the oxygen content of the air to 12½ per cent in the first half-hour, 6·3 per cent in one-and-a-half hours and 3½ per cent in two-and-a-half hours. The maximum percentage of oxygen allowable in the atmosphere in order to prevent combustion varies with different materials but generally speaking it is between 12 per cent and 16 per cent. The reduction of oxygen in the atmosphere to 13 per cent will prevent combustion and deal with most fires when general cargo is involved but further reductions may be necessary for materials of a smouldering nature.—*The Shipping World, 9th May 1956; Vol. 134, pp. 442-443.*

Experiments with Tanker Models

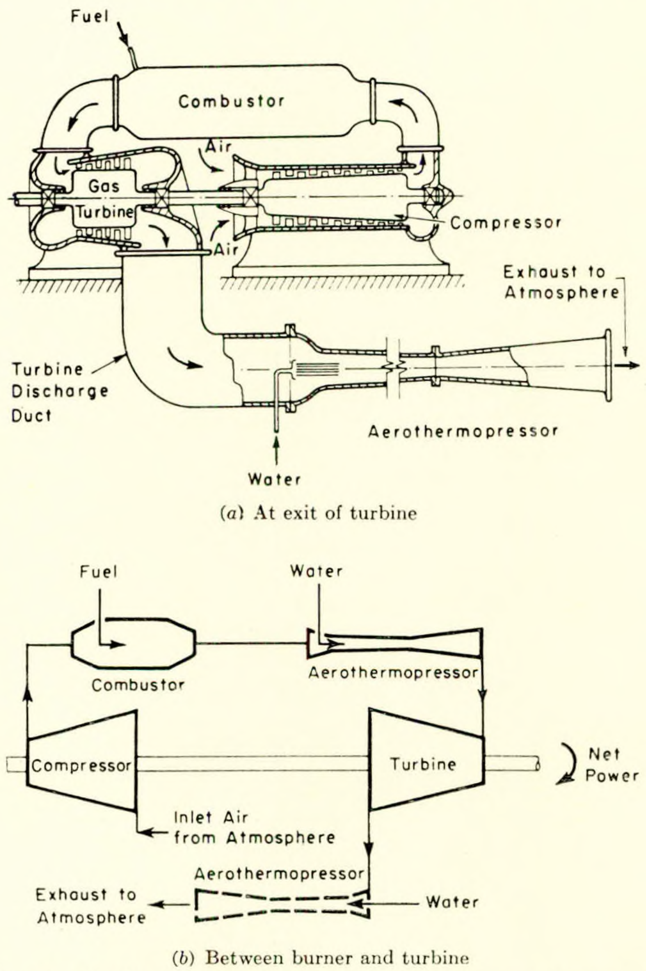
A systematic series of tests with tanker models has been carried out at the Swedish State Shipbuilding Experimental Tank for the purpose of investigating the effects of variations in form and proportions on the resistance and propulsive qualities. The parent form was that of a 15-knot single-screw tanker of about 22,000 tons displacement and the shape of the forebody sections, the length-breadth ratio and the breadth-draught ratio were the first variables to be considered. The tests involving the shape of the forebody sections indicate that U-form is generally superior to V-form and that earlier experimental comparisons may have been influenced by laminar flow. The length-breadth ratio appears to influence performance only to a limited extent, while an increase in the breadth-draught ratio causes greater resistance but improved propulsive efficiency. The breadth-draught ratio variations enabled the investigations to be extended to forms suitable for large tankers of about 40,000 tons displacement. The form with the higher breadth-draught ratio was used as the parent form for a series involving variation of the block coefficient. The effect of varying the longitudinal position of the centre of buoyancy has also been investigated.—*Paper by H. Edstrand, read at a meeting of the North-East Coast Institution of Engineers and Shipbuilders on 6th April 1956.*

Stability of Ships

For passenger ships the perilous skirting about small *GM*'s for comfort has given way to the requirements for damage stability and without much misgiving owing to the influence on rolling of bulkier transverse sections of ships. The precautions against a disposition to heel readily in small passenger ships is in the same direction, but is not necessarily so encompassing where moderate freeboards are concerned. Both take care of stability at small inclinations, but assessment of the capsizing risk usually demands thoughtful examination of *G Z* curves. In ocean cargo ships the variation in stability between departure and spent arrival conditions is frequently marked, due to consumption of fuel oil and fresh water from its storage in double bottom tanks, and sometimes permits appreciable negative *G M* on arrival. This may be due to a restriction in beam or a desire to limit *G M*'s in loaded departure conditions. While only one modern instance of a cracky condition at sea of an ocean freighter has come to light, such stability provision is a temptation to masters to work over appreciable distances with small *G M*'s and is to be discouraged. This is particularly serious when the superstructure is discontinuous. The view is taken that, at least, a practical, satisfactory, worst service arrival condition should be worked out and included in the stability information. To aim at only 1ft. *G M* means in a freighter of 14,000 tons displacement that a shift of 75 tons of cargo through 24 feet would heel her $7\frac{1}{2}$ degrees and absorb 4 feet of freeboard one side. This increase may involve filling one or more ballast tanks at sea, if available, to compensate for oil or water consumption. Such practice has never been favoured where tanks are large and undivided. Where water ballast must be admitted, it should be done before the oil or water tank is broached in order to avoid temporary diminution of stability below the intended minimum for a prolonged period. The tendency in small ships has been to improve stability and nothing is more likely to maintain improvement than the construction of *G Z* curves in the shipyard and imaginatively pondering over them. For ordinary home trade and coasting cargo vessels liable to lift bulk cargoes, the author has general confidence in *G Z*'s approximately 1 foot at 30 to 45 degrees inclination associated with *G M*'s of about 18 inches, but that is not to discredit the many past and present ships which, without being able to satisfy such criteria, have proved safe and seaworthy craft for their respective services; nor, on the other hand, is it sufficient to justify careless stowage or imprudent navigation. There is no comprehensive short cut to adequate stability. Type of ship, service, nature of cargo and all the other factors have to be taken into account in the light of experience and casualties, not the least being a well maintained and operated ship and an informed and imaginative interpretation of *G Z* curves. Complete satisfaction about integrity and operation may well justify smaller margins of calculated stability. But it must not be overlooked that good calculated stability provides a margin against unforeseen contingencies, weather extremes, and especially human failures, which are common and variable enough. It is, therefore, advisable not to be too complacent about satisfying minimum standards, either as to calculated stability or to the associated factors.—*Paper by H. E. Steel, read at a meeting of The Institution of Naval Architects on 21st March 1956.*

The Aerothermopressor

Theoretical and experimental investigations of a novel gas-dynamics device having no moving parts yet performing the function of a compressor, are described. This device, called the "Aerothermopressor", exploits the possibility of raising the total pressure of a high-speed gas stream through cooling of the gas. When placed at the exhaust of a gas turbine, the Aerothermopressor will reduce the exhaust pressure, thereby improving both fuel economy and power capacity per unit of air flow. Basic elements of the apparatus comprise a nozzle which accelerates hot gas into an evaporation section; a water injection system which delivers finely atomized water into the high-speed stream; an evaporation section in which the gas is cooled and most of the water evaporated; and finally, a diffuser in which the gas stream is decelerated and the static pressure increased. Although the Aerothermopressor is simple in structural arrangement, the physical processes occurring within it are exceedingly complex in their details. The simultaneous effects on the gas stream of droplet drag, evaporative cooling, area variation, and wall friction lead to many régimes of operation, including the hitherto unknown passage from subsonic to supersonic speeds in a constant area duct. Theor-



(*a*) At exit of turbine

(*b*) Between burner and turbine

FIG. 2—*Application of aerothermopressor to simple gas turbine*

etical calculations of a one dimensional nature, involving for the gas stream the equations of continuity, momentum, and energy, and for the liquid droplet cloud the equations of motion, heat transfer, and mass transfer, have been carried out on a high-speed, electrical digital computer. The theory reproduces all the behaviour patterns of experimental units and is in generally good quantitative agreement with the experimental data. The results of experiments on a small scale, constant area unit of 2·13in. diameter are presented and compared with theoretical calculations. The experiments and theory both show that a net stagnation rise is possible only with gas flows greater than about 2lb. per sec.; below this value the detrimental effects of wall friction completely absorb the gains due to cooling. In the range of 25lb. per sec, a net stagnation pressure rise of about 10 per cent seems assured, while 20 per cent seems possible. Early tests on a recently completed medium scale unit of 25lb. per sec. capacity have already demonstrated a net overall rise in stagnation pressure.—*A. H. Shapiro, K. R. Wadleigh, B. D. Gavril and A. A. Fowle, Transactions A.S.M.E., April 1956; Vol. 78, pp. 617-653.*

Combating Cylinder Wear and Fouling in Large Low-speed Diesel Engines

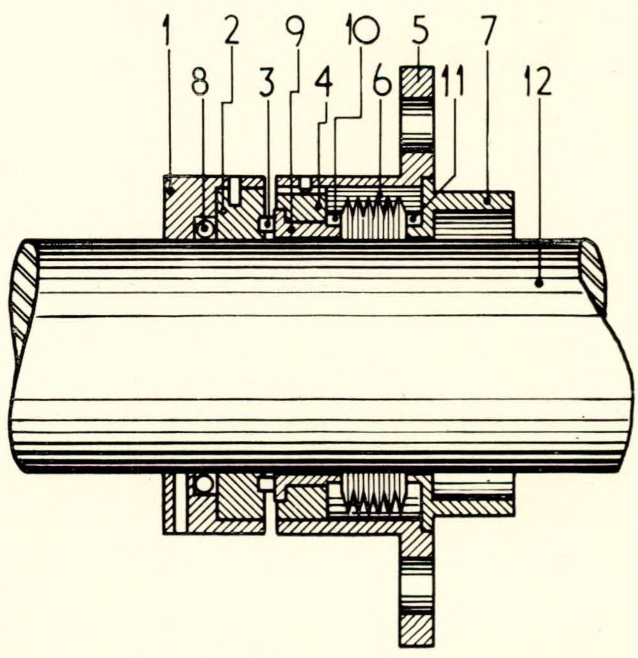
In the competitive struggle of the various types of propulsion machinery for ships, the Diesel engine has been able to obtain a fair share of the field. It is natural that efforts are being made to strengthen the position of the Diesel engine in this application by a further increase in thermal efficiency, the use of cheaper fuel and a reduction in maintenance cost. High rates of cylinder wear contribute to a large extent to the maintenance costs of low-speed marine Diesel engines and it is therefore unfortunate that the use of heavy fuel oil, which has been shown to be economically attractive and technically feasible, has often resulted in high cylinder wear, particularly in two-stroke engines. Careful cleaning of the heavy fuel is essential, but is not the solution of the problem. It has been found that high cylinder wear in marine Diesel engines having separate cylinder lubrication cannot be sufficiently counteracted by using the heavy duty (H.D.) oils which are so effective in high- and medium-speed Diesel engines. An extensive study of the problem has resulted in the development of an emulsion-type lubricant, containing particularly effective additives. By the use of this lubricant considerable reductions in wear, relative to that experienced with conventional lubricants, have been realized. It is also very effective in combating abnormally high wear sometimes experienced when using marine Diesel fuel. Marked improvements in piston and cylinder and piston rod cleanliness are also obtained when this emulsion lubricant is employed.—*Paper by M. J. van der Zijden, read at a meeting of the Institute of Marine Engineers on 28th February 1956.*

Hydraulic Power Systems

Hydraulic power systems are made up of hydraulic pumps, hydraulic motors, cylinders, pistons, valves, and integral piping used individually or together to transmit some form of hydraulic or mechanical power. The life of a hydraulic power system, as far as ship personnel are concerned, may be divided into three phases—installation, operation, and overhaul or repair. During these phases, care must be taken to prevent contamination of the working hydraulic fluid. All hydraulic systems have filters for performance and safety. The filters generally are placed in the storage tank or in the discharge side of the system in a position where the fluid can be filtrated before it enters the system. The filters remove particles from 10-25 microns (0·004-0·010 inch). A filter stops particles smaller than its nominal openings after an initial period of service. Reduction of the filter holes because of contamination impairs the flow. If the filter becomes clogged or damaged, it cannot do its work properly. Therefore, the filter elements should be replaced periodically. A clogged filter can be as ineffective as no filter at all. Cavitation also may take place. The vacuum may cause the fluid pressure of the remaining oil film to equal its vapour pressure at the existing temperature. Then the liquid will vaporize. Vapour bubbles alternately form and collapse, causing pitting of the parts and a marked decrease in efficiency. Normally, periodic inspections are not needed. However, when the equipment is overhauled or repaired, several precautions should be followed: (1) Parts should be inspected for excessive wear, and reported when necessary. (2) Tubing should not be welded, brazed, or silver-soldered after assembly unless absolutely necessary because proper cleaning then is more difficult. (3) All openings into hydraulic systems should be covered to keep out dirt, metal, slivers, and filings when work such as drilling, tapping, soldering, welding, or brazing is being done on or near the unit. (4) When the equipment is not being worked on, it should be covered with a clean cover. (5) Clean or replace the filter elements. (6) Before reassembling, remove all dirt, sludge, water, or rust. (7) Use a wire mesh screen in refilling the unit. Sludge contains abrasives and causes excessive wear circulating through hydraulic systems. Grit, as an abrasive, causes scoring on precision finished surfaces. Dirt results in leakage, excessive wear, mutilation, and scoring of mechanical parts. If sludge, grit, or dirt collects in the system, it must be removed. Oil has a cloudy, murky appearance when emulsified with water, and should be replaced.—*I. Gendelman, Bureau of Ships Journal, March 1956; Vol. 4, pp. 15-16.*

Rotary Magnetic Seals

The life of a centrifugal pump shaft depends to a large extent on the manner in which the glands are packed, and the method of packing employed; too tight a fit causing scoring and overheating. With pumps handling non-inflammable liquids, a certain amount of leakage is permissible and provides lubrication for the packing; but when handling petroleum spirit, for instance, leakage would not only be dangerous but wasteful. The J. C. Rotary Magnetic Seal Co., Ltd., have developed a mechanical seal of an entirely new type, which dispenses entirely with stuffing boxes and packing materials. As will be seen from the accompanying drawing, the seal is formed by a carbon ring located between two magnets. No coolant is required with this type of gland as any slight friction



The magnetic rotary seal

(1) Driving carrier; (2) Magnet A; (3) Carbon ring; (4) Magnet B; (5) Housing; (6) Bellows; (7) Locating collar; (8) Sealing ring; (9) P.B. insert; (10) Screwed collar; (11) Screwed collar; (12) Shaft.

heat created is dissipated through the magnets direct to the shaft and pump body: a point of particular interest to pump users handling petroleum products as the seal can be used with absolute safety. Although the seal is magnetic, no static electricity is generated, and the magnets being circular, the magnetic field is a closed circuit. The types of material used in the manufacture of the seals vary according to their duty, and the housing and back plate are usually of gunmetal construction, with a phosphor-bronze insert. The magnets at present in use are of high-grade steel. Gilded metal in one, two or three wall thicknesses is used for the bellows, and for special applications stainless steel is used. The rotating sealing face is of carbon. Seals can be supplied for shaft diameters from ½ inch to 7 inches; the minimum overall length of the smallest seal being about 2½ inches. There is a wide range of applications to which these seals can be used other than pumps, such as worm and gearboxes, also engines or any rotary shaft protruding from casings where liquid has to be retained. A Stothert and Pitt anchor windlass on the *Southern Cross* has a rotary magnetic seal for the vertical worm shaft, and this is reported to be very satisfactory. The major advantage of this type of seal is that there is only one wearing part, namely, the carbon ring, and this should only need renewal at very long intervals. Complete alignment is assured by the magnetic attraction of the sealing faces, and any vibrational frequency of the shafts is counteracted automatically by the movement of the magnets. Tests carried out on screw pumps handling petroleum spirit, showed that after two years the wear on the carbon ring amounted to 0·014 inch only, and none of the other components of the seal showed signs of wear or fatigue. The seals can be used for pumps with pressures up to 250lb. per sq. in., and vacuum up to 26in. Hg. They are suitable for any form of liquid.—*The Shipping World, 11th April 1956; Vol. 134, p. 363.*

Marine Reduction Gearing

Perhaps no feature of marine engineering has received more detailed attention in technical discussion or more perseverance in production technique than reduction gearing, and it is a sobering reflection that reports of defects are still not uncommon. The slow realization of the degree of accuracy required in production and, in Great Britain, the tardiness with which the necessary machines were thereafter made generally available resulted in only a gradual accumulation of reliable information on defects that could be positively attributed to particular shortcomings of design. Confusion still seems to exist in assessing the relative significance of design and production to the defects that arise. Entirely apart from such considerations, it must be recognized that the design of gears is influenced by a confusion of variables, and, it is generally realized that without what may be regarded as a matrix establishing inter-relationship, the best use can never be made of research, partly on account of the partial vitiation of results by the uncoordinated free play of variables, and partly on account of the difficulty of properly rating the conclusion in the absence of a comprehensive system of comparison. It is, moreover, impossible, without such an examination, to establish a proper method of assessing the loading of a gear and, while the well-known K factor is invaluable, it has been imbued with quite imaginary qualities in the representation of tooth distress, reflecting a gross oversimplification of a vital and involved function. This lecture refers to essential requirements of design and to certain important practical features of production which it is believed are still receiving less than general attention. There follow some observations on gearcase alignment and maldistribution of loading due to pinion distortion, and on the establishment of cardinal relationships affecting tooth design and criteria of tooth loading, these being supported by detailed treatment in Appendices, which are divided into a number of sections for the sake of clarity. The suggestion is made also that, with highly loaded gears, small gear face width ratios give unnecessary sensitivity to bearing mis-alignment. The lecture concludes with some notes on the trend which further developments are taking.—*Twenty-eighth Thomas Lowe Gray Lecture, given by A. W. Davis at the Institution of Mechanical Engineers on 20th January 1956.*

Vibration Analyser

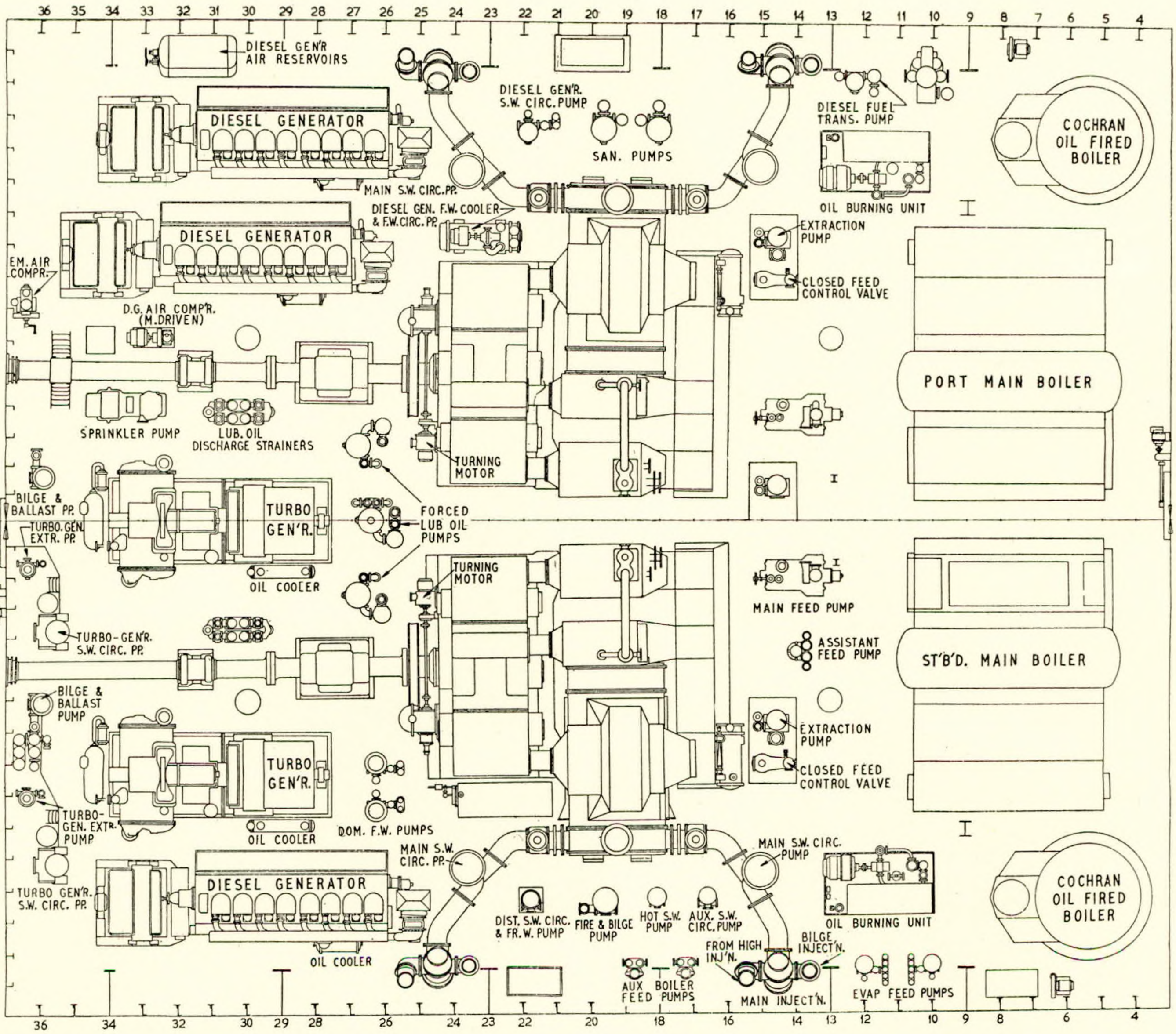
It is difficult, even when a ship is in dry dock, to remove vibrating equipment and send it to be balanced by conventional means, possibly in a distant permanent installation. However, in recent years portable electronic instrumentation for on-the-spot vibration analysis and dynamic balancing has been developed. The instrument detects, locates, measures, and provides means for correction of unbalance in rotating parts. One east coast dry dock uses the vibration analyser for a wide range of maintenance and repair problems. This dry dock company has found that the sensitivity of the instrument's seismic pick-up—which can detect vibration of a displacement of 0·000001 inch—enables its operators to trace-out and eleminate sources of vibration long before the unbalance becomes dangerous. The instrument thus is a tool for preventive maintenance, forecasting repair work ahead of need. Normal checks by visual means, "calibrated fingertips", ear, or even the customary gauges and other instruments, frequently provide information too late. The dry dock company uses the vibration analyser also to find out what must be fixed. The instrument unerringly finds the actual cause of the predominant frequency of vibration—pin-points the defective or worn gear, shaft, spindle, rotor, in minutes. Trouble-shooting becomes scientific. For instance, if the instrument shows vibration of 0·001in. displacement at 1,725 c.p.m., the operator knows instantly that the source is a component rotating at 1,725 r.p.m.—possibly an electric motor. If it shows the vibration at 1,000 c.p.m., the operator knows the trouble is in a component turning at 1,000 r.p.m., and he need give no further time to the motor. Blueprints or his own information will immediately identify the part. The vibration analyser is made up of three external components—seismic vibration pick-up, mechanical filtering probe, and stroboscopic lamp—and a small console housing electronic circuitry which renders vibration data on displacement and frequency meters. The seismic pick-up has an electrical output of 105 millivolts at a displacement of 0·001 inch and frequency of 60 c.p.s. The pick-up is built to withstand even drops on concrete floors or steel decks. Its operating temperature range is from − 25 deg. F. to 250 deg. F. The mechanical probe, attached to the pick-up, permits reaching otherwise inaccessible sources of vibration, such as a bearing set deep between two housings. The stroboscope, housed in a flashlight type case, is fired in synchronism with the predominant vibration as reported by the pick-up. Thus it visually "freezes" the vibratory motion of the part being studied for observation of the location of unbalance and for watching progress in balancing. The actual balancing is done in four simple steps, with the strobe lamp showing the location of unbalance and the amplitude meter showing the amount of correction required. The analysis is done usually with the part turning at normal speed in its own bearings.—*Marine Engineering, March 1956; Vol. 61, p. 56.*

Belfast-built Liner for Pacific Line

The Pacific Steam Navigation Company's new passenger liner *Reina del Mar* has entered her owners' service. The *Reina del Mar* is a twin-screw turbine driven ship of 20,225 tons gross. She has been built under Lloyd's Register of Shipping and Ministry of Transport survey. Her principal dimensions are:—

Length o.a.	600ft. 7in.
Length b.p.	560ft. 0in.
Breadth moulded	78ft. 0in.
Depth moulded to C deck ...	44ft. 0in.

The hull of the ship is largely riveted, though plating butts are welded. Welding has been extensively used inside the ship. The hull is divided into eleven compartments by ten watertight bulkheads. The double bottom is used for the carriage of fresh



Machinery arrangement of the Reina del Mar

water, water ballast, oil fuel and lubricating oil, while the fore and after peaks are arranged for fresh water or water ballast. In addition to these tank spaces, deep tanks are fitted immediately forward and aft of the machinery space, the forward tanks to carry oil fuel and the after tanks fresh water. The *Reina del Mar* is fitted with Denny-Brown stabilizers. The propelling machinery consists of a two-shaft arrangement of Parsons' double reduction geared turbines having a total power in service of 17,000 s.h.p., with propeller revolutions of 112 per minute. The general design is in line with current practice. Steam at 525lb. per sq. in. pressure and 825 deg. F. temperature is generated in two watertube boilers made by Harland and Wolff to Babcock and Wilcox controlled superheat three-drum design, each provided with superheaters, ecomonizers and air pre-heaters, and arranged for Howden's system of forced and induced draught. Two Cochran oil-fired auxiliary boilers supply steam when the vessel is in port and for appropriate services of ship and engine room where saturated steam is required. In addition a Weir steam generator, supplied with heating steam from the main boiler saturated range, provides steam for miscellaneous steam services, and is capable of being operated together with both auxiliary boilers to meet exceptional peak requirements. The Weir closed-feed system is employed for the main steam turbines and the turbogenerators. With the exception of the air ejectors and feed pumps which are steam operated, all the auxiliaries are driven by electric motors. They include the usual auxiliary condenser, feed heaters, evaporator, oil purifiers, filters and tanks, oil and water coolers, etc. Separate well-equipped workshops for engineers and electricians are also provided for maintenance purposes and minor repairs. A Weir vertical evaporator with distiller, fitted with independent filter, produces 70 tons of fresh water a day for boiler feed make-up and domestic purposes. Single distillation is used for domestic supplies, and double distillation, drawing from the domestic fresh water tank, for boiler feed make-up. An alternative source of feed make-up is available from the Cochran boilers or the Weir steam generator. The generating plant consists of two turbo-driven main generators, each with an output of 1,000 kW. at 225 volts d.c. arranged to run in parallel, and three Diesel-driven main generators, each with an output of 500 kW. arranged to run in parallel. There is also a Diesel-driven emergency generator having an output of 100 kW. An emergency 220-volt battery is fitted which will automatically connect to the busbars on the emergency switchboard for maintaining services essential for the safety of the ship in event of failure of main generators. Power is distributed from the main switchboard to auxiliary switchboards and masterboards throughout the vessel. An interconnector is fitted for supplying the emergency switchboard from the main switchboard busbars.—*The Shipping World, 2nd May 1956; Vol. 134, pp. 421-424; p. 430.*

Flash-type Distiller

A new, flash-type distilling plant which provides a positive and low cost solution to the fresh water problems of arid seashore communities and of ships requiring large scale water production has been developed and tested in operation. The new unit is available in capacities ranging from 8,000 to 1,000,000 g.p.d., and in two or more stages of flash depending upon the efficiency desired. Distillation of sea water involves the production of water vapour by the application of heat, elimination of entrained sea water from the vapour, subsequent condensation of the vapour, and collection of the distillate for use. Vapour may be produced in two ways: (1) by boiling sea water through use of heated, submerged surfaces; or (2) by heating the water, without boiling, and allowing it to enter a vacuum chamber where part of it flashes into vapour. The first method is employed in all submerged-tube and vapour-compression distilling plants. The flash-type plant functions in the second manner. In the flash-type plant there is complete absence of boiling brine from hot submerged surfaces, and there is no increase in the density of the sea water in any of the heating surfaces. Instead, sea water only is heated inside the tubes of the heat exchangers to a temperature not exceeding 170 deg. F. Whenever sea water is heated above 170 deg. F. a substantial amount of scale forms on the heating surfaces. The amount and tenacity of this scale increases with rising temperature and brine density or salt concentration of the boiling brine. In order to realize reasonably high efficiency, multiple-effect submerged-tube and vapour-compression plants operate at temperatures in excess of 170 deg. F. and at brine densities 1½ to 5 times the concentration of sea water. Such scale as may form in a flash plant will be inside the tubes of the salt water heater and readily removable. Tests have shown that such removal will be necessary only once or twice a year, and require only a fraction of the time and labour for other types of distillers. The flash distiller on the *Cubore,* for example, has been in continuous operation for more than seven years. Although designed to operate with a top feed temperature of about 180 deg. F., as compared with the 170 deg. F. maximum for the present Bethlehem unit, this plant is subject to only light scale forming in the tubes of the salt water heater. No scale has been found in the tubes of the stage condensers. To maintain this plant at peak efficiency, it is necessary to clean it only twice a year, and only five to six man hours of labour are required. Operation of the flash-type distilling plant is extremely simple. Once vacuum has been obtained and the pumps placed in operation, the plant is controlled by one valve. The steam supply is orificed to provide the desired capacity, and the feed control valve maintains the proper feed temperature. There are no levels to control and no brine densities to be maintained; therefore, the plant can be operated by unskilled labour. Once in operation it is extremely stable and is not upset by variations in steam pressure or feed quantity. The flash plant does not require a pressure regulating valve on the steam supply for it is able to absorb the normal swing in auxiliary exhaust or bleeder steam, such as encountered on shipboard.—*Marine Engineering, March 1956; Vol. 61, pp. 49-50; p. 83.*

Light-weight Anodized Aluminium Wire for Electric Motors, etc.

The possibility of using anodized aluminium films as an electrical insulant has engaged the attention of engineers for the past twenty-five or thirty years. Aluminium oxide, which is built up by anodizing, is an insulator that maintains its insulating properties at very high temperatures. The normal insulating materials used on magnet wires for winding electrical machines are organic. Therefore, they lose their insulating properties rapidly if temperatures rise above 80 or 100 deg. C. For some time, engineers have felt that, if an insulant with higher temperature characteristics were available, substantial economies in the use of component parts would be possible and great reductions in weight and size realized. Aluminium has offered this potential but, until now, the anodically produced films have been too brittle, while the cost of producing films with electrical properties has been too great for adoption commercially. After several years of research, metallurgists have developed a new process of anodizing aluminium wire with alternating current to give it a ductile oxide coating which, in effect, becomes an electrical insulation. It is stated that completely new horizons in design are open to manufacturers of electrical equipment as a result of this development. Electrical equipment wound with light, heat-resistant aluminium wire (instead of the heavier copper wire now used universally) could be made smaller, cheaper and lighter, and could run hotter, it was pointed out. A demand for more aluminium, up to thousands of tons yearly, is foreseen if aluminium wire is used as a general replacement for copper in this field. According to the Aluminium Union, Ltd., a few technical problems involved in using anodized wire remained to be solved, but they were co-operating with British manufacturers of electrical equipment in working them out. The process involves pulling the aluminium wire through tanks containing chemical solutions, which quickly give it a thin, hard coating. In eighteen months of research at the company's plant at Shawinigan Falls, Quebec, the metallurgists of Aluminium, Ltd., overcame two major obstacles, viz.:—(1) A process capable of providing an insulated film at commercial speeds was devised. (2) There was developed an anodic film sufficiently ductile to withstand the stressing and flexing operations involved in winding electrical coils. The lack of these properties has prevented the use of anodized aluminium wire for this purpose in the past.—*The Shipbuilder and Marine Engine-Builder, May 1956; Vol. 63, p. 343.*

Carbon-dioxide Shielded Metal-arc Welding

The carbon-dioxide shielded metal-arc welding process appears to be one of the most significant developments in welding in the past several years. The importance of this process is emphasized by some of its advantages. First, the process has a high potential for welding cost reduction; second, it produces excellent weld metal quality; third, it is an automatic welding process with a visible arc; fourth, the process does not require flux for arc protection, thus eliminating slag removal problems after welding. The equipment necessary for use with the carbon-dioxide welding process is similar to equipment used with the shielded inert-gas metal-arc processes. It requires a welding power supply unit which will provide adequate and reliable welding current, an automatic welding head to feed the wire to the work, an electrical control unit to control the automatic welding head, and a nozzle which provides a means of surrounding the welding puddle with carbon dioxide gas, as well as providing an electrical contact to the wire for the welding current. When using the carbon-dioxide shielded metal-arc welding process, it is important to consider the design of the welding head and nozzle. The welding head must be of such design as to provide higher wire feed speeds and still maintain good control of the welding arc. The nozzle design is also of prime importance, because proper shielding of the molten puddle is necessary in order to ensure quality welds. A series of metallurgical investigations were made on weld metal deposited with the carbon-dioxide shielded metal-arc process, taken from various welds made both in production and the laboratory. This investigation revealed that the weld metal was free from nitride inclusions, as determined by heat treating the specimens to precipitate excess nitrogen in visible form. The study also revealed that the weld metal was clean and sound, free from segregations and oxide inclusions. Metallurgical investigations were also conducted on welds made with argon and helium under similar circumstances, and the results were quite similar. From the metallurgical standpoint, no differences were detected between welds made with carbon dioxide, argon or helium.—*R. J. Keller and J. Koss, The Welding Journal, February 1956; Vol. 35, pp. 145-151.*

Testing and Calibrating Spray Valves

Spray valves of deaerating feed tanks should be examined regularly to see that they are operating properly. Correct spraying of the incoming condensate in the deaerating feed tanks is necessary for adequate heating of the feed and for initial deaeration. Spray nozzles that do not open at the proper pressure, or those that have weak springs or badly scored seats, impair the operation of the deaerating feed tank. A rig has been developed for testing deaerating feed tank spray nozzles. When deaerating feed tanks are open for inspection, the spray nozzle should be removed, tested, and repaired. A test rig similar to that shown in Fig. 1 is needed. The rig requires a minimum of 10lb. per sq. in. water supply, furnished either from shipboard or dockside. The water supply should be connected by a globe valve to the ½-in. International Pipe Size (I.P.S.) nipple. A 0 to 3lb. per sq. in. pressure gauge or a 0 to 10-inch U-tube manometer containing mercury should be connected to the ¼-in. I.P.S. side outlet pressure tap. There is a ¼-in. I.P.S. connexion at the bottom for drainage if required. Each spray valve can be tested and calibrated separately: (1) Mount the test rig, with its connected water supply and indicating gauge, in an angular position similar to that of the spray nozzle when installed in the actual feed tank. (2) Install the spray valve to be tested or calibrated on the 3-in. coupling indicated in Fig. 1. A rubber gasket or similar material can be used instead of a copper gasket for mounting the spray valve. (3) Fill the test rig with water and lift the valve head either by hand or by water pressure to remove the air pockets. (4) To determine the condition of the valve seats and the lift of the valve head, operate the water supply valve slowly. Individual instructions are given for each deaerating feed tank. During the build-up in pressure required to open the valves, leaking will be clearly evident if there are scored or poor seats. The indicated pressure should be recorded when the spray valve opens; if it does not correspond with the pressure indicated in the instruction book, the valve spring tensions can be reset. If there are seat leaks, the valves should be reseated before any final spring or lift adjustment is made. If the 3-in. coupling has been threaded for a particular size of spray head, adapters can be fabricated for fitting other sizes of spray heads to the coupling.—*Bureau of Ships Journal, March 1956; Vol. 4, p. 24.*

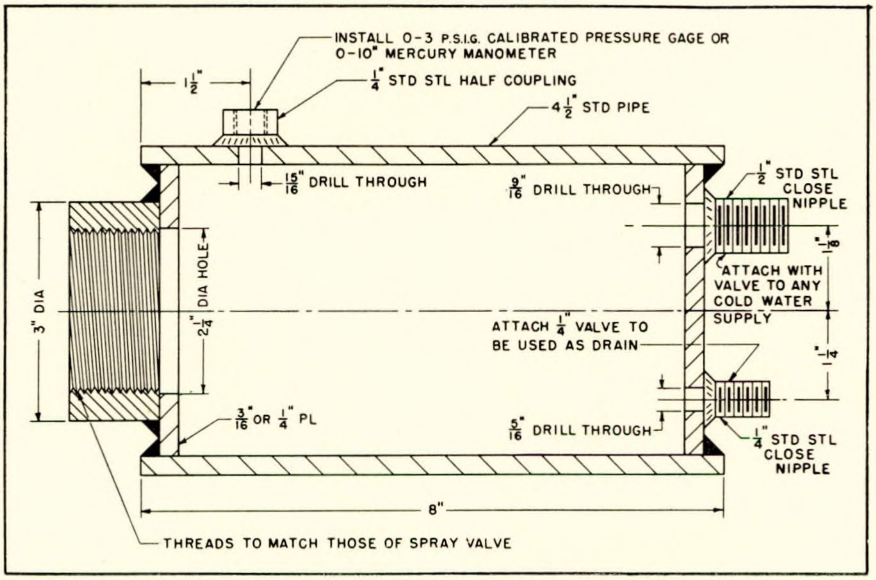


FIG. 1—*Test rig for deærating feed tank spray valve*

New Marine Gas Turbine

A version is being developed of the Bristol Proteus turboprop engine, which is the engine used in the Bristol Britannia airliner. This work is being undertaken by Bristol Aero-Engines, Ltd., in collaboration with the Admiralty, and the engine is intended for the powering of high-speed patrol boats. The Proteus engine has a free power turbine, and is, therefore, capable of efficient operation over a wide range of powers and speeds. For this reason it seems probable that it will be used as the sole propelling machinery in patrol craft, and not as a booster in the manner of the Metropolitan-Vickers G2 gas turbine. The Admiralty will thus have two gas turbines suitable for this purpose: the Proteus and the Rolls-Royce RM60. The latter develops 6,000 s.h.p., and is probably best suited to the larger sizes of patrol craft. The Proteus develops 3,500 s.h.p., and as it only weighs 3,000lb. it can offer a very favourable weight-power ratio. The Proteus marine version is basically similar to the Proteus 755 which is used for advanced production versions of the Britannia airliner. The principal modification is the incorporation of Allen-Stoeckicht reduction gearing, while another important change is the replacement of all magnesium parts by aluminium alloy. The engine has already completed over 500 hours under simulated seagoing conditions, and these trials have demonstrated that the Proteus starts, idles and runs entirely satisfactorily on Admiralty gas oil. In one test of 225 hours, salt water was sprayed into the engine at twice the highest rate ever recorded at the intake of a gas turbine at sea. After this test it was shown that if the engine's compressor blades become so encrusted with salt that performance is affected, they can be washed clean and normal power restored within five minutes by running the engine at idling speed while distilled water is injected into the air intake. —*The Shipping World, 28th March 1956; Vol. 134, pp. 301-302.*

Swedish Ore Carrier Design

Scandinavian Ore Carriers, Inc., a recently-formed subsidiary of Nordstrom and Thulin, of Stockholm, has been formed primarily for the carriage of iron ore from the new Labrador mines. The first three ships which it has ordered are now under construction in Great Britain and Sweden. One, the *Atomena,* was launched on 28th February from the yard of

Sir James Laing and Sons, Ltd., where a sister ship is on order. The third ship, *Cassiopeia,* was launched by Kockums Mek. Verkstad on 8th March. The leading particulars of all three ships are the same, but the designs are not identical. The *Cassiopeia* is a vessel of 19,000 tons deadweight. In common with other ships intended for the Labrador trade, she is designed with an alternative trade in mind, as the mines are closed to shipping during the winter months and the ore-carrying tonnage must seek employment elsewhere. The larger ships so far built have been combined ore carrier/tankers, but the *Cassiopeia* class are intended for general bulk cargoes during the off season. The cubic capacity of their holds is therefore larger than that of a pure ore carrier of the same deadweight capacity, and they can load 15,000 tons of coal or grain. It is claimed by the builders that they are the largest general purpose bulk carriers in the world. The *Cassiopeia* is only intended for service between ports equipped with loading and unloading facilities for bulk cargoes, and she has no cargo handling equipment of her own. The original requirement was for a vessel able to carry the 15,000 tons of coal or grain in a single-deck hull not longer than 538 feet and with a draught not exceeding 27 feet. It was to be a self-trimmer. The resulting design gave a hull with comparatively high freeboard, and with sufficient strength for heavier loading. It was possible to increase the draught to 31ft. 9in. when carrying heavy cargoes such as ore, giving a deadweight of 19,000 tons. The other leading particulars of the design are as follows: —

Length o.a.	535ft. 10in.
Length b.p.	500ft. 0in.
Breadth moulded...	70ft. 6in.
Depth moulded	44ft. 3in.
Cubic capacity	776,000 cu. ft.
Bunker capacity, tons	1,120
Gross tonnage	13,900
Net tonnage	7,650

The hull is of the double-skinned type normal in ore carriers, though the hold capacity is, of course, larger than with this type of tonnage. The cargo space is divided into three holds. The transverse bulkheads separating the holds are horizontally corrugated and stiffened with vertical web frames, one on the centre line and one on each side. The angle of the corrugation is sufficiently steep to prevent cargo lodging on the sloping portions of the bulkheads. The hatch covers are of a folding steel design, and are operated by hydraulic rams situated at the corners of each hatch. Longitudinal alleyways for the crew and for cable runs are provided to port and starboard, but instead of being arranged immediately beneath the upper deck, as is the common practice with ore carriers, they are arranged at the sides of the ship and serve to separate the upper from the lower tank spaces. The main engine consists of a Kockum-M.A.N. 8-cylinder Diesel engine of two-stroke type, developing 7,200 b.h.p. It is designed to give the ship a speed of 15 knots at a lighter draught of 27 feet, and of 14 knots at a draught of 31ft. 8in. It is arranged to burn heavy fuel.—*The Shipping World, 28th March 1956; Vol. 134, pp. 311; 317.*

Paddle-wheel Experiments

The nineteen sets of experiments, the results of which largely constitute this paper, cover a reasonable range of most of the variables likely in paddle-wheel design. Using the charts it should be possible to approximate fairly closely to most normal wheels and operating conditions. In doing so, certain assumptions must inevitably be made; for example, that the effect of star-centre location shown in Fig. 14 can be extended to other immersions, number of floats, etc. While such assumptions are probably valid for small changes in the other variables, they may well break down if extrapolated too freely. Judicious estimation of the limits within which data may be used with safety is, however, a feature of ship design by no means unfamiliar to the naval architect. The few comparisons which have been considered serve to indicate the probable trend in each instance and also indicate a fairly satisfactory degree of consistency. The diagrams given represent only a fraction of the almost infinite range and combination of assumed design conditions possible and no simple principles can be laid down which would be universally applicable. The results of the experimental work, considered as a whole, fall into place reasonably well and the broad pattern of wheel performance has been very considerably clarified. The results have in many respects merely confirmed empirical knowledge which extends back over many years. Small entry and exit angles and forward and upward displacement of the star-centre are shown to be beneficial, as they were known to be, but the reason now appears to be tied up with the angularity of the floats to the vrtical and consequent reduction in effective circumference and the peculiar shape of the thrust distribution curve. The link between efficiency and effective circumference at any immersion is remarkably consistent throughout and is probably amenable

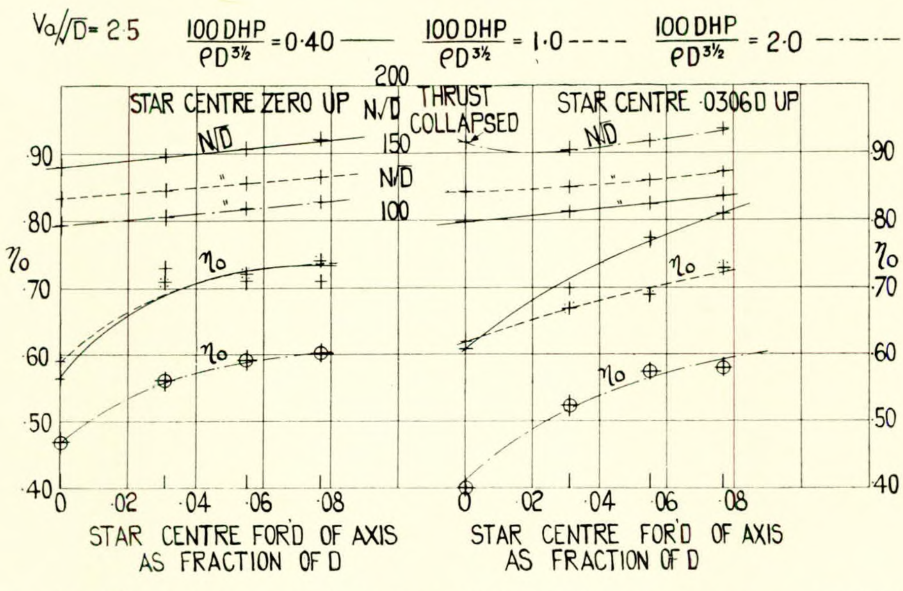


FIG. 14—*Effect of star-centre location on efficiency and r.p.m. at constant speed of advance and three powers (9 curved floats. Immersion coefficient 0·20)*

to a very simple explanation. If a single float on an arm is instantaneously in the vertical, the torque would be simply the thrust multiplied by the distance from the axis to the effective centre of pressure. Any decrease in this distance, that is, rise in centre of pressure, gives a reduced torque for the same thrust and hence a higher efficiency. Thus a small effective radius is related to a high ratio of thrust: torque. An explanation of the association of a small effective radius with approximately vertical floats is suggested. For practical purposes the next step in the paddle-wheel research programme must clearly be to establish a reliable relationship between ship and model. Previous experience suggests that the thrusts predicted from the model wheel are too high and powers too low, although it is difficult to envisage any size effect which would satisfactorily explain this result. By analysing all reliable trial data that may be made available, it should be possible to determine the extent of any departure from the dynamic law which may exist and hence derive the necessary correction factors.—*Paper by H. Volpich and I. C. Bridge, read at a meeting of The Institution of Engineers and Shipbuilders in Scotland on 13th March 1956.*

Fast French Oil Tanker

The largest oil tanker yet built in France has been delivered to her owners, Esso Standard Société Anonyme Française. This vessel, the *Esso France,* 37,500 tons d.w., was built at the Chantiers de l'Atlantique (Penhöet-Loire), St. Nazaire. Besides being the largest tanker so far built in France, the *Esso France* is one of the fastest oil tankers in the world, having reached a speed of 18·4 knots in ballast. The contract provided for speed and fuel consumption trials with the ship fully laden at the normal rated engine power of 17,500 h.p., at which the ship should be capable of a speed of 17 knots, and a further trial at 19,000 h.p. without a minimum speed imposed. The results of these trials were as follows:—at 17,000 h.p. the vessel reached an average speed of 17·8 knots, and at 19,000 h.p. the average speed was 18·2 knots. The *Esso France* is powered by C.E.M.-Parsons type steam turbines built at the La Loire works having a maximum permissible power of 19,000 h.p. The vessel was built in the large building dock at St. Nazaire and floated out last June. The *Esso France* will carry crude oil to three of the large Esso refineries in Europe. The principal particulars of this vessel are as follows:—

Length o.a.	693ft. 11in.
Length b.p.	666ft. 0in.
Breadth	90ft. 11in.
Depth	48ft. 5in.
Draught	36ft. 6in.
Deadweight, tons...	37,500
Number of cargo tanks	33
Volume of cargo tanks	1,742,548 cu. ft.
Volume of fuel and ballast tanks	152,833 cu. ft.
Volume of ballast and water tanks	52,965 cu. ft.
Maximum continuous engine power, h.p.	17,850
Maximum permissible power, h.p.	19,000
Speed in service, knots	17

The *Esso France* is propelled by a set of Parsons-C.E.M.-Loire steam turbines driving a single screw through reduction gearing. The five-bladed propeller is of bronze and weighs 30 tons. Both turbines and gearing have been built at the St. Nazaire works. These turbines are capable of developing a service power of 17,000 h.p. at 104 r.p.m., and a maximum designed power of 19,000 h.p. at 108 r.p.m. The main turbine condenser is arranged below the l.p. turbine, circulation being effected by means of an electric pump having an output of 4,350 cu. metres per hour. The condenser is provided with a group of air ejectors comprised of double elements, each double element consisting of a first and second working in series. Each double element is able to maintain a vacuum of 95 per cent, with the main engine operating at 19,000 h.p. and the temperature of the water being 24 deg. C.—*The Shipping World, 7th March 1956; Vol. 134, pp. 247-249.*

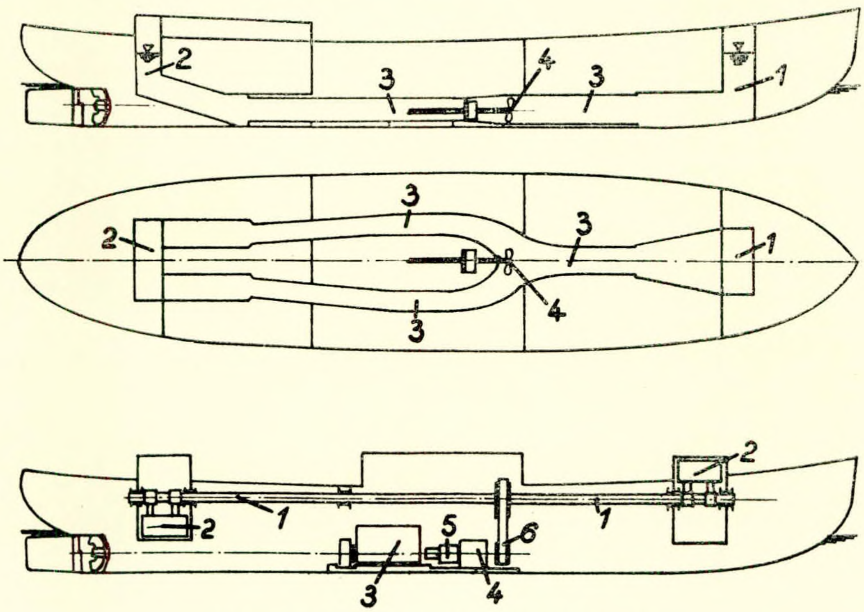
New Rope Material

The use of synthetic fibres for various marine applications is now commonplace, although ropes made from this substance are probably not yet widely used on board ship. One type of synthetic fibre known as Perlon has successfully been used by the Royal Air Force for aircraft glider towing and parachute cords; and rope in this material is now obtainable for marine use in the United Kingdom. One of the main advantages claimed for Perlon, is that it has an elongation capacity of 40 per cent as against the maximum elongation capacity of 25 per cent of the other synthetic fibres. It also has a very high tensile strength, and is immune to bacteria and so cannot rot. In the new passenger liner *Bergensfjord,* which has just been completed by Swan, Hunter and Wigham Richardson, Ltd., for the Norwegian America Line, several Perlon ropes will be used. These are in 12-fathom lengths with an eye at one end and have been supplied as tails for mooring ropes. They consist of three 6½in., five 7½in., and three 9in. ropes of 35, 45 and 71 tons breaking strain respectively. For the manufacture of ropes, Perlon is mostly used in the form of endless fibres, and possesses a very high tensile strength. Ropes made from this synthetic fibre can therefore be thinner and lighter, yet still have the same strength. This strength is hardly affected by tropical and arctic temperatures, whereas, in the case of natural fibres, there is a distinct change, especially in terms of shrinkage due to reduced moisture content in high temperatures. The lessening in the strength of Perlon due to water absorption is very slight, since no change in texture takes place, and it does not swell in the same way as rope made from natural fibres. As opposed to natural fibres, Perlon stretches by about 1 to 2 per cent when wet, while natural fibres shrink. Ropes made from this material are therefore just as easy to handle wet as dry, and water absorption and resultant increase in weight are considerably less than in the case of natural fibres. A particular advantage is that they can also be stowed away wet, without fear of their being attacked by mould or bacteria. These qualities make this synthetic fibre the ideal raw material for ropes which have to be really strong and stand up well under wet conditions. Like natural fibres, Perlon is susceptible to attack by organic and mineral acids; but on the other hand, it is resistant to alkalines, oils, grease, petrol and other chemicals. It is not subject to attack by vermin; it does not burn, but melts at a temperature of 460 deg. F. Tests carried out showed that the natural fibres carbonized when subjected to currents of hot air at the following temperatures: manilla 290 deg. F.; sisal 260 deg. F., and hemp 320 deg. F. At a temperature of 360 deg. F., Perlon starts to become soft; whereas hemp, manilla and sisal ignite at a temperature of 480 deg. F., the melting point of Perlon is 460 deg. F. The resistance to dry Perlon to chafing is about as great as that of manilla and sisal but, under wet conditions, is far superior. As the synthetic fibres are considerably thinner than the natural fibres, the individual fibres are less subjected to friction and rubbing so that the rope surface takes on a furry character. In practice, however, it has been shown that the lessening in strength which follows this surface roughening is only very slight relatively and that the "surface fur" thus created protects the underlying fibres from further chafing. It can be seen from the foregoing that Perlon can be used satisfactorily for special applications and, in fact, for any job which lays stress on maximum elasticity and minimum weight, e.g. for towing, whether on water or in the air. Its high dropping strength also makes Perlon ideal for safety lines and painters.—*The Shipping World, 30th May 1956; Vol. 134, p. 514.*

Patent Specifications

Applying Pitching Motion to Marine Craft

This invention aims at improving the icebreaking action of a vessel. For this purpose the vessel is provided with means for causing a pitching or punching motion of the vessel which is approximately in resonance with the natural pitching period of the vessel. In Figs. 1 and 2 the arrangement for augmenting pitching motion consists of two tanks (1, 2) which are partly filled with any liquid and are connected by a pipeline (3) having a pump (4) incorporated. With the aid of the pump (4) a quantity of liquid corresponding to the desired pitching angle is periodically pumped from the stem to the bow and vice versa, so as to initiate pitching or punching of the vessel. The direction of delivery of the pump is periodically reversed, as for example by providing an impeller having adjustable blades. Fig. 3 shows another form of vessel in accordance with the invention. A shaft (1), supported in the longitudinal direction of the ship, carries at its ends weights (2) which are displaced in relation to each other by 180 degrees, and attached to lever arms. The shaft is set in rotation so that the time of one revolution approximately corresponds to the time of the natural pitching of the ship. Through these revolving weights radial centrifugal forces are generated which act as free forces upon the vessel. The horizontal centrifugal forces produced in addition to the vertical forces will cause an additional yawing of the vessel thus preventing the vessel from sticking fast in the ice-sheets, and contributing greatly towards the ease with which the vessel may be disengaged. —*British Patent No. 750,855, issued to H. Waas, Bad Godesberg, Germany. Complete specification published 20th June 1956.*



FIGS. 1 (above), 2 (centre) and 3 (below)

Cooling of Gas Turbine Reheat Combustion Chambers

This patent is concerned with the cooling of reheat combustion chambers of open cycle gas turbines. In the plant illustrated, Fig. 9, atmospheric air entering at (1) is compressed in a low pressure compressor (2) and passed through an intercooler (3) in the usual manner to a high pressure compressor (4). The high pressure air from the compressor (4) is then passed through a heat exchanger (5) (in which its temperature is raised) into a main combustion chamber (6) where the fuel entering at (7) is burnt. The products of combustion are passed through a conduit (8) to a high pressure turbine (9) which is employed to drive the high pressure air compressor (4). The exhaust gases from the high pressure turbine (9) are passed to a reheat combustion chamber (10) in which further fuel entering at (11) is burnt in the exhaust gases from the turbine (9). These gases are then conducted to a low pressure gas turbine (12), which drives the low pressure com-

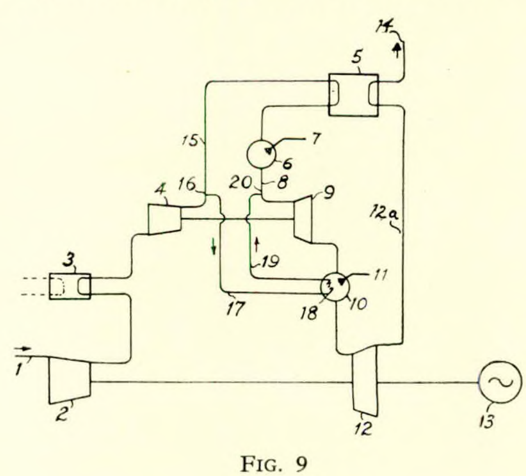


FIG. 9

pressor (2) and an alternator (13). The exhaust from the low pressure turbine (12) is conducted by a conduit (12a) to the heat exchanger (5) in which some of its heat is transferred to the air delivered from the high pressure compressor (3) to the main combustion chamber (6). The exhaust is then discharged to the atmosphere at (14). The conduit (15) connecting the high pressure compresser (4) with the heat exchanger (4) is tapped at (16) and connected with a bypass conduit (17) which leads high pressure air from this tapping point (16) to the reheat combustion chamber (10) where it is circulated, as indicated at (18), through suitable passages. In this way those parts of the reheat chamber which are liable to overheat are cooled. It will be understood that the high pressure cooling air is not released into the gas stream in the chamber (10) but is conveyed in a closed circuit so far as the latter is concerned. On leaving the chamber, the cooling air is returned through conduit (19) to the main gas cycle, and is injected at (20) into the conduit (8) connecting the main combustion chamber (6) with the high pressure turbine (9). It will be appreciated that the pressure differences between the tapping point (16) at which the diverted air is bled from the main cycle and the location (20) at which such air is returned to the main cycle will be sufficient to ensure adequate circulation.—*British Patent No. 749,267, issued to Metropolitan-Vickers Electrical Co., Ltd. Complete specification published 23rd May 1956. Engineering and Boiler House Review, July 1956; Vol. 71, p. 239.*

Boiler

In this boiler the superheater and the supporting provisions are so arranged within the cavity that the superheater tubes and their supports are accessible and the parts of the supporting means most liable to damage are readily replaceable. The marine boiler shown in Figs. 1 and 2 has a superheating section which comprises inclined rows of horizontally extending, nested, U-shaped tubes (42) positioned in the superheater cavity (30) between the main bank of steam generating tubes (37) and the screen tubes (37a). Each superheater tube consists of three nested U-shaped tubes with the legs of the innermost tube (42a) spaced apart sufficiently, for example 13¾in., to permit a man to walk between them for inspection or repairs. As indicated in Fig. 2, the tube end and header arrangement is such that each tube end can be radially connected to the corresponding cylindrical header and yet leave sufficient accessible header area between the tube ends to be readily inspected, repaired or replaced. The superheater tubes are supported on support tubes so as to remain in their designed nested and spaced relation during operation and yet to be readily removable when replacement is necessary.—*British Patent No. 753,103 issued to Babcock and Wilcox, Ltd. Complete specification published 18th July 1956.*

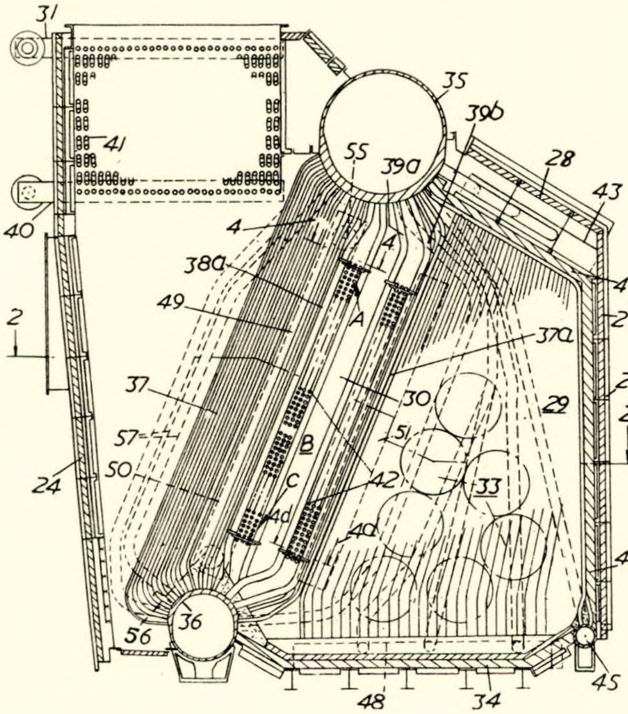


FIG. 1

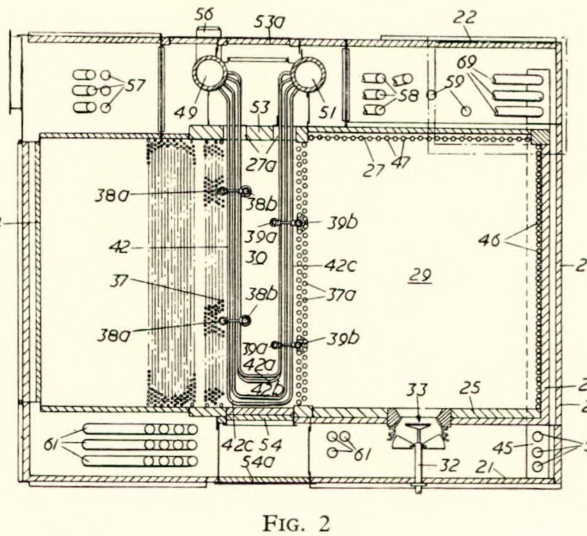
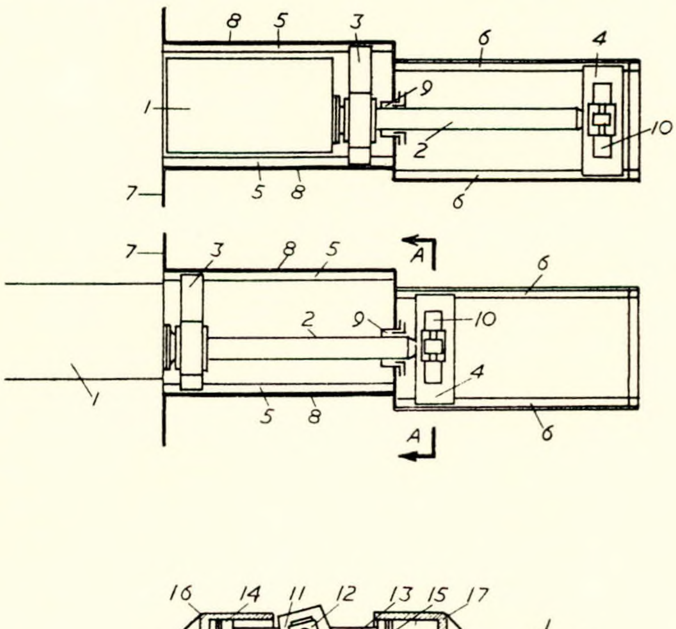


FIG. 2

Damping the Rolling Movement of Ships

The invention provides a device for damping the rolling movement of ships by means of extensible and retractable foils



FIGS. 1 (above), 2 (centre) and 3 (below) of stabilizers which are rotatably mounted on two movable transverse members, and the characteristic feature of the invention is that each foil or stabilizer is provided with a separate driving means for rotating the stabilizer, the driving means being extended and retracted together with the associated stabilizer. Referring to Figs. 1, 2 and 3, a hydrofoil or stabilizer (1) is fixed to the shaft (2). The shaft (2) is rotatably mounted in the transverse members (3, 4). The transverse members are guided on guide rails (5, 6) and are moved in and out by known means, not illustrated. In order to prevent water from entering the ship, a water-tight box (8) attached to the hull (7) contains the stabilizer (1) and the outer transverse member (3). The shaft (2) is guided through a stuffing box (9) into the interior of the ship. The prime mover (10) for rotating the stabilizer (1) is mounted on the inner transverse member (4). Fig. 3 shows by way of example how the rotating means may be constructed and mounted. On the shaft (2) a lever (11) is fixed in which a block (12) is slidable. To this block is fixed a piston rod (13) which carries pistons (14, 15) which move in cylinders (16, 17). The pistons can be operated by steam, compressed air, water or other medium. The supply of the working medium is effected by means of slides or valves which can be controlled by means of a gyroscope.—*British Patent No. 752,744 issued to F. A. Süberkrüb. Complete specification published 11th July 1956.*

Safety Valve

A sectional view of a safety valve constructed in accordance with this invention is shown in Fig. 2, while Fig. 3 is a sectional view showing the main valve features when the latter is in the open position. When a high pressure fluid such as steam flows through the central inlet opening (10) of the valve seat *r*, the main valve disc *b* is forced upwards. As soon as the upward pressure of the steam has become higher than the downward pressure exerted by the action of the spring (3) and the weight of the main valve disc *b*, together with its associated parts, the main valve disc *b* is lifted slightly. Steam is then permitted to flow radially outward through the passage (11) formed between the bottom surface of the main valve disc *b* and the valve seat *r* and passes into the vortex groove *s* formed on the top surface of the interior valve seat *r*, forming a vigorous vortex of the high pressure steam throughout the groove. As a result of the vortex action, the lifting power of the main valve disc *b* is increased so that the valve opens rapidly and sensitively. At the same time, some of the steam flowing out to the exterior, passes into the clearance *m* between the guide cylinder *c* and the main valve disc *b* and acts against the bottom surface of the chock *o* to raise the latter relative to the main valve disc. As a result of this action, the chock *o* is lifted more rapidly than the main valve disc *b* and vigorously struck against the bottom q^1 of the chock-receiving flange *p*. Thus the valve opening action of the main valve disc *b* is assisted by the chock guide *o* striking against the flange *p*. This action, combined with the action of the vortex grooves, results in the safety valve of this design operating sensitively and rapidly.—*British Patent No. 751,393 issued to Tsunetaro Ohta. Complete specification published 4th July 1956. Engineering and Boiler House Review, August 1956; Vol. 71, pp. 272-273.*

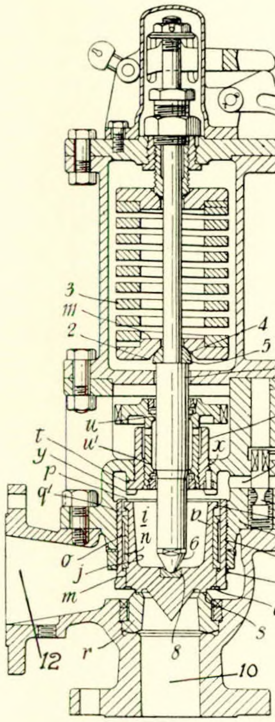


FIG. 2

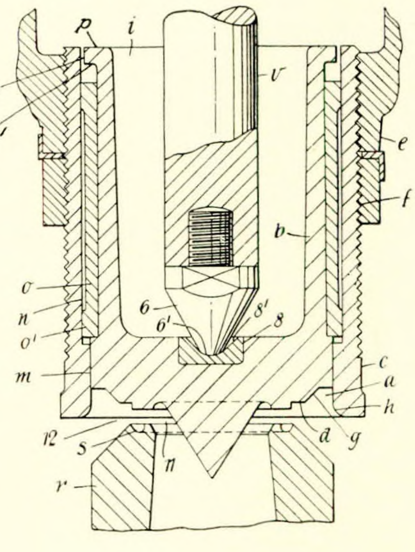


FIG. 3

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Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 10, October 1956

Swedish Tanker with Directional Short Wave Radio

The Swedish motor tanker *Helfrid Billner,* which was delivered in March to Billners Rederi A/B, of Gothenburg, by Kockums mek. Verkstad, is notable for the directional short wave radio aerial system which is fitted. The *Helfrid Billner,* a vessel of 19,830 tons deadweight, is likely to spend a good deal of her life on the route between the Persian Gulf and Europe, and for most of the time on this route she will have Scandinavia on her beam. Reception of high frequency radio transmission is not always satisfactory from the Persian Gulf area, and it was thought worth while to try fitting a permanent directional aerial to improve reception. To give a directional effect at the frequencies required the aerial array must be large, and it has been rigged between the foremast and the radar and signal mast on the bridge, both of which have been increased in size for the purpose. The array consists effectively of four pairs of horizontal dipoles, arranged at the corners of a square 22 metres long and 12 metres high, with 2·9 metres spacing between the dipoles of a pair. To ensure that the various elements are in phase the system is fed from the centre by means of feeder cables spaced apart by reinforced glass fibre bars. The system was designed by the Swedish Telegraph Board's wireless section at Gothenburg, and should increase tenfold the radiation on either beam at the expense of the signal strength in the fore and aft directions. Thus in addition to improving reception in the desired direction, the system will reduce interference elsewhere. In addition to the experimental aerial, the ship has the normal types of aerial for long wave and short wave transmission and reception. The main particulars of the *Helfrid Billner* are as follows:—

Length, o.a.	557ft. 0in.
Length, b.p.	525ft. 8in.
Beam	71ft. 9½in.
Depth moulded...	40ft. 1in.
Draught	30ft. 11½in.
Gross tonnage	12,994
Net tonnage	7,554
Contract trial speed, knots ...	15¼

The hull is longitudinally framed and practically all-welded. The cargo capacity, 929,580 cu. ft., is divided into nine centre and eighteen wing tanks. There are two pump rooms each provided with two steam-driven duplex compound pumps, capable of handling 500 tons of water per hour, and a stripping pump of 150 tons capacity. The main engine is a 9-cylinder two-stroke single-acting Kockums-M.A.N. Diesel engine developing 8,100 b.h.p. (9,500 i.h.p.) when running at 115 r.p.m. The auxiliaries consist of two Diesel-driven and one steam-driven three-phase a.c. generators of 275 kVa, 380 V, 50 c/s each. Steam for various services is provided by two oil-fired Scotch boilers and one Spanner boiler, the latter utilizing the main-engine exhaust gas.—*The Shipping World, 4th April 1956; Vol. 134, p. 341.*

Reducing Deformation of Shell Plating in Welded Ships

In welded structures complicated varieties of deformation occur. When floor plates or frames are welded to the shell of a ship, deformation appears as shown in Fig. 1. As a result of this, when observed from outside, the frame lines can be seen clearly just like the appearance of the breast of a thin horse; it is commonly called, therefore, in Japan: "thin horse-like deformation". This phenomenon is generally called "unfairness" in English, but in this report, in order to show the character of deformation clearly, it is called "arc-form deformation". Though this deformation has been discussed from the viewpoint of outside appearance, it has become important in regard to the strength of the bottom plating because it may

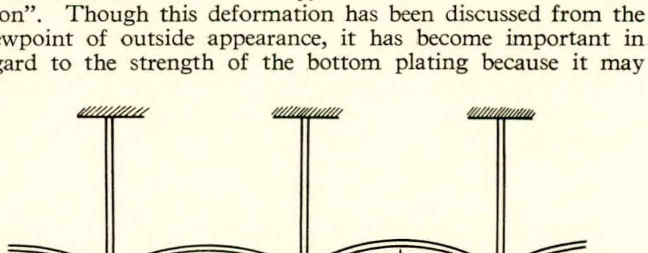


FIG. 1—*Bottom shell plating under axial compression and water pressure*

Note: 1. *Arc-form deformation occurs due to fillet welding between floor and shell plates*
2. T = *compressive force due to hogging*
3. p = *water pressure*

be the cause of buckling or corrugation failure of the bottom plating. When the compressive forces due to hogging and water pressure are applied to the initially deformed plate as shown in Fig. 1, the outer surface of the bottom plate may yield, the deformation be increased and the plate be corrugated. During 1952-53 this kind of failure was found in ten of the 10,000-ton class cargo ships in Japan. This subject was investigated from various points of view by the Ship's Hull Failures Investigation Committee of Nippon Kaiji Kyokai (Japanese Marine Corporation). For the phenomenon of "arc-form deformation" the prime cause of the problem can be attributed to reaction stresses originating from constraint of angular stresses originating from constraint of angular change due to welding. Accordingly it is advisable that the "angular change", in the strict sense "change of free angle due to welding", be considered as more important than the deformation or stresses in the analysis of this phenomenon. The "change of free angle" may be calculated from a change of inclination of deformation at the weld joint. The distribution of residual stresses calculated theoretically from the angular change coincides well with that obtained experimentally. Consequently, the "arc-form deformation" and residual stresses due to welding in a general framework may be solved as a problem of inherent stresses originating in a statically indeterminate frame structure. Effects of the degree of constraint and other welding procedures on the angular change are as follows: (1) There exists nearly a linear relation between logarithm of the rod consumption per unit weld length (which corresponds to the weight of deposited metal for unit length, namely the sectional area of metal deposited) and the angular change. (2) When the weight of deposited metal is constant, there is a slight difference in the angular change with a change of diameter of electrode. (3) The degree of constraint has a great influence on the angular change, and an increase of it causes the angular change to reduce. Nearly a hyperbolic relation will be obtained between these two quantities. It may be considered that this phenomenon will present an effective means for the reduction of "arc-form deformation". It is difficult to determine the most effective means for minimizing the "arc-form deformation" in ship structures because the bottom structure of a ship is very complicated. However, the following facts may be, at least, ascertained from the knowledge obtained so far: (1) Weight of deposited metal. Lessening the weight of deposited metal is the primary factor reducing "arc-form deformation". The length of leg in fillet welding, therefore, should be limited to the minimum value necessary for strength. (2) Welding procedures. As thorough investigations have not yet been made on the effect of electrode diameter, gap of fillet, the application of bevelled fillet welding or the use of deep penetration-electrodes, nothing can be said decisively on welding procedures. However, studies on welding procedures are very useful if the weight of deposited metal can be reduced by an improvement of welding process as seen, for instance, in the application of deep penetration welding which will reduce the length of leg. But it is considered that a great improvement in the problem cannot be expected unless the weight of deposited metal is reduced. (3) Suppression of the angular change by an additional constraint. Since the degree of constraint has a remarkable effect on the angular change, it is considered very useful for controlling the angular change to give an additional constraint to the original constraint by using strong backs or stays. When this practice is adopted it is needless to say, however, that means should be taken to prevent an increase of welding work in preparing the additional constraint or possible failures that might arise from the welding of the additional constraint to a strength member such as a shell plate.—*Kouichi Masabuchi et al., International Shipbuilding Progress, March 1956; Vol. 3, pp. 123-133.*

Comparative Sea Trials of Two Belgian Motor Ships

During the years 1953 and 1954 extensive sea trials were carried out by the Centre Belge de Recherches Navales on m.v. *Lubumbashi,* the first of a series of new ships ordered by the Compagnie Maritime Belge. The ship was equipped with torsionmeter, thrustmeter, pitometer log, anemometer and windvane, and for varying conditions of draught, fouling and weather, numerous records were collected of speed, power, thrust, revolutions, ship motions, wind and waves. Two measured mile trials were carried out at Polperro, the first as part of the official trials of the ship in the ballast condition, the second in the loaded condition at the beginning of her maiden voyage. Four of this series of new ships are now in service: these sister ships are, in addition to the *Lubumbashi,* the *Lubilash,* the *Lukala* and the *Lufira.* The first three were built by the John Cockerill yard in Hoboken-Antwerp, while the fourth, the *Lufira,* comes from the Nakskov yard in Nakskov, Denmark. The main engine of all these ships is a Cockerill built Burmeister and Wain double acting, two-stroke Diesel engine 6·59 W.F. 125/45, developing in normal service conditions 6,000 b.h.p. at 112 r.p.m.; and specially built to operate on residual fuel. However, on the *Lufira,* this main engine is supercharged. It was expected to develop some 8,000 b.h.p. This is the first double acting two-stroke supercharged Diesel to be built, and extensive tests were carried out at Cockerill's in Seraing as well as at sea. Because of that, besides the official trials of the ship in the ballast condition, a measured mile trial was carried out at Polperro in the loaded condition at the beginning of her maiden voyage in the same way as had been done on m.v. *Lubumbashi.* A torsionmeter was fitted on the shaft, and this allowed an accurate measurement of the ship's power. The measured mile trials of both ships were carried out in the loaded condition, the draught being nearly the same. Comparison of these two trials is the principal purpose of this article. The engine of the *Lubumbashi* develops 6,000 b.h.p. at 112 r.p.m. in the loaded condition; but in service (loaded condition and fine weather) the engine is run at a continuous output of 5,500 b.h.p. at 107 r.p.m. The highest power developed on the measured mile at Polperro was 7,500 b.h.p. at 117 r.p.m., but in service (loaded condition and fine weather) the engine is run at a continuous output of 7,100 b.h.p. at 114 r.p.m. On both vessels the performance was satisfactory with residual fuel of a viscosity as high as 3,500 seconds Redwood No. 1 at 100 deg. F.—*G. Aertssen, International Shipbuilding Progress, April 1956; Vol. 3, pp. 199-206.*

Procedure to Impart Specified Dynamical Properties to Ship Models

Up to the present time, almost all testing of ship models in waves has been done with the model towed in head or following seas. If the resulting two-dimensional motion of the model is to be considered meaningful for the full scale ship, the centre of gravity of ship and model must correspond and the radius of gyration in pitch must be appropriately scaled. The ballasting of the model must then be such as to yield a specified displacement, trim, centre of gravity, and pitching moment of inertia. The first two of these four requirements may be met in a straightforward manner. The other two requirements can also be satisfied concurrently with the first two by a direct method such as the one described in this report. It has, however, been common practice to ignore the vertical location of the centre of gravity and to arrive at the appropriate moment of inertia by a trial and error procedure. Further, one of the methods frequently used for finding the moment of inertia rests on the assumption that moments of inertia in yaw and pitch are almost identical. Although this assumption seems to be a good one in most instances, it serves to introduce an indeterminate systematic error into the results. This unsatisfactory situation with respect to widely accepted ballasting procedures motivated the present work. It is possible to prescribe a routine procedure for ballasting a ship model which will provide simultaneously the required displacement, trim, centre of gravity, and moment of inertia in pitch by a direct, non-iterative method such as the method described below. It is designed to take advantage of the widespread practice of using a towing bracket pivoted at a fixed point in the model. Although it depends on the possibility of suspending a model from a freely pivoting towing bracket, the analysis can be readily modified to correspond to other means of model suspension which may be more convenient for models equipped with other towing arrangements. In the paper, the required analysis is performed, some remarks are given about details of the procedure which might be helpful in practice, and finally, an outline for a suggested ballasting procedure is presented.—*H. R. Reiss, David W. Taylor Model Basin; Report 986, March 1956.*

Molten Babbitt Poured into Large Bearings

At the New York Naval Shipyard, molten babbitt is being poured—rather than ladled—into large bearings. The babbitt pot is drilled and tapped near the bottom for a 1½in. or 2in. pipe. The pipe is fitted with a valve located inside the pot. The pot is elevated until the bottom is about 18 inches above the bearing. The valve is opened by the handle and the molten babbitt is allowed to flow in a continuous pour until the bearing is full. Previously, molten babbitt was ladled from pot to bearing by hand. This method was slow, dangerous, and unsatisfactory. It was difficult to keep out air bubbles and slag; it was impossible to maintain the even heat necessary for a good bond. Fifty per cent of all bearings contained slag or air bubbles that had to be removed with a torch. The resulting holes had to be filled with new metal. After they were machined, approximately 20 per cent of the bearings showed loose babbitt or porosity, which meant complete remelting, repouring, and remachining. Pouring produces a higher quality bearing. When the metal is taken from the bottom of the pot, air bubbles and slag are eliminated. There is a better bond between the babbitt and the bearing shell because the temperature remains even when the metal enters the bearing in one pour. The pouring method also eliminates a safety hazard, since the operator no longer has to handle a hot ladle containing 250lb. of molten metal.—*Bureau of Ships Journal, April 1956; Vol. 4, pp. 40-41.*

Daylight Radar Indicators

The dimness of the pictures shown on radar indicators has long been a problem. Only recently has a probable solution been found that is expected to correct this defect—the development of direct-view storage tubes. Fig. 2 shows the "Iatron" (image amplifier), one of the types of direct-view storage tubes developed. It is described here as representative of its class. The Iatron is being engineered under a BuShips' contract into a tube suitable for use on ships and planes. The chief components of an Iatron are a writing gun, a storage target, a flood gun (used for reading), and a phosphor screen, arranged as illustrated in Fig. 2. The writing gun is similar to that used in a standard radar cathode ray tube except that it can be made smaller and is more sensitive because it must supply only a fraction as much energy. The storage target is the heart of the device. It consists of a fine metal mesh screen upon which is deposited an insulating material. The assembly can store an electrostatic charge in the spot pattern written upon it by the writing gun. The flood gun supplies a large continuous beam of electrons focused to spread out over the entire storage surface. The flood is controlled by the charge pattern stored on the target. That is, at any given spot, the quantity of electrons that are accelerated to pass through the mesh—or are repelled so that they do not pass through the mesh—depends upon the amount of positive or negative charge at each point on the mesh. Thus, the electron pattern passing through the mesh represents an exact "image" of charge stored on the target. The electron image in the flood beam is then accelerated by the high voltage on the phosphor screen at normal cathode ray potentials of 8,000 to 10,000 volts. A luminescent output is produced by each point on the screen proportional to the number of electrons at the corresponding spot in the electron image. Because the beam impinges continuously on the phosphor screen (compared with once every few seconds in a radar tube and once every 1/30 second in a television tube), the picture display can be comparatively brighter. The brightness gain is indicated by the values shown below*. When other characteristics are considered, the storage tube performance does not look so favourable. In the present stage of development, the Iatron does not give as many half-tones as either radar or television tubes, nor is definition attainable up to the standards of conventional tubes. Further development work is expected to improve such features.—

**Display Means*	*Light Output*
Conventional long-persistence radar screen	Small fraction of a foot lambert (too small to be measured by a meter)
Average television picture tube	40- to 80-foot lamberts
Iatron display	3,000- to 10,000-foot lamberts

F. R. Darne, Bureau of Ships Journal, March 1956; Vol. 4, pp. 29-31.

Corrosion Rates in a Tanker

Corrosion rates were measured continuously in different tanks of a T-3 tanker during a round voyage in the Gulf of Mexico lasting about eight days. The ship carried mostly gasoline with smaller amounts of other products, and some of the cargoes carried a proprietary rust inhibitor. The centre tanks used for sea water ballast were cathodically protected with magnesium anodes, and the ship was equipped with a dehumidification system for the tanks. Certain tanks were cleaned during the voyage by the Butterworth technique. The following results were obtained:—With a gasoline cargo, the oil-soluble inhibitor had a pronounced effect while the cargo was present in the tank, reducing the corrosion rate to 15-20 per cent of the uninhibited corrosion rate. The bottoms of the gasoline tanks consistently corroded faster than the tops. Unhibited kerosene was almost as corrosive as unihibited gasoline. Diesel fuel, however, was non-corrosive even without an inhibitor. During ballast, the inhibitor carried previously in the ballast tank had no effect in reducing corrosion. Magnesium anodes designed to provide a current density of 30 milliamperes per sq. ft. were effective in reducing corrosion, during sea water ballast, to a negligible value. Washing the tanks with hot sea water for half-an-hour increased the cor-

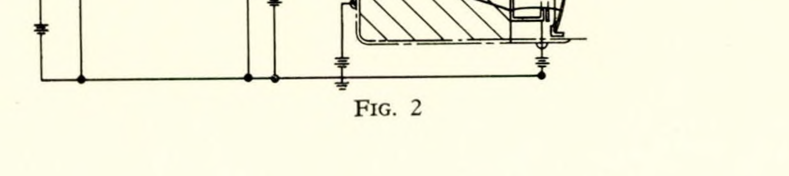


FIG. 2

rosion rate in the washed tanks ten- to fifteen-fold. Whether or not the tank had previously carried inhibited cargo made no difference in the corrosion rate. Dehumidification appeared to have some effect, but did not reduce the corrosion rate to tolerable levels during the test period.—*G. L. Marsh and A. V. Koebley. Paper read at Thirty-fifth Annual Meeting of the American Petroleum Institute, 1955. Journal, The British Shipbuilding Research Association, February 1956; Vol. 11, Abstract No. 11,323.*

Structural Materials for High-temperature and High-pressure Steam

A method was developed for ascertaining long-term creep strain from tests carried out in a comparatively short time. The deductions were based on the following assumptions: (1) in the initial period of creep the strain is proportional to a power of the time; (2) the creep rate decreases at first, but reaches a constant value after a certain period of time; (3) the latter period was temporarily assumed to be 2,000 hours. Regarding attack by steam, it seems that most of the cracks which have recently been found in boiler and turbine components are the result of decarbonization and embrittlement from the action of hydrogen. Accordingly, experiments were carried out to study the effect of pure hydrogen on steels and also the effect of steam on mild steel, cast steel, and Cr-Mo cast steel. It appears from these experiments that when steel is exposed to high pressure and high temperature hydrogen gas, there is a decrease in tensile strength, elongation, and reduction of area. Further, where severe decarbonization takes place, the steel develops internal cracks probably owing to the escape of hydrogen out of the steel. High pressure and high temperature steam have an embrittling effect on steel similar to that of hydrogen, but the rate is much slower; also, the creep rupture strength is decreased by steam treatment.—*Shipbuilding Research Association of Japan, Report No. 4, 1955. Journal, The British Shipbuilding Research Association, February 1956; Vol. 11, Abstract No. 11,279.*

Mooring and Salvage Vessel

There has recently been completed by Richard Dunston, Ltd., at Thorne, for William Cory and Sons, Ltd., of London, the steam-driven mooring and salvage vessel *Cormooring*. The vessel is of welded construction. The compact and efficient layout is evident from the drawings reproduced in Fig. 2. The *Cormooring* will be principally employed in the lifting and laying of mooring buoys, as well as the raising of sunken barges in the River Thames. The principal dimensions and other leading characteristics of the vessel are given below:—

Length, b.p.	80ft. 0in.
Breadth moulded	21ft. 0in.
Depth moulded...	9ft. 3in.
Cathead safe working load, tons	20
Maximum lift, tons	60
I.H.P.	250
Corresponding r.p.m.	300
Steam pressure, lb. per sq. in. ...	160

The equipment includes a strongly braced cathead with a 20-ton safe working load, and which is fitted with three large sheaves. A heavy steel tube is welded between the cathead cheek plates for use when making 60-ton hoists, which are made by purchase blocks from a deck anchorage. A recess below the tube is arranged for the anchor stowage, and apron skids are fitted on each side of the cathead for use when dragging chains on board. A special steam salvage winch, manufactured by Clarke, Chapman and Co., Ltd., of Gateshead, has two independent wire-rope barrels and warping drums, and is capable of exerting a pull of 10 tons. A large, well-lighted salvage hold is arranged forward of the winch, and is fitted with racks and lockers. The hold is served through a hatchway by a tubular steel derrick, which has a safe working load of 2 tons and is mounted on an unstayed tubular steel mast. The propelling machinery, manufactured by Plenty and Son, Ltd., of Newbury, consists of a compound engine capable of developing 250 i.h.p. at 300 r.p.m. The engine is complete with air, bilge and feed pumps and a separate surface condenser. The steam-driven auxiliaries consist of a centrifugal circulating pump, a donkey pump and general-service pump. A duplex salvage pump, with a capacity of 150 tons per hour, is arranged to draw from or to discharge overboard. Salvage-hose connexions are located port and starboard of the casing, and there is one portable connexion forward. Provision for water ballasting is arranged in the fore and aft peaks and double bottom. Electrical power is provided by a steam-driven, 5-kW, 110-volt, d.c. generator set, which has a belt-driven fuel-oil pump, and there is a 12-volt d.c. battery-charging generator. Steam, at a working pressure of 160lb. per sq. in., is provided by a Scotch marine-type boiler, which is fitted with Wallsend gravity-feed oil-burning equipment and is operated under normal draught.—*The Shipbuilder and Marine Engine-Builder, March 1956; Vol. 63, pp. 154-155.*

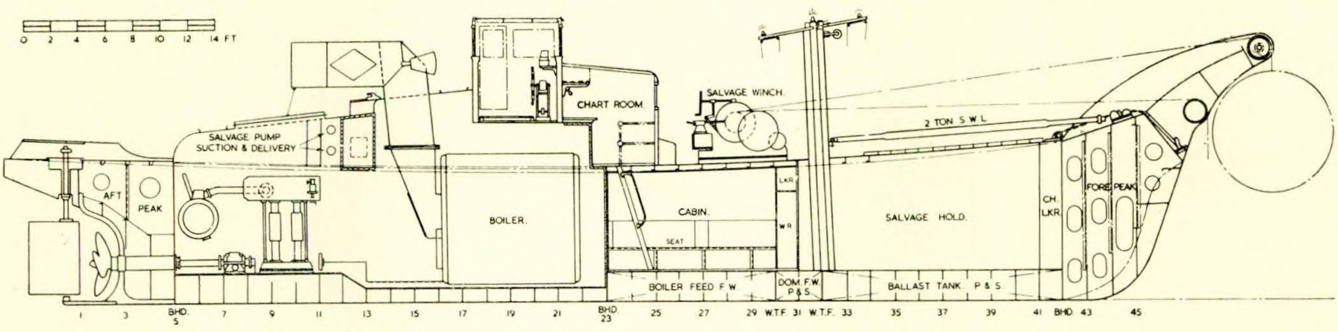


FIG. 2

German Cargo Liner for South American Service

The first of a pair of cargo liners for the German shipowners Rudolf A. Oetker, Hamburg, has been delivered by Lübecker Flenderwerke. This vessel, the *Cap Roca,* has been put by the owners into the fast service from Hamburg and Continental ports to South America of the Hamburg-Süd-amerikanische Dampfschiffahrts-Gesellschaft (Eggert and Amsinck). The sister ship, *Cap Verde,* has just been delivered by the same builders. The *Cap Roca* is a vessel of about 6,200 tons gross, with a deadweight of 9,200 tons as a shelterdecker and 10,200 tons as a full scantling ship. Her principal particulars are as follows:—

Length, b.p.	460ft. 1in.
Breadth	62ft. 7in.
Draught	25ft. 7in.
Depth to shelterdeck	39ft. 6in.
Depth to second deck	29ft. 1in.
Service speed, knots	17

The ship has been built to the highest class of Germanischer Lloyd. She has five cargo holds, giving a total of about 590,000 cu. ft. of cargo capacity, of which about 100,000 cu. ft. is refrigerated. The weather deck hatches are fitted with MacGregor-type sliding steel hatch covers. The accommodation is arranged amidships, the crew having single- and double-berth cabins. The main engine of the *Cap Roca* is a Borsig-Fiat Diesel engine, designed to burn boiler fuel of up to 3,500 seconds Redwood No. 1 at 100 deg. F. It is a nine-cylinder engine, of single-acting two-stroke crosshead type, built at the manufacturers' works in Berlin. The cylinder bore is 750 mm., and stroke 1,320 mm. The service power is 7,000 b.h.p. at 125 r.p.m., at which the fuel consumption is 0·346lb. per b.h.p.-hour. On 3,500-seconds boiler fuel, this consumption would rise to 0·358lb. per b.h.p.-hour. Test-bed runs showed that the output of the engine could be stepped up if required to 8,000 b.h.p. at 130 r.p.m., while retaining smoke-free combustion and moderate exhaust temperatures. The engine is well suited to the combustion of heavy boiler fuel, and the manufacturers' guarantee covers the unrestricted use of boiler fuel up to 3,500 seconds viscosity. With the price differential between Diesel and boiler fuel at about 35 per cent of the higher figure, and with a 3 per cent higher fuel consumption of the cheaper fuel, a reduction in fuel costs of 33 per cent is possible. The ability of the engine to burn very heavy fuels of this sort is due to a number of design modifications, in addition to the inherent suitability of the two-stroke crosshead-type engine for this purpose. A spill valve in the fuel injection pump allows the injection pressure to be varied to suit the fuel in use, while ample water cooling at the injectors prevents the formation of carbon deposits at the nozzles. The divisions between individual scavenge and exhaust ports are also water-cooled to discourage the formation of carbon deposits. The cylinder liners are of a wear-resistant cast iron. —*The Shipping World, 11th April 1956; Vol. 134, p. 352.*

Cargo Vessels for Ellerman Lines

The first of a group of four vessels ordered by Ellerman Lines, Ltd., has now been delivered. This vessel, the *City of Colombo,* 10,420 tons d.w., has been built by Barclay, Curle and Co., Ltd., and is a single-screw Diesel engine-driven cargo ship specially designed for the company's Eastern service. The *City of Colombo* is shortly to be followed by the *City of Ripon,* building at the Naval Yard of Vickers-Armstrongs (Shipbuilders), Ltd., Walker-on-Tyne. Two other vessels, the *City of Winnipeg* and the *City of Newcastle,* are building at the shipyards of the Caledon Shipbuilding and Engineering Co., Ltd., and Alexander Stephen and Sons, Ltd., respectively. All four vessels are expected to be in service before very long. The principal particulars of the *City of Colombo* are as follows: —

Length, o.a.	507ft. 3in.
Length, b.p.	470ft. 0in.
Breadth moulded	55ft. 6in.
Depth to shelter deck	42ft. 0in.
Depth to second deck	32ft. 6in.
Draught	28ft. 0in.
Deadweight, tons	10,420
Gross tonnage	7,739
Cargo capacity (bale)	641,160 cu. ft.
Service speed, knots	15

The *City of Colombo* is of the open shelterdeck type with forecastle, built to Lloyd's Register of Shipping highest class, having five cargo holds with complete lower and upper tweendecks. The vessel has a raked stem, with ample sheer forward, and a cruiser stern. Two deep tanks, one in the after end of No. 2 hold and the other in the forward end of No. 4 hold, are provided for the carriage of water ballast, general cargo, latex, edible oil or oil fuel. A duct keel is fitted and is used for housing the suction pipes to the forward deep tank. Steam heating pipes together with suctions to the tanks forward of the deep tanks are also carried in the duct keel to avoid running them through double bottom oil fuel tanks or cargo spaces. Oil fuel is carried in the double bottom tanks, and fresh water is carried in one of the after double bottom tanks as well as in the afterpeak tank. The propelling machinery consists of a Barclay Curle-Doxford opposed-piston oil engine having six cylinders of 750 mm. bore and a combined stroke of 2,500 mm. The output is about 8,000 b.h.p. at 105 r.p.m. Scavenge air is supplied by three lever-driven pumps on the back of the engine. The engine is arranged to burn heavy oil fuel, and five de Laval purifier/clarifier units are fitted in a special compartment in the forward end of the engine room. The oil is heated by means of Heatrae steam heaters. This compartment is provided with exhaust ventilation.—*The Shipping World, 21st March 1956; Vol. 134, pp. 290-291.*

Dutch-built Oil Tankers

The first of a group of four oil tankers being built by the Netherlands Dock and Shipbuilding Company, Amsterdam, for the Afran Transport Company, Liberia, has now been completed. This vessel, the *Western Gulf,* 37,000 tons d.w., is the largest oil tanker yet built in Holland; she is also the first oil tanker that the company has built for Afran Transport, who have another vessel of the same tonnage, as well as two others of 30,800 tons d.w., on order from N.D.S.M. The *Western Gulf* is powered by a set of steam turbines and has the following principal particulars: —

Length, o.a.	695ft. 0in.
Length, b.p.	660ft. 0in.
Breadth moulded	90ft. 6in.
Depth moulded to upper deck...	48ft. 0in.
Draught	36ft. 6in.
Deadweight, tons	37,000
Speed on trials, knots	16·7

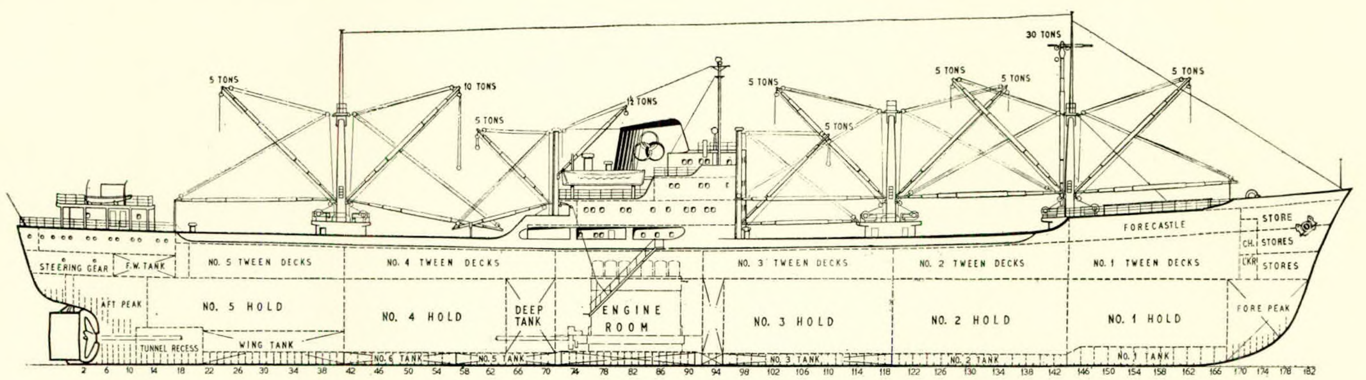
The *Western Gulf* has been built under special survey to the highest class of Lloyd's Register of Shipping and the American Bureau of Shipping, for carrying petroleum in bulk. She and her sisters are of the poop, bridge and forecastle type, with machinery aft. These deckhouses are connected by a fore and aft walkway fitted with aluminium alloy gratings. The forward derricks are served by two steam-driven cargo winches, and the winches aft by one steam-driven cargo winch. A steam-driven windlass, suitable for 2$\frac{11}{16}$in. stud link chain is arranged on the forecastle, two warping winches on the upper deck, and one warping winch on the poop deck. All these winches work on steam at a pressure of 100lb. per sq. in., and have been manufactured by Figee of Haarlem. Four aluminium alloy lifeboats are carried, each 25ft. 11in. in length. The cargo space is divided into eleven centre tanks and twenty-two wing tanks. A dry-cargo hold has been arranged under the forecastle space, and below this there is a deep tank for the carriage of fuel oil, and a pump room serving the ballast and fuel oil tanks. The main pump room is in way of the engine room bulkhead, and is equipped with four turbo-driven pumps, each having a capacity of about 1,025 tons per hour. The steam turbines are installed in the engine room and drive the pumps through shafts passing through gastight glands fitted in the engine room bulkhead. Four vertical duplex steam-driven stripping pumps are fitted, each having a capacity of 150 tons per hour. A steam-driven bilge pump is also fitted in the pump room. Each of the four main cargo oil pumps can be worked independently, and the tanks are divided into four groups so that four different cargoes can be carried simultaneously. One cargo and one stripping pump are connected to the main suction line of each group, and to a separate loading line by valves and spectacle flanges. The cargo oil mains are of 14-in. diameter and fitted with 12-in. suctions in each tank. Each of the cargo pumps can drain from its group of tanks, or the sea, and discharge to the deck, to tanks or overboard. For direct filling from the deck, or flooding from the sea, the pumps can be bypassed. Two 8-in. main stripping lines each serve two groups of tanks with 6-in. suctions in each tank. An 8-in. fuel line is fitted running fore and aft with loading connexions at the cargo oil loading station, for filling and transferring fuel oil. In the forward pump room there is a steam-driven duplex transfer pump, and an identical pump is also fitted for bilge and ballast duties. The forward pump room is ventilated by means of a turbine-driven fan. The main pump room is ventilated by two electrically driven fans, the motors being placed in the engine room and the fans in the pump room. The driving shafts pass through gastight sealing glands in the engine room bulkhead, one fan acting as a supply fan and the other as an exhaust. The design is at the request of the owners, and it is claimed that this arrangement requires less electrical wiring and permits direct control of the motors by the engineer on watch. The propelling machinery in the *Western Gulf* consists of a set of two steam turbines driving a single propeller through double-reduction gearing. The turbines are of N.D.S.M.-Parsons make, developing a normal output of 13,750 s.h.p. at 105 r.p.m. of the propeller, and a maximum output of 15,000 s.h.p. at 108 r.p.m. Steam is supplied by two N.D.S.M.-Babcock and Wilcox boilers at a pressure of 600lb. per sq. in., and temperature of 800 deg. F. at the superheater outlet. The boilers are oil fired on the closed duct forced draught system.—*The Shipping World, 18th April 1956; Vol. 134, p. 377.*

Largest Norwegian-built Dry Cargo Vessel

The cargo motorship *Hassel* completed by A/S Rederiet Odfjell, of Bergen, and built by Bergens Mekaniske Verksted, is a vessel of 12,500 tons d.w. She is the largest dry-cargo vessel yet built in a Norwegian shipyard. The *Hassel* has two complete decks, with a forecastle, midships deckhouse and half-height poop. Her principal dimensions are as follows:—

Length o.a.	464ft. 2in.
Length b.p.	430ft. 0in.
Breadth moulded	62ft. 0in.
Depth moulded to shelter deck	39ft. 6in.
Depth moulded to main deck...	30ft. 0in.
Draught	29ft. 5in.

Her gross tonnage is 8,817 tons and her cubic capacity 665,000 cu. ft., the latter giving a cubic of 53 cu. ft. to the ton. Composite longitudinal and transverse framing has been employed, with longitudinal framing on the decks and double bottom, and transverse on the sides. The engine room is amidships, and the five holds are arranged three forward of and two abaft the machinery space. Centreline bulkheads are fitted throughout the holds, and the tank tops in way of the hatches have been reinforced to withstand grab discharge. A deep tank for vegetable oils or water ballast is arranged immediately abaft the engine room: it is divided into two by a longitudinal bulkhead. The 'tweendeck above this tank and No. 4 hold is of considerable length, and is served by a hatch 64ft. 6in. long. Another deep tank, divided into three sections, is arranged forward of the engine room, and is intended for fuel oil or water ballast. The total tank capacity for fuel oil is 1,970 tons and for water ballast 3,340 tons. All fuel tanks have been equipped with heating coils, the main engine being fitted to burn heavy oil. The outfit of derricks is carried on three bipod masts and two pairs of samson posts, all of them of course unstaved. The main engine of the *Hassel* is an Uddevallavarvet-Götaverken Diesel engine, developing 5,400 b.h.p. at 112 r.p.m. and giving the ship a speed of 14·5 knots at full load. There are three Diesel generators, with Diesel engines of the shipbuilders' own manufacture developing 275 b.h.p. at 500 r.p.m. direct-coupled to 185-kW 220-volt generators. There is also a 30-kW set for port use.—*The Shipping World, 13th June 1956; Vol. 134, pp. 551-552.*



Dutch-built Cargo Motor Ship for Finland

The cargo motor vessel *Polaris,* built by Scheepswerf de Haan en Oerlemans, Heusden, one of the shipyards comprised in Verolme United Shipyards, has joined the services of her owners, the Finska Angfartygs Aktiebolaget, Helsingfors, Finland. The ship is of the shelter deck type; she has been constructed to Lloyd's Register of Shipping class 100 A1 and meets the requirements of the Finnish Iceclass IA. The leading characteristics of the *Polaris* are as follows:—

Length overall, metres	93·50
Length b.p., metres	84·50
Breadth, metres	13·30
Depth to main deck, metres ...	5·20
Depth to shelter deck, metres ...	7·55
Draught, metres	5·10
Deadweight, tons	2,235
Gross tonnage, R.T.	1,518
Grain capacity, cu. ft.	137,754

The m.s. *Polaris* is sturdy in appearance, the ship's profile being mainly determined by the well-raked bow with icebreaker stem and by the placing of the bridgedeck-house which is well abaft amidships. The ship has three cargo holds, two of which are arranged forward and one aft of the amidships deckhouse. Cargo is handled by 3- and 5-ton derricks attached to two masts with collapsible topmasts and one pair of derrick posts fitted against the bridgefront. Of these derricks, four 5-tonners serve No. 2 hatch, which has a length of 15 m., while each of the other two hatches are served by 3-ton derricks. The derricks are served by 3- and 5-ton electrically operated cargo winches arranged in accordance with the Ward-Leonard system. The winches are placed on winch deckhouses which, together with the long foredeck provide ample space for the carriage of deck-cargoes. The main propulsion machinery consists of an 8-cylinder, single-acting M.A.N. Diesel engine of the crosshead type having an output of 3,200 h.p. at 170 r.p.m. The thrust of the screw is received by a Michell thrust bearing of the 5B type for a shaft diameter of 306 mm. at 170 r.p.m. and 3,200 s.h.p. The thrust load is 27,500 kgs. The block is self-contained with its own oil-bath lubrication and is fitted with a cupro-nickel cooling coil in the oil space.—*Holland Shipbuilding, April 1956; Vol. 5, pp. 34-35.*

Applications of the Deltic Engine

Deltic engines are at present being produced in two forms, the first having eighteen cylinders and the second nine cylinders. Both types of engine are in service with the British Navy and both will shortly be in commercial operation. For commercial marine use the continuous rating of the eighteen-cylinder engine is 1,725 s.h.p. and the one hour rating 1,900 s.h.p., both at 1,500 crankshaft r.p.m. The b.m.e.p. at the continuous rating is 84·6lb. per sq. in. and the piston speed 1,812ft. per minute, both these figures being extremely conservative. The oil consumption of the eighteen-cylinder engine at its continuous rating is 7·48 pints per hr. this being about 1·3 per cent of the fuel consumption. Both eighteen- and nine-cylinder engines operate on normal marine Diesel fuel and while experimental work is proceeding on the use of residual fuels it seems doubtful whether this will prove to be economically advantageous. At the conditions stated, the minimum anticipated period between piston examinations is 5,000 hours, but based on practical evidence now being obtained it is anticipated that this period will be considerably exceeded. Investigations show that the loss of serviceability in motorships due to engine maintenance is, even today, quite considerable. The Deltic offers an entirely different approach to this problem. Deltic policy has been formulated on the basis that the marine requirements are similar to those which apply with even greater force in the air transport business, namely, that the engines shall be completely reliable whilst in service and that the serviceability time of the ship must be maintained at the highest possible value. This is achieved by the adoption of the "repair by replacement" policy, which means that every component and every major assembly and functional unit of the engine is interchangeable. The vast majority of running repairs can, therefore, be achieved by a simple replacement of parts without the necessity for skilled labour and with a minimum loss of serviceable time. The periods for reliable service are known and when this time is reached the engine is removed from the ship as a unit and replaced by another engine. There is, therefore, no extended period, either at sea or in port, during which the ship needs to become unserviceable because of major engineering work arising from engine maintenance. Furthermore, the use of engines requiring little maintenance which can be expected with confidence to operate without trouble for a known period, coupled with the safety of the ship derived from the use of multiple engines, reduces the number of seagoing engineers per ship required, with resultant savings in operating costs. A proposal has been prepared for a general cargo ship. Four Deltic marine engines are employed for this installation mounted in a two-tier stacked arrangement. Each of these engines develops 1,725 s.h.p. at 1,500 r.p.m. and is geared down through a reverse and reduction gearbox which at full rated output is designed to operate at 110 r.p.m. The propeller r.p.m. for full power can, of course, be varied to meet the requirements of a particular ship by introducing a different reduction ratio in the gearbox. A simpler gearbox can be achieved by the use of a controllable pitch propeller. Each of the engines has a fuel consumption of 0·370lb. per s.h.p.-hr. This installation is for a ship with a limited auxiliary load and the simplest of cargo handling gear. It includes a vertical steam boiler using exhaust gas when the ship is at sea to supply steam for the electric generators, with a total output of 50 kW and sufficient for lighting, steering and engine room pumps. The boiler would normally be oil fired in port and of sufficient capacity to meet all deck requirements. The total weight of the installation is about 67·7 tons, including the engines, fluid couplings and gearbox, which is equivalent to and represents a saving in weight of about 393 tons when compared with conventional machinery installations. Saving in space has been achieved with this proposal compared with a direct coupled reversing installation, and it should be remembered that in addition to the saving in length of the propeller shaft the tunnel is also eliminated. An alternative arrangement for the four engines, which is perhaps more conventional, is where the engines are again coupled to the gearbox through fluid couplings, but in this case are mounted in the same horizontal plane and driving into each face of the gearbox. While this arrangement does occupy more longitudinal space it has the advantage that the engines are more readily accessible and the gearbox can be of simpler and less expensive construction. Another proposal has been prepared for a 7,500-ton general cargo ship, length overall 436ft. 3in., moulded breadth 57ft., and moulded depth 25ft. 6½in., but, as in the case of proposal one, the arrangement can be used for other types of ship. This proposal is shown in Figure A and it will again be seen that the Deltic marine engines, two in this case, are arranged to

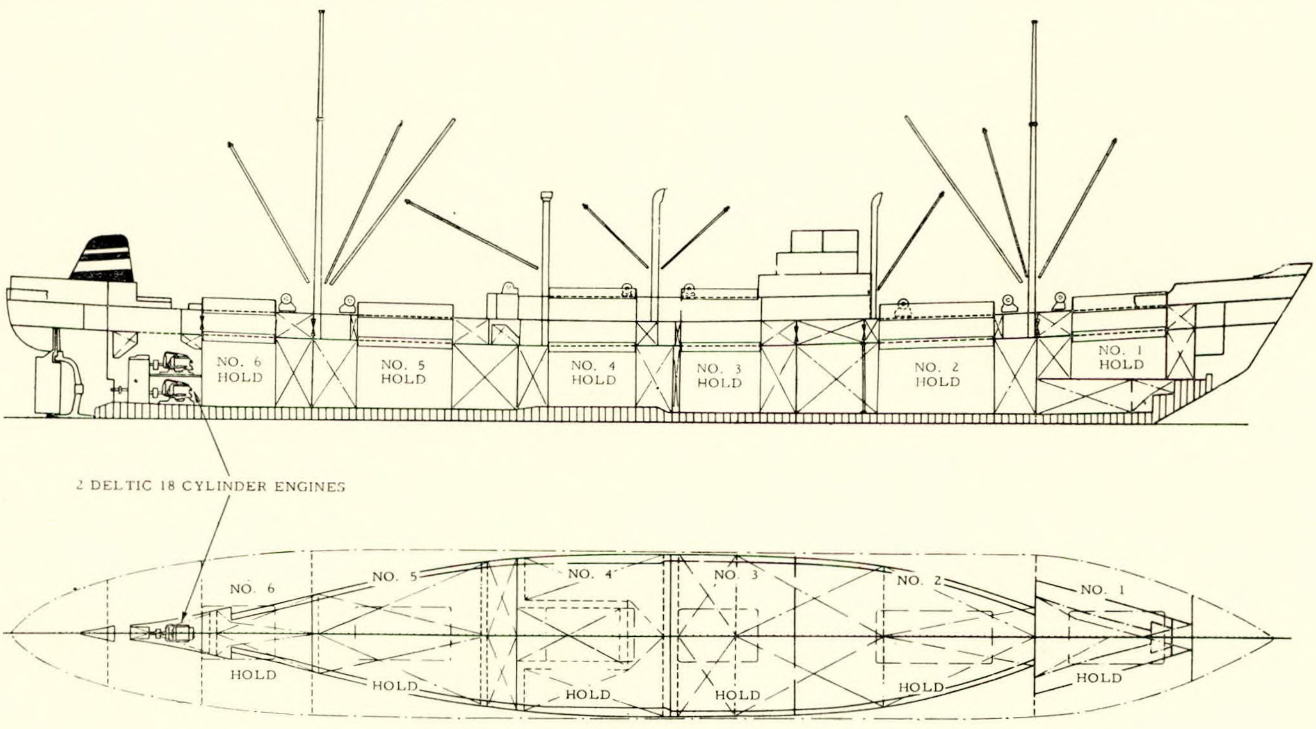


FIG. A

drive through fluid couplings and a reverse and reduction gearbox to the propeller shaft. The engines are again installed in a tiered arrangement and the proposed conversion increases the cubic capacity available for cargo from 469,500 cu. ft. to 525,100 cu. ft., an increase of 55,600 cu. ft., which represents an increase in the original capacity of the ship of 12 per cent. It is interesting to consider the relative weights in this case; the existing machinery weighs about 229 tons and the Deltic machinery now proposed for the same power weighs about 34·9 tons. The cost of the Deltic machinery, including engines, gearbox and auxiliary equipment, would be about £102,500, which is equivalent to about £32 per h.p. There is also an alternative arrangement of the engines and the gearbox, where again the engines are mounted in the same plane and driving through fluid couplings into one face of the gearbox. In certain classes of ship a considerable economy in space has been found possible by mounting the engines in this arrangement aft of the gearbox.—*The Shipping World, 29th February 1956; Vol. 134, pp. 228-230.*

Improved Electric Couplings

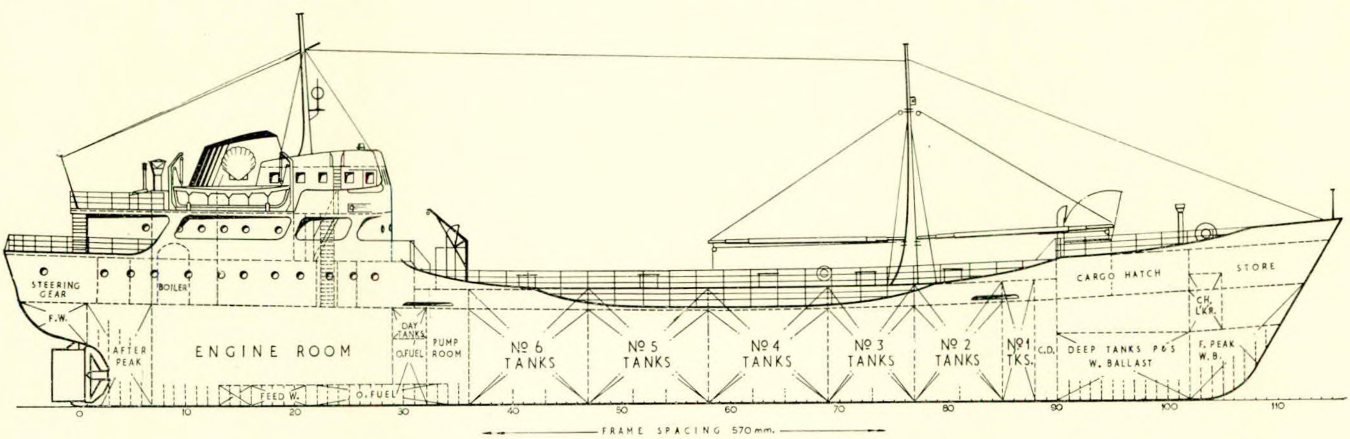
Where previous electric couplings have been overhung from the Diesel engine and driven gear respectively, a new electric coupling for the U.S. Navy's LST vessels will be supported by its own bearings. Electric couplings are devices for transmitting torque by means of electromagnetic forces, in which there is no contact between the driving and driven member. The outer member carries poles which are excited by direct current through slip rings. The inner member has a double-bar, squirrel-cage winding. Rotating either member will, by induction, cause torque to be exerted on the other member and the speed of the two will only vary by a small slip required to produce the necessary torque. Electric couplings are used to connect more than one Diesel engine to pinions driving a common bull gear connected to a ship's propeller. The electric coupling eliminates shocks and limits the transmission of torsional vibrations, acts as a quick disconnect clutch, limits the maximum torque to a safe value, and permits a small amount of engine gear misalignment. In past applications, the inner element has usually been overhung from the engine shaft and the outer element from the gear pinion shaft, although there are cases where this has been reversed. Because of high shock requirements, the LST couplings have been supplied as a complete unit with bearings and bedplate. Another feature of the LST coupling is the provision for straight through drive in case of electrical failure. This drive is the equivalent of supplying a flexible coupling of fuel-engine horsepower capacity that will take misalignment. When not used for emergency drive, the direct drive parts become ventilating fans.—*Westinghouse Engineer, May 1956; Vol. 16, pp. 90-91.*

Shipbuilding in Portugal

Portugal has few shipyards, and those that it has are mostly concerned with the building of small vessels for the home market. At least one yard, however, has recently begun to turn its eyes towards the export market. This yard is Estaleiros Navais de Viana do Castelo, S.A.R.L., situated at Viana do Castelo, a town at the northern end of the Portuguese Atlantic seaboard some 250 miles from Lisbon. This yard is engaged primarily in the construction of trawlers and similar craft, but it is capable of building vessels up to about 7,500 tons deadweight. Among the vessels under construction at present are two small escort vessels for the North Atlantic Treaty Organization, and the firm's order book includes an order for a coastal tanker and bunkering vessel for the Portuguese subsidiary of the Shell group, Shell Portuguesa. Estaleiros Navais occupies a site of about fourteen acres, of which four acres are covered by buildings. A good deal of shiprepairing work is carried out in addition to shipbuilding, and ships are built in one or other of the firm's two dry docks. No. 1 dock has a length on the dock bottom of 498ft., with a breadth at entrance of 60ft. 7in., the corresponding figures for No. 2 dock being 417ft. and 60ft. 7in. The largest ship yet built by the yard is the *Gil Eannes,* of 2,600 tons deadweight, a well-equipped mother ship for the Portuguese Grand Banks fishing fleet. This ship was successfully completed to the highest class of Lloyd's Register of Shipping. The Shell tanker which is to be built is a smaller vessel, having a deadweight of about 1,245 tons. It is intended for coastal and bunkering service. The design for this ship was prepared in Germany by Maierform, its principal dimensions are as follows:—

Length o.a.	228ft. 0in.
Length b.p.	207ft. 0in.
Breadth moulded	35ft. 6in.
Depth moulded...	16ft. 0in.

It will be of trunk deck type, with six cargo tanks divided into port and starboard halves by a single centreline bulkhead. No. 1 tank is intended for the carriage of gas oil and the remaining tanks for fuel or Diesel oil, but the design is also suitable for the carriage of low flash point cargoes. The framing will be longitudinal for deck and bottom, and transverse for sides. The engine will be a Crossley Diesel engine developing 1,100 b.h.p. at 320 r.p.m., and is designed to give a loaded speed of 10½ knots.—*The Shipping World, 4th April 1956; Vol. 134, pp. 331-333.*



Profile of the Shell coastal tanker building by Estaleiros Navais de Viana do Castelo

Installation and Maintenance of Gas Turbines

Two 4,000 horsepower marine gas turbine engines will soon be installed in a PT-812 boat on an experimental basis. By experimenting with the engine, the U.S. Navy plans to obtain data on maintenance and reliability and to gain operating experience on gas turbine propulsion engines. Propulsion machinery in general use now in the PT-809-812 boats provides peak power of 10,000 s.h.p., but the duty cycle is limited since full power is available only for short periods. The Metropolitan-Vickers gas turbines, or G-2 engines as they are also called, are designed for an operating life of 300 hours at full power plus 700 hours at 70 per cent of full power. The engine design is slightly conservative, the engine weighing a little more than two pounds per s.h.p. This weight can be compared with weights of one pound or less per s.h.p. Engine designs of one pound or less reflect aircraft concepts, where weight is a primary consideration. In fuel consumption these gas turbines—like nearly all gas turbines in use at present—cannot compete with conventional reciprocating engines. The gas turbine fuel consumption rate is 0·86lb. per h.p.-hr. at full power. However, these engines burn Diesel fuel, a fact that adds an economic and safety factor in their favour. Although conversion of the PT-812 raises many difficult problems of machinery weight and space, it provides a propulsion plant with many desirable characteristics. Two 800-h.p. Diesel engines will be installed inboard and at the aft end of the machinery space, and the gas turbines will drive the outboard shafts. There are no clutches in the gas turbine shafting. The inboard, or Diesel, shafts have controllable reversible pitch propellers. All low-speed manœuvring will be under Diesel power only. The two Diesel engines provide 1,600 s.h.p.—equivalent to an 18-knot cruising rate. When top speed is required, usually within striking distance of the target, the gas turbines can quickly be brought to full power. The combination is a plant that gives tried, reliable power at the lower cruise range plus a reserve of relatively lightweight equipment—a total installed power of 9,600 h.p. Diesel fuel is to be bunkered so that a cruising range equivalent to that of present boats will be possible.—*H. H. Horak, Bureau of Ships Journal, April 1956; Vol. 4, pp. 15-16.*

Apparent Pitching Axis

The kinematics of a ship in head seas are discussed. The location of the instantaneous axis of rotation, of the point of no vertical motion and of the point of minimum vertical motion are found. It is shown that in general the longitudinal locations of the instantaneous axis of rotation and of the point of no vertical motion are not fixed relative to the ship. Only in two special cases do these positions remain fixed: first, when the heaving and pitching motions are in phase, the points are fixed and are located aft of the midship section, and secondly when the motions are 180 degrees out of phase the fixed points are located forward of midships. The point of minimum vertical motion referred to as the apparent pitching axis, is fixed relative to the ship for a given set of conditions. It is located aft of the midship section if the heave lag referred to pitch is in the range of $-\pi/2$ to $\pi/2$, otherwise its location is forward of the midship section. The longitudinal location of the apparent pitching axis depends on the pitch and heave amplitudes as well as on the phase difference between these motions. As an example, experimentally determined amplitudes and phases for a 5-ft. model of the Series 60, 0·6 block are used to compute the location of the apparent pitching axis and the results are compared with computations based on theoretical motion predictions. It is shown that the apparent pitching axis at resonant speed is located midway between midship and stern if the ship is heading into waves which are 25 per cent longer than the ship. The limited case, when the waves are much longer than the ship, is studied in some detail. This investigation gives some confidence in the correctness of the proposed method.—*V. G. Szebehely, Schiffstechnik, April 1956; Vol. 3, pp. 184-191.*

Combating Turbine Blade Corrosion

Practically all steam turbine operators and manufacturers have encountered problems involving erosion and corrosion in steam turbines. The presence of moisture in steam sometimes makes these problems difficult to overcome, but present research, centred around improvements in design and treatment of blade materials, is making considerable headway. It is not possible to remove all the moisture through turbine design. The most promising possibilities lie in improving the surface of the blade. Current experiments in this direction fall within these categories: 1. Improving the mechanical characteristics of the material so that it may better withstand the forces of the water droplets. This might be done by using 12 per cent chromium steel with a modified heat treatment, in which tempering would be in the region of 600 deg. F. The resulting hardness is then about 375 to 400 Brinell instead of 200 to 240 Brinell as in the conventional heat treatment, and an izod impact strength of about 35ft. per lb. is obtained instead of 60-80ft. per lb. Such treatment presents some problems in the machining of fastenings. Designs would have to be free of stress concentrations and some blade endurance limits would have to be checked. An alternative to this treatment might be to flame-harden the area subject to deterioration forces. However, this method would leave a heat affected zone adjacent to the hardened zone, with the resulting material being of doubtful qualities. 2. Application of a separately cast or wrought strip to the blade. This method, in which a strip of high hardness, high alloyed material is silver brazed to the surface, has been widely used. The principal difficulty is in producing good fit-ups, so that the strip does not become detached and cause damage in the turbine. Application of strips must be controlled carefully to secure a high quality bond. A danger in this method is the possible danger of overheating the blade and consequent damage to the mechanical properties. 3. Direct application of high alloy compositions of the cobalt-chromium and nickel-boron types. This has not been practised widely in the U.S.A. The hazards of direct application of these materials are due to the possible grain growth of the base material. Grain growth can be combated by applying materials of low melting point and/or completely retreating the blade after deposition. From the point of view of brittleness of the material, the nickel-boron type may offer some advantages as compared with the cobalt-chromium type, due to its lower melting point. Both materials, in powder form, may have great possibilities. Finely powdered granules of the material are sprayed on the surface to the required thickness, after which the powder is fused to the blade. The smoothness and surface conditions of these deposits can be controlled much more easily than in a method based on use of the conventional rod and acetylene torch.—*F. H. Pennell, Marine Engineering/Log, April 1956; Vol. 61, pp. 108-109.*

Automatic Pressure Butt Welding Process

This bulletin describes the Burton pressure butt welding process, which is based on the principle of allowing the plasticity of the steel being welded to control its own welding cycle. Essentially, the process consists in bringing the faces to be joined together under a small load, and heating the welding zone by means of a multi-jet oxyacetylene oscillating-ring burner until a pre-set thermal expansion is reached. A second higher or control load is then applied to return the pipe to its original length, when the final butting pressure operates to complete the weld. All sequences are controlled automatically by limit switches, which are also arranged to control upset and to cut off the gas supply just before completion of the weld. Two machines using these principles have been constructed, one for shop use and the other a prototype portable model. The development of the latter was undertaken with a view to using this process for welding pipes on site or in positions of limited access. So far, welding with these machines has been confined to mild, carbon-molybdenum, and chromium-molybdenum steel pipes, but more highly alloyed steels can probably be joined. The process is fully automatic; apart from ensuring the correct setting of the machine and occasional checks, highly skilled operators are not needed.—*Admiralty Bulletin No. 73. Journal, The British Shipbuilding Research Association, February 1956; Vol. 11, Abstract No. 11,255.*

Diesel-electric French Trawler

The *Cap Fagnet III*, one of the world's largest fishing vessels at present under construction, is nearing completion in the French yard of Ateliers et Chantiers de la Seine Maritime for the owners, Pecheries de Fécamp. A vessel of an overall length of 245ft., a moulded breadth of 37ft. 9in., a depth of 19ft. 8in., and a maximum draught aft of 19ft. 4in., she will operate on the Grande Sole off Newfoundland. A deep sea trawler of the 68 mètre class and upwards requires a propulsion power in the region of 1,200 s.h.p. to obtain a passage speed of about 11 knots and the power required for trawling at 3-4 knots is of the order of 1,000 s.h.p. To achieve a comparatively small increase in passage speed, about twice the horsepower is needed, and—with a conventional machinery layout—this would result in the engines running at very much reduced output when trawling. The owners of the *Cap Fagnet III* have overcome these difficulties by specifying Diesel-electric propulsion. This will give the vessel an increased power of 2,000 b.h.p.; effect a passage speed of between 13 and 14 knots; and avoid the harmful consequences of running the engines at half power for long periods when trawling. Diesel power is provided by three Ruston-Paxman Vee-form engines, supplied through Etablissements Tiano, Paris. The engines are pressurecharged, intercooled units, each developing 750 b.h.p. at 750 r.p.m. and each driving two Sautter-Harle self-ventilating and constant speed generators. The generators are mounted in tandem; one is the propulsion generator and the other an auxiliary generator used for supplying either the trawl winch motor or auxiliaries. The propulsion generators each have a continuous output of 510 kW at 750 r.p.m., and the auxiliary generators each have a maximum output of 195 kW (one hour rating) and a continuous rating of 150 kW. The three propulsion generators are coupled up in series, for feeding—also in series—the two propulsion motors. These motors, each rated at 950 h.p. at 850 r.p.m., drive the propeller through a reduction gear which allows a higher motor speed within a reduced weight and size. The generators can be coupled to the motors in the following combinations: Full power for passage—3 generators on 2 motors. Trawling—2 generators on 2 motors. Slow speed and hove to—1 generator on 2 motors. The flexibility thus obtained is supplemented by simplified maintenance at sea. Of the 100 to 120 days' duration of the average fishing trip, only sixteen of these will be spent in passage. During the remainder of the time, spent on the fishing grounds, one of the engines can be shut down. With no separate auxiliary generator sets to be maintained, there is an obvious advantage in the reduction in the number of spares to be carried. Any one of the propulsion sets is capable of propelling the vessel and the risk of total immobilization is thus reduced to a minimum.—*World Fishing, April 1956; Vol. 5, p. 34; 42.*

Crankcase Explosions: Factors Governing the Selection of Protective Devices

Remedies which have been suggested for crankcase explosions include the use of warning devices to detect overheating in the crankcase, and the provision of relief vents to limit the explosion pressure to a safe value. Data were obtained experimentally at the Thornton Research Centre for the conditions necessary for the ignition of mists of lubricating oil in air in order that the margin of safety offered by a detector of overheating might be more fully assessed. The venting of explosions was also studied both on a rig scale and in the crankcase of a Diesel engine of 1,100 h.p. The results indicated that it would not be practical to provide sufficient venting area on an engine of this size, to limit the maximum explosion pressures to a safe value for the more violent explosions which might occur. For venting to provide complete protection, it would seem necessary to take measures to prevent the flame from spreading throughout the whole crankcase.—*Paper by H. G. Freeston, J. D. Roberts and A. Thomas, read at a meeting of The Institution of Mechanical Engineers on 24th April 1956.*

Calculation of Stresses in a Stayed Mast

A method for the calculation of stresses in the mast and stays of a stayed mast is developed. Though the method is based on theoretical considerations some assumptions have to be made. These assumptions are discussed as well as the various doubtful factors involved in the calculation. The various forces acting on the mast and the bending moments producing the deflexion of the mast are considered. The method of calculation is then explained and an attempt to justify the assumption on which the solution of the problem is based, is made in an appendix. For design purposes, a method for estimating the maximum load in the stays and for determining their approximate sectional areas is discussed. A numerical example of this method is given in an Appendix.—*B. Burghgraef, International Shipbuilding Progress, April 1956; Vol. 3, pp. 207-228.*

Effect of Superstructure on Strength of Ship

This report describes strain gauge measurements of the strain distribution during longitudinal bending of an actual ship, and of steel box type model structures; and photoelastic investigations on celluloid models. The object of the work was to obtain better theoretical values than are given by the simple beam theory. The ship was the *Brazil Maru*. The positions for the strain gauge measurements were located mainly near the 'midship section. The box type models were devised to simulate a simplified ship structure such as a deckhouse. The results of the investigation are not complete and thus no final conclusions have yet been reached. As far as the ship is concerned, the measured stresses agree fairly well with those computed on Bleich's theory. This theory seems to be satisfactory only when the length of the deckhouse is sufficient and the stiffness of the deck does not vary along its length.—*(Shipbuilding Research Association of Japan, Report No. 5, September 1955.) Journal, The British Shipbuilding Research Association, February 1956; Vol. 11, Abstract No. 11,246.*

Effects of Heat Treatment and Microstructure on Transition Temperature

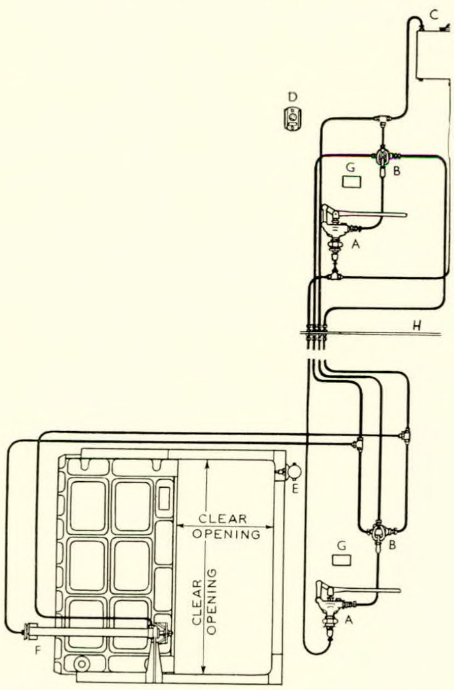
Among the factors known to affect the temperature at which the fracture of mild steel in a notched bend test changes from a tough to a brittle character is the thermal history of the material, particularly that part of the history which follows the conclusion of hot working. If, as is usually the case, the material is supplied and used in the "as rolled" or the normalized condition, the thermal history can be defined in terms of either the temperature at which rolling finished or at which normalizing was carried out, and the cooling rate from that temperature. These factors of the thermal history also affect the microstructure of the steel, and it seems reasonable to seek some correlation between microstructure and transition temperature. One of the advantages of such a correlation, if it were found, would lie in the fact that different features of the microstructure are established in different parts of the cooling range and the correlation could show which portions of the cooling range are more, and which less, significant from the point of view of transition temperature. The authors have examined the relationships between transition temperature in a notched bend test, microstructure, and thermal history in the case of a ½-in. thick plate of 0·24 per cent carbon mild steel. Austenite grain size at the commencement of cooling is shown to be a major factor affecting the transition temperature. Cooling rate also has a substantial effect, which is more marked during the transformation of the pearlite than in other parts of the cooling range.—*G. Burns and C. Judge, Journal of the Iron and Steel Institute, Part 3, March 1956; Vol. 182, pp. 292-300.*

Measurement of Deep Ocean Currents

Direct and reliable measurements of the currents in the deep ocean basins have been made with the aid of a neutrally-buoyant float developed by Dr. J. C. Swallow of National Institute of Oceanography. The float may be set to operate at any desired depth and tracked with the aid of the acoustic signals which it transmits. The transmitter is powered by a 360-volt battery and consists of a resistance-capacitance circuit which discharges through a soft gas tube to energize a magnetostriction ring scroll of nickel and with toroidal windings. The frequency is about 10 kc/s. It was originally intended that the buoy's transmitter should be of the responder type, its responses being triggered by the outgoing pulses of the survey vessel's echo sounder. This elegant arrangement was discarded as the narrowness of the echo sounder's beam made searching for the buoy extremely difficult. To locate the buoy, the ship is stopped and two hydrophones are lowered over the side as far apart as possible. These receive the signals from the buoy and pass them via separate amplifiers to an oscilloscope whose timebase can be triggered by the signal from either hydrophone. As the hydrophones are distant from each other, it follows that they receive signals from the acoustic buoy at different times, and this enables the bearing of the float to be obtained. Altering the ship's heading gives other bearings and hence a "fix" on the buoy. Knowing the buoy's position and one bearing its depth can be obtained in a similar manner. The range at which the buoy can be located is understood to be about two to three miles depending upon the depth at which it is operating.—*British Communications and Electronics, May 1956; Vol. 3, p. 242.*

Hand/hydraulically-operated Watertight Doors

An improved hand-operated watertight door is being produced by J. Stone and Co. (Charlton), Ltd. The system comprises a hydraulic cylinder, a hand pump and a control valve near the door. A second pump and control valve may be situated above the bulkhead deck, together with an indicator and supply tank. This method eliminates the use of shafting and bevels, simplifying both the installation and maintenance work when in service. The system can, of course, be used in conjunction with the normal power-operated door arrangement and, as stated, eliminates mechanical gearing. The door may be closed or opened by means of the local pump and control valve or by the unit above the bulkhead deck. With the control valve above the bulkhead deck at neutral, the door may be actuated locally by holding the local control valve lever in the "close" or "open" position while the local hand pump is operated. The control valve cannot be locked in any position and when released returns to neutral. An electric indicator at the point of operation above the bulkhead deck illuminates a ruby glass disc when the door is closed.—*The Motor Ship, June 1956; Vol. 37, p. 91.*



General layout of Stone's hand-operated watertight door

(A) Hand pump; (B) Four-way valve incorporating auxiliary valve; (C) Supply tank, minimum five gallons capacity; (D) Indicator, illuminated when door is closed; (E) Indicator light switch; (F) Hydraulic cylinder; (G) Instruction plate; (H) Deck

Steam-operated Distilling Unit

A new vertical basket type distilling unit has been developed, and two effect units of 10,000 gal. per day capacity are installed on the DE-1006 class destroyer escorts. Also, four 50,000 gal. per day quadruple effect units are being installed on CVA-61. The vertical basket unit operates on the same principle as the old submerged tube unit. Sea water feed is boiled and vaporized in contact with the heating element. In the submerged tube type, the heating element consists of a bundle of tubes with steam inside, and the sea water feed surrounding the tubes in the evaporator shell. The vertical basket type has a deeply corrugated vertical cylindrical basket surrounded by a vertical shell. Steam is introduced into the interior of the basket. The steam then transfers heat to the sea water feed in the spaces between the "fingers" of the deep corrugations of the basket and between the basket and the shell. The vertical basket unit is superior to the submerged tube unit because the scale that forms on the heating surface is readily and effectively cracked off by the cold shock operation. In preparation for cold shocking, the salt water side of the evaporator effect to be shocked is drained. Then steam at 15lb. per sq. in. gauge is admitted into the basket. The "fingers" of the corrugations are slightly expanded by the steam pressure. The scale is cracked and loosened as it dries and becomes brittle from the heating of the steam. The steam is then secured and the shell is rapidly filled with cold sea water. The resulting condensation of the steam in the basket creates a vacuum of approximately 28 inches of mercury, causing abrupt contraction of the "fingers" of the corrugations. This further cracks and loosens the scale, and the majority of it drops off and sinks to the sump space under the basket. Some loosened scale may still adhere to the basket, but if the unit is operated for an hour or so, the violent boiling action will remove it. Then the unit should be shut down, the access doors in the bottom of the evaporator opened, and the scale raked out. The first effect, which has the most scale formation, is usually cold shocked about every seventy-five hours. Subsequent effects should be cold shocked at double this interval or more. In the case of the quadruple effect unit, the fourth effect will probably require cold shocking only once or twice a year. The vertical basket unit has the same accessory equipment as the submerged tube type, such as distiller condenser, vapour feed heater between effects, and a distillate cooler. Its main advantage over the submerged tube unit is the effective scale removal by cold shocking.—*C. B. Tuley, Bureau of Ships Journal, April 1956; Vol. 4, pp. 23-24.*

Crankcase Explosions: Development of New Protective Devices

Tests of a crankcase explosion relief valve 6 inches in diameter, provided with various wire gauze flame traps, showed such flame traps to be ineffective when severe explosions were made with mixtures of town gas and air. It was discovered that coating the wire gauze with lubricating oil greatly increased the effectiveness of the flame trap. An internal, oil-wetted flame trap of less than half the original size was fully effective with the most severe explosion that could be produced. An oil-wetted flame trap, covering an aperture in a dividing partition of a cylindrical explosion vessel fully charged with gas-air mixture, was found to limit combustion to the chamber in which the mixture was ignited, and to limit the maximum pressure to one-quarter of the value reached without the partition flame trap. Internal oil-wetted relief valve flame traps and partition flame traps were then successfully tested on a three-cylinder engine of 9 inches bore. From the results obtained, the requirements of a large engine are estimated, and it is concluded that the use of the two new devices would provide adequate protection at acceptable cost. The reason for the remarkable effectiveness of coating the gauzes has not yet been clearly established. The effect must be due, in part at least, to the increased amount of heat which the assembly can absorb before reaching the temperature at which the rate of removal of heat from the residual air, fuel and combustion products passing through, is insufficient to prevent the passage of flame. It is doubtful whether the effect is wholly due to the increase in heat capacity of the flame trap, especially in view of the fact that a considerable part of the coating may be removed from the ganze by the gas stream before it has been vaporized. There are other possibilities. For instance, the temperature at which combustion ceases when the reagents are cooled may be a function of the fuel/oxygen ratio, and the enrichment of the mixture (of which the oxygen content has already been greatly reduced by combustion) by the addition of the vapour from the flame trap coating may make combustion cease at a higher temperature. These various considerations indicate that the process is complex, and that a detailed investigation would be necessary to obtain a full understanding. *—Paper by W. P. Mansfield, read at a meeting of The Institution of Mechanical Engineers on 24th April 1956.*

Scandinavia's Largest Dry Dock

The new dry dock of Burmeister and Wain at Copenhagen is able to accommodate vessels of up to 38,000 tons d.w. With the completion of the new dock, Burmeister and Wain are now in a position to obtain contracts for the repair and overhaul of the large number of tankers being built in the 32/38,000-ton d.w. range. The dock, situated at the south end of the shipyard, can be approached directly from Copenhagen port, under favourable wind and space conditions. It has inside dimensions of 713ft. 6in. length and 99ft. 6in. width, and has a depth of water over the keel blocks of 23ft. 6in. forward and 26ft. aft. The width of the entrance is the same as the breadth of the dock. Of the single plate flap type, the dock gate is hinged on the lower edge so that it can be lowered to the bottom by means of electric winches on each side. The time for opening and closing the gate is about five minutes. For the purposes of docking and undocking there are four 10-ton electric capstans and a special hauling arrangement. The hauling equipment consists of mules running on rails on each side of the dock, directing ships into the centre of the dock with the aid of wires. A pump room is situated on each side of the dock, draining being carried out by four submerged screw pumps, each with a capacity of 8,600 tons per hour. The time taken to empty the dock when unoccupied is about 1 hour 45 minutes. The pump pipes are of the siphon type without valves. Filling the dock is accomplished within one hour by means of two equilibrium valves. In addition, there are two drainage pumps, each with a capacity of 400 tons per hour. The dock is equipped with one row of releasable oak keel blocks, and side support is effected by twelve sets of bilge shores on each side. These shores can be moved sideways, and are wedged against the bottom of the ship from the dock sides by compressed air operated gears. On the north side of the dock there is a 15-ton Titan crane with a maximum radius of 34 metres, while a Demag crane with a maximum capacity of 7½ tons and a maximum radius of 22·5 metres is positioned on the south side. There is a roller scaffolding on each of the dock sides, the radius of which may be adjusted to the parallel part of the side of a vessel. For the storage of fuel oil, etc., there is on each side of the dock bottom a 300-ton tank with heating coils and separate pumping system. A service tunnel runs through both of the side walls to the dock. Housed in these tunnels are the lines to the various services of the dock, including high and low pressure steam, fresh and salt water, compressed air, acetylene and oxygen, 110-volt d.c. power for ships' auxiliary machinery, a.c. power and telephone services. All the service lines are connected by means of portable pipe bridges from the dockside to the ship.—*The Shipping World, 18th July 1956; Vol. 134, p. 56.*

Large Sulzer Turbocharged Engine

Trials are being carried out at the Winterthur Works of Sulzer Bros., Ltd., on the nine-cylinder 11,700 b.h.p. two-stroke turbocharged engine which they have built, and the results already obtained are sufficient to indicate the notable performance of this class of machinery. It is the first European-built engine of the type. The cylinder bore is 760 mm. and the piston stroke 1,550 mm. The rated output mentioned is obtained with a b.m.e.p. of 100lb. per sq. in., the speed being 119 r.p.m. There are three turbochargers, to each of which the exhaust from three cylinders is delivered by the shortest path. In the system adopted in the Sulzer turbocharged engine employing the pulse system for the exhaust turbine, it is unnecessary to have any auxiliary scavenge pump. It was found during the trials that the engine started satisfactorily and that the exhaust was smokeless even at an overload of 10 per cent, when the output was approximately 13,000 b.h.p. Thus, with a twelve-cylinder engine on a corresponding overload, approximately 17,000 b.h.p. would be delivered. The fuel consumption on the trials was about 0·35lb. per b.h.p. per hr., this figure being maintained from about 85 to 110 per cent of full output. The consumption is lower than that of the non-turbocharged engine, and at half load was 158 kg. per b.h.p. per hr. With further improvements, particularly with a new arrangement of ports in the liners, it is found that an even more favourable figure can be reached. With the new liners the consumption was 152 gr. per b.h.p. per hr., or under 0·34lb. per b.h.p. per hr.—*The Motor Ship, June 1956; Vol. 37, pp. 56-57.*

Ship with Aluminium-lined Holds

The second of three new style refrigerated cargo ships, with their patent aluminium lined holds, is the 6,500-ton single-screw steamer *Carrillo*, building for Empresa Hondurena de Vapores, of Honduras. The *Carrillo* is 425ft. long, and has a moulded breadth of 59ft., a depth to upper deck of 36ft. and a draught of 26ft. She has been built under the special survey of the American Bureau of Shipping. There are four main decks—upper, main, lower and orlop. Cargo spaces are divided by transverse watertight bulkheads in the four main compartments, insulated for the carriage of refrigerated cargoes. The insulation in the fruit cargo spaces is to the owners' patent. The spaces are faced with aluminium sheeting and the air ducts are also of aluminium. It is arranged with an absolutely flush, bright surface whenever in contact with cargo. Aluminium covers are used for the upper covers of the cargo hatches. Insulated plug hatches are fitted below these hatches on the upper deck. The plugs extend for part of the length of the hatch and the remainder of the opening is closed by a large insulated slab which moves on rollers, sliding hydraulically under the deck and operated by a stainless steel screw driven by an air driven motor. Insulating plugs are fitted in hatches below the upper deck where required by the insulating scheme Cooling of the holds is effected by batteries of air coolers and fans. Propelling machinery consist of a single screw, two-cylinder articulated double reduction geared steam turbine, developing 9,000 s.h.p. at 125 r.p.m.—*Shipbuilding and Shipping Record, 31st May 1956; Vol. 87, p. 466.*

Closed-link Television X-ray Inspection System

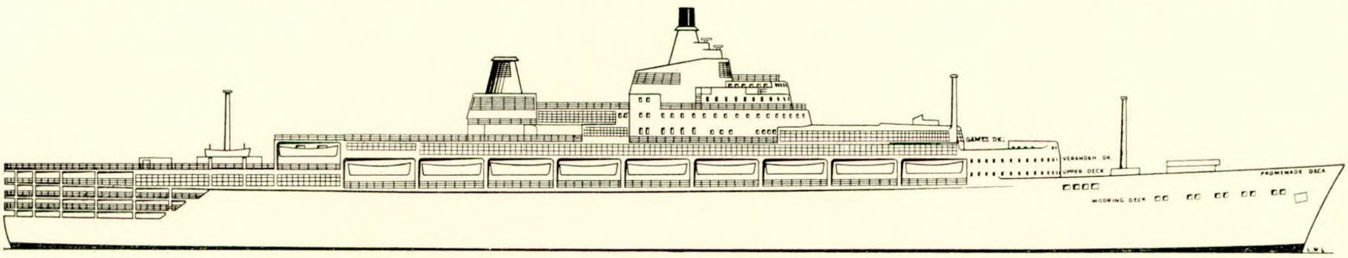
Naval ordnance continues to grow in size and complexity, and with this growth a greater emphasis is placed on the reliability and safety of weapons. The use of propellant, electronic gear, and newer and greater thicknesses of metals in weapons, missiles, and ships requires the inspection of many diverse items. Each item has its own specifications, so that special techniques and equipment are often required. In an attempt to reduce the cost of inspection, other methods and tools have been developed that, in some cases, have replaced radiography. These methods, such as Magnaflux, ultrasonics, fluoroscopy, and the use of eddy currents, have been very successful in the inspection of specific items and have materially reduced the cost of inspection while maintaining the quality demanded by specifications. The use of television as another inspection tool was investigated because of its inherent advantages. One of these advantages is the use of television with a wide band of X-ray energies. That is, television can view, on a fluorescent screen, the image that is produced either by low voltage or high voltage X-rays. Thus, its range of application as a filmless method of inspection greatly exceeds that of conventional fluoroscopy. It also offers such advantages as immediate inspection and remote viewing. In some instances, the possibility of remote viewing may simplify the radiation shielding problem for the inspector. The television chain was designed with 1,029-line scan and special amplifiers to minimize the effect of noise. Picture quality and fluorescent screen performance are treated in detail. At the present time, penetrameter sensitivities of 4 per cent and better in the range of 0·50 to 4·00in. of aluminium and about 7 per cent for 0·25 to 1·00in. of steel are reported. The system, although not having high radiographic sensitivity, is specially characterized by its sensitivity to very low light levels. Images produced by X-ray intensities as low as 5 mr. per min. can be observed. —*D. Polansky and E. L. Criscuolo. Non-Destructive Testing, May/June 1956; Vol. 14, pp. 18-21.*

Contour Bevelling with Electronic Tracer

Contour bevelling with the so-called "electronic tracer" is in the early stages of successful commercial practice. It has grown out of the development of the flame-cutting process as a production tool and its mechanization for straight-line and shape cutting of steel plate with squared edges. The increasing use of irregularly shaped steel weldments requiring bevelled edges for full penetration welds focused attention on the need for automatic contour flame-bevelling equipment. Automatic contour flame-bevelling eliminates additional materials handling by accomplishing the desired bevel for an irregularly shaped steel weldment while performing the original pattern cut. This means that the straight edge cut on irregular steel shapes need not be followed by additional handling for layout, set-up and a separate bevelling operation. Contour bevelling is done with special attachments operating single or multiple torches on present standard equipment resulting in a constant and continuous bevel on an irregular contour. The torch is mounted on a segment of a circle, so designed that the projection of the centre of the cutting tip intersects the centre line of the vertical revolving support member at the layout control point of the material to be cut. Open or closed bevels may be cut. The torch need only be revolved 180 degrees to change the setting from an open to a closed bevel. Templates are as simple as for square edge cutting provided the layout is considered the bottom of the bevel. A bevel around an entire contour requires one 360 degrees revolution of the torch. This is accomplished electronically. A synchro-transformer picks up the direction signal from a synchro-transmitter in the electronic tracer as it progresses around the template. The torch is revolved by a motor according to the signal received from the synchro-control transformer. The torch revolution is in unison with that of the tracer drive wheel and provides a constant bevel at a preset angle on the contour traversed.—*H. Cary and R. F. Helmkamp, The Welding Journal, May 1956; Vol. 35, pp. 450-455.*

New Orient Liner

Aerodynamic tests with large scale models of the new 40,000-ton passenger liner for the Orient Steam Navigation Co., Ltd., are being carried out on the problems of wind velocity and funnel smoke at the National Physical Laboratory, Teddington. The vessel, which will cost about £10,000,000, will be ordered shortly from a British shipyard for delivery in 1960. At the N.P.L. various funnel shapes are being tested in the search for a design that will ensure freedom from smoke pollution at deck level at an economical discharge velocity. Experiments in ventilation are also in progress to find a means of preventing the oily odours from the engine and boiler room from reaching the recreation decks. The design of the decks is now completed, but the layout of the after decks has yet to be planned. Since air conditioning will be used almost throughout the new ship, the problem of getting rid of the foul air has also to be considered. For this purpose a funnel-shaped structure has been designed which will be erected abaft the funnel, as shown on the accompanying drawing. This will be louvred and the fumes from the engine room, boiler room and the accommodation will be exhausted through this structure into the atmosphere, well away from the decks.—*The Shipping World, 6th June 1956; Vol 134, pp. 531; 538.*

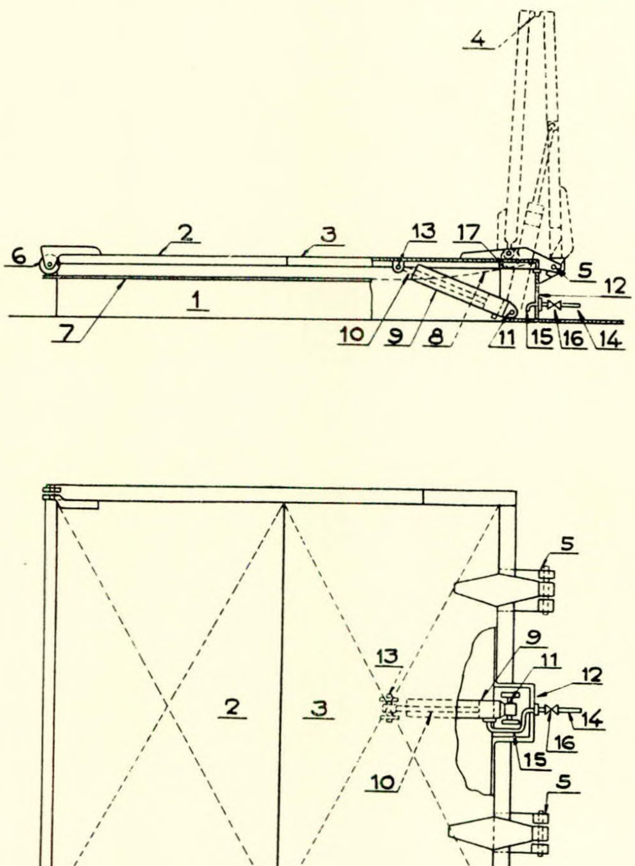


Proposed outboard profile of new 40,000-ton passenger liner for the Orient Line. The promenade deck below the lifeboats and the covered promenade above can be seen. The conical structure abaft the midships structure is for exhausting the engine and boiler room fumes

Patent Specifications

Operation of Hatch Cover

This invention refers to a hatch cover which may be made in one or more sections and which is swingable about hinges located outside the hatch opening. The invention is principally distinguished by the feature that a jack actuated by a pressure medium is pivotally secured to the hatch cover as well as to a portion of the deck parallel to the hinge axis of the cover. As will be seen in Figs. 1 and 2, for the operation of

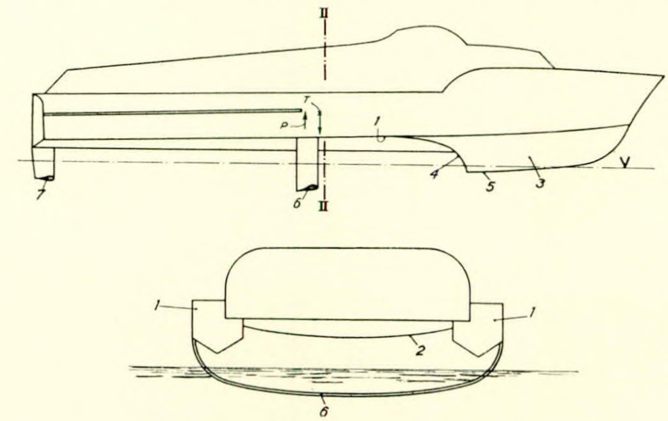


FIGS. 1 (above) and 2 (below)

the hatch cover sections, the jack (9) has a piston rod (10) running in a cylinder. The cylinder is swingably secured about a pivot (11) arranged on a portion of the deck within the coaming of the hatch, and the piston rod is in a similar manner swingably secured to the hatch cover section (3) by means of a pivot (13).—*British Patent No. 752,537 issued to A.B. Götaverken. Complete specification published 11th July 1956.*

Hydrofoil Craft

This invention relates to a hydrofoil craft and is characterized in that the principal portion of the weight of the craft when under way is carried by a dynamically lifting system comprising at least one hydrofoil. The upwardly directed resulting force of the hydrofoil is located at, or somewhat astern of, the normal centre of gravity of the craft, while the rest of the weight is supported by one (or several) planing or gliding surfaces arranged ahead of the centre of gravity and bearing a small load. When under way, the floats shown in Figs. 1 and 2, with the exception of the gliding surface (5),



FIGS. 1 (above) and 2 (below)

are entirely raised above the surface of the water and the craft is supported by a dynamic system, which in the example shown is formed by a hydrofoil (6) of the conventional type. The hydrofoil which is preferably of the self-stabilizing, i.e. laterally stabilizing type is secured to the floats (1), and preferably is made all of a piece and extends transversely below the craft, but without any portion extending beyond the sides of the craft.—*British Patent No. 752,639 issued to International Aquavion, S.A. Complete specification published 11th July 1956.*

Steam and Water Separator for Sea Water Evaporator

This invention relates to a separator for producing dry steam from a mixture of steam and entrained water. Separators incorporating the features of the invention may be used in the construction of evaporators which are installed aboard ship to distil fresh water from sea water for drinking or other usage. It is suggested that the separator can most advantageously be used as the secondary separator in the sea water evaporator. In the example of Fig. 3, the separated water will drain through the perforated plate (43) on to the partition (17) which closes the inner shell (19). Thus, the water will drain from the partition (17) outwardly into the annular sump (S') located adjacent to the cylindrical wall of the dome-like cover of the evaporator. The water is drained from the sump through a plurality of tubes (53) located in circumferentially spaced positions at the bottom of the sump (S') to extend through the cylindrical side wall of the dome-like cover. It will be apparent that drainage can thus be effected from the sump no matter to what angle the evaporator is tilted in the roll of a ship. During roll of a ship there may be a tendency for the water to splash within the sump (S'). To prevent undesirable splashing, a number of circumferentially spaced vanes (55) are fixed along the inner shell wall (19) to extend into the sump. Tests

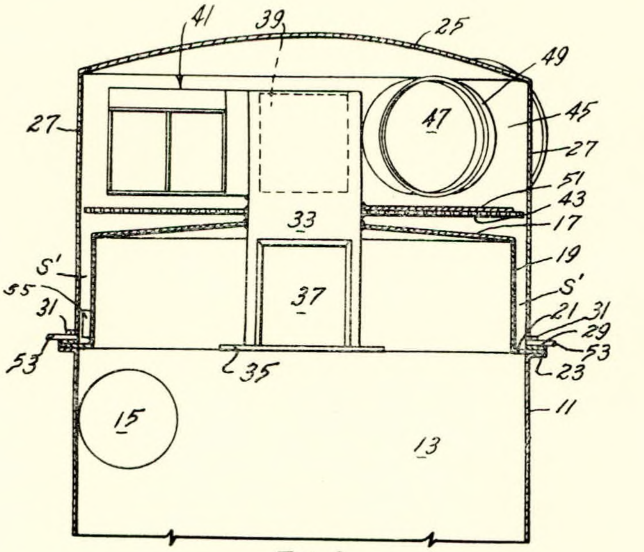
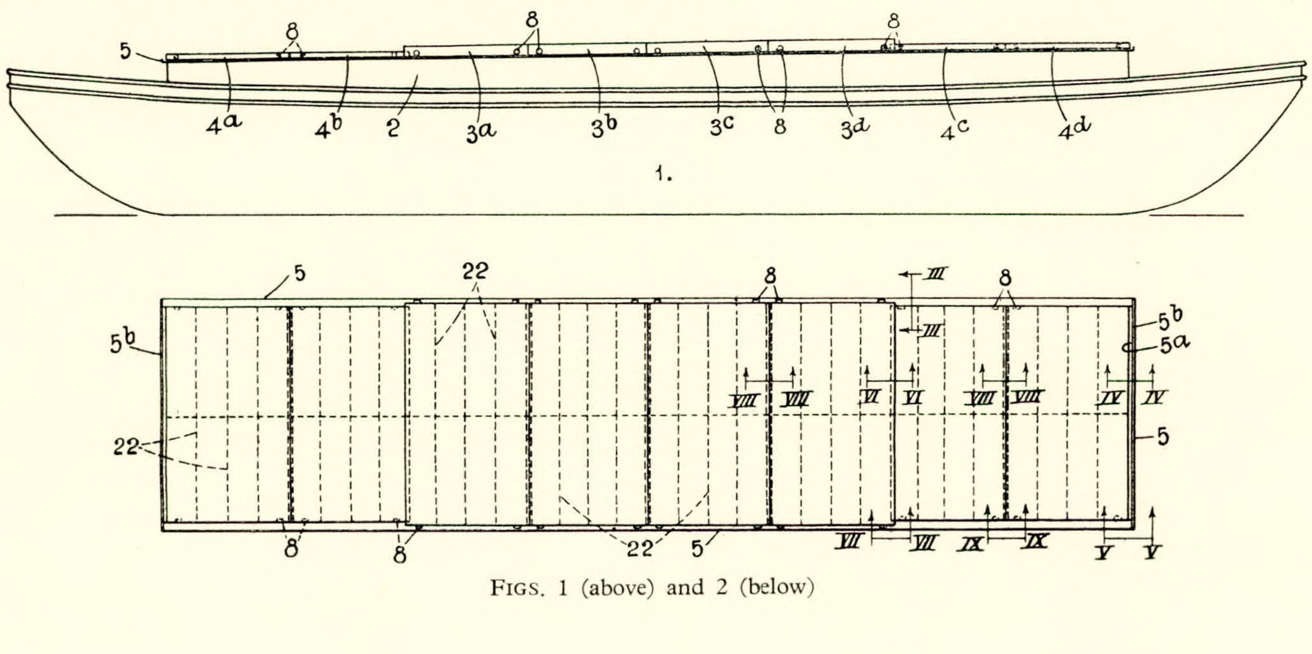


FIG. 3

of sea water evaporators incorporating the separator described have indicated that the salinity content of the distillate approximates to 0·04 grains per U.S. gallon, while the sea water capacity has been increased by 50 per cent as compared with evaporators of substantially equal size or requiring substantially equal space for installation.—*British Patent No. 752,237 issued to The Maxim Silencer Company. Complete specification published 4th July 1956.*

Hatch Construction

This invention relates to hatch constructions for barges of the kind wherein the hatch covers are made up of a number of separate metal sections, telescoping one within another. According to the invention the envisaged hatch construction is characterized by the employment of one or more composite sections built up of individual sections which do not telescope together but are arranged to telescope with another composite section. In Figs. 1 and 2 a barge (1) has a hatchway extending along the major part of its length and comprising a coaming (2) with four central cover sections (3a, 3b, 3c, 3d) and four end sections (4a, 4b, 4c, 4d) disposed two at each end. Thus there are in effect four telescoping composite sections each consisting of two non-telescoping single sections (viz. 4a and 4b, 3a and 3b, 3c and 3d, and 4c and 4d), giving a wide choice of positions where the hatch opening for working cargo may be made available.—*British Patent No. 751,939 issued to R. MacGregor and J. MacGregor. Complete specification published 4th July 1956.*



FIGS. 1 (above) and 2 (below)

Improved Tugboat

This invention relates to bow-driven tugboats and proposes that, for obtaining maximum course and transverse stability for the smallest possible length and breadth of the ship, the towing hook should be placed approximately in the after third of the ship. The invention consists in the arrangement of the driving member at the front and the towing hook at the rear part of the tug. In Fig. 1 the rudder (8) is adapted to swivel

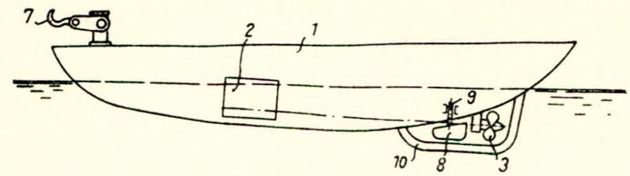


FIG. 1

about a vertical axis (9), while a protective frame (10) embraces both the propeller and the rudder and acts as a protection from contact with the bottom. Fig. 3 shows a construction in which

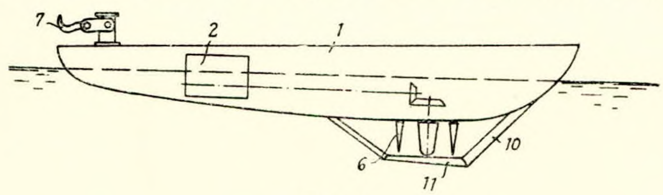
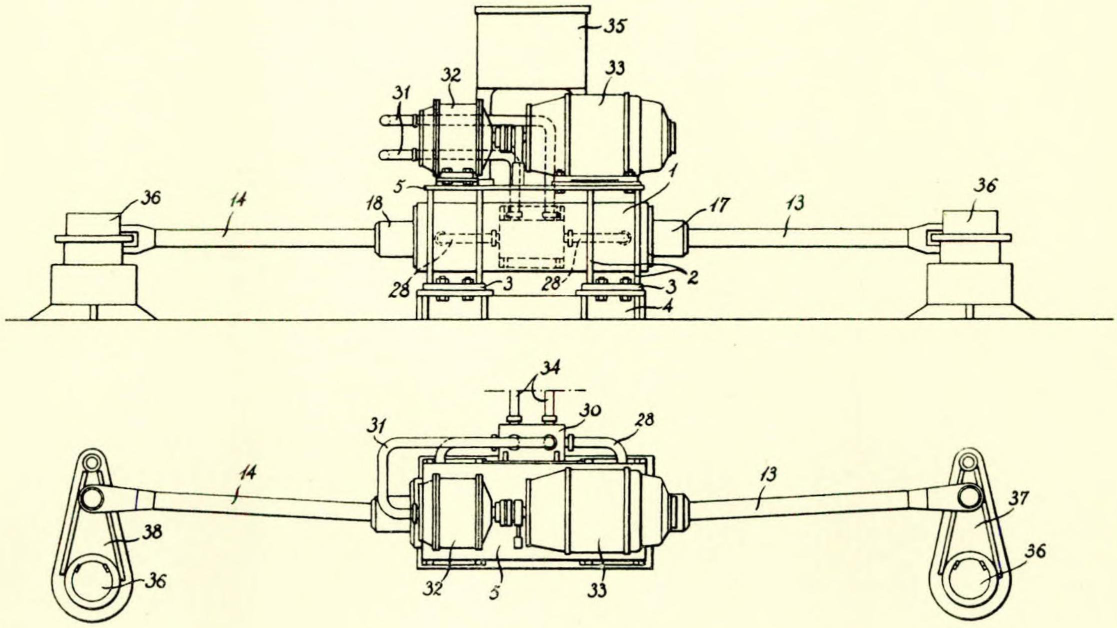


FIG. 4

the screw (5) is provided with a casing (16). A casing (17) carrying the screw can be swivelled about an axis (18) and contains an electric motor supplied from a generator (19) driven by the motor (2). As shown in Fig. 4, a cycloidal vanewheel propeller (6) acts as the propelling and steering member, and is also surrounded by a protective frame (10). The latter is closed at the bottom by means of a wind-like plate (11), which serves to increase the thrust.—*British Patent No. 748,850 issued to J. M. Voith G.m.b.H. Complete specification published 9th May 1956.*

Ship's Steering Gear

In ships' steering gear as hitherto designed, a rudder is actuated by at least two rams comprising a plunger piston which act in opposite directions on a tiller mounted on the rudder stock. The invention relates to improvements in steering gears, which reside in employing as driving member a jack comprising a double-acting piston connected to the tiller by a connecting rod which is pivotally connected by means of a gudgeon to the centre of the piston within a tube connected to the piston, the tube sliding through the cylinder in the direction of its axis and defining annular cylinder spaces on either side of the piston. In Figs. 1 and 2 the body of the jack (1) is a cylinder mounted on a frame fixed on the deck of the ship. A double-acting piston slides in the cylinder. The connecting rods (13, 14) are separated from the cylinder by tubes (17, 18) fast with the piston. The two piston tubes extend over a sufficient length to terminate beyond the ends of the cylinder regardless of the position of the piston. They slide in cylinder heads (22). The two cylinder chambers on either side of the double-acting piston are therefore annular and are bounded between a cylinder head and the opposite piston face by the wall of the cylinder (1) and the piston tube extending through this cylinder head. The two pipes (28) connect the two ends of the cylinder to a distribution block (30) which in turn is connected by two pipes (31) to a pump (32) coupled with an electric motor (33).—*British Patent No. 751,608 issued to Etablissements Paul Duclos. Complete specification published 4th July 1956.*



FIGS. 1 (above) and 2 (below)

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Marine Engineering and Shipbuilding Abstracts

Volume XIX, No. 11, November 1956

Turning Ships

In this article, which is entitled "Handling Ships in Narrow Waters", the author points out that the handling of a ship, reduced to its simplest terms, is the ability to control her turning, plus the ability to control her movement through the water. Taking first the question of controlling the turning of the ship, the most obvious forces affecting this which are under one's immediate control are the screws and rudder. Fig. 1 shows the forces acting from the action of the propellers when a twin-screw ship with out-turning screws is turned at rest with one engine ahead and the other astern. It is not only essential to understand these forces, but also to appreciate that their proportional effect, one with another, will vary accord-

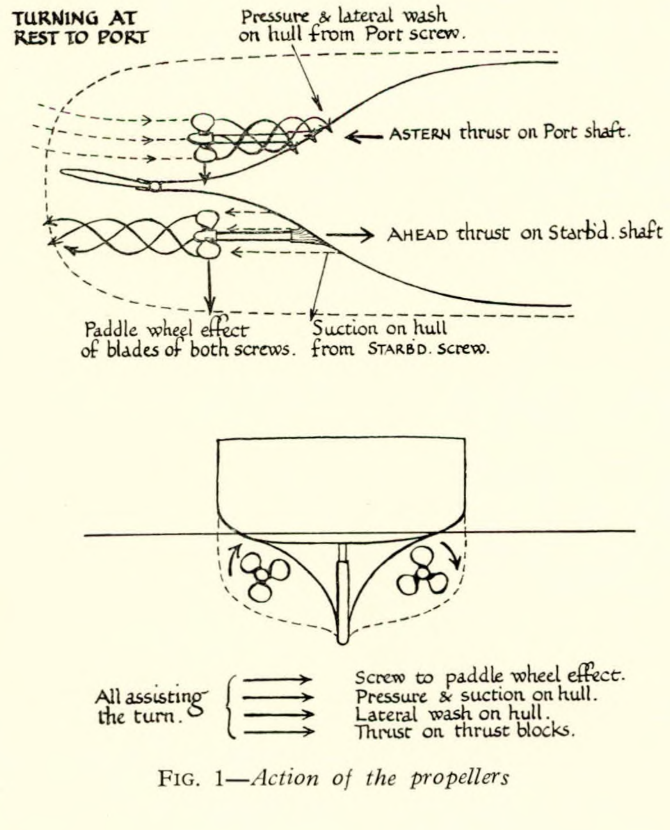


FIG. 1—*Action of the propellers*

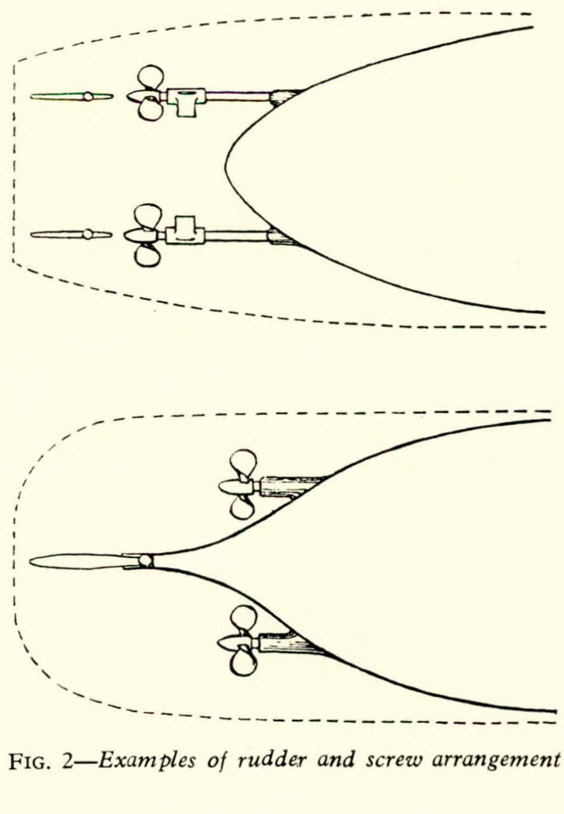


FIG. 2—*Examples of rudder and screw arrangement*

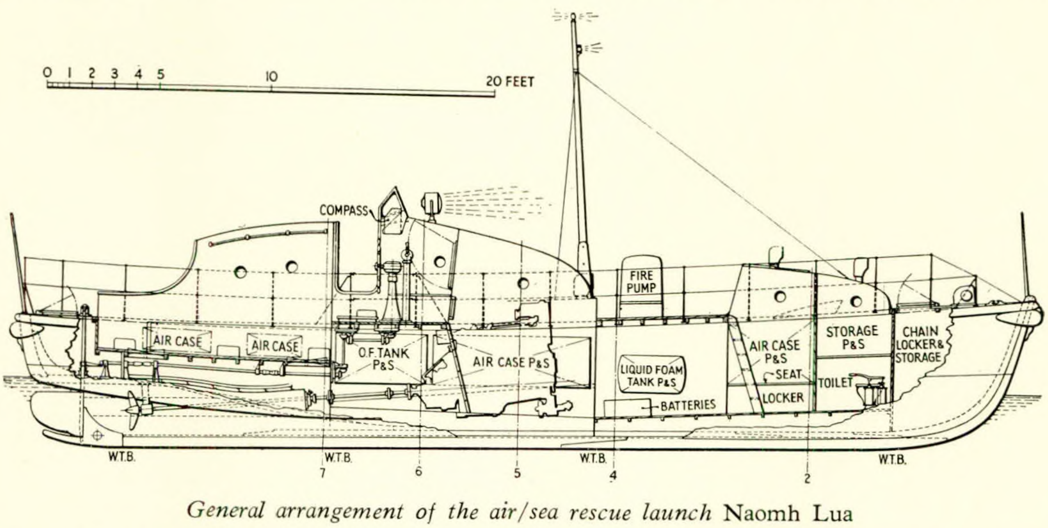
ing to the particular hull shape, size and immersion of the screws, position of the rudder or rudders in relation to the screws, etc. Fig. 2 shows the after part of two ships, each with twin out-turning screws, but otherwise dissimilar. In the destroyer type of hull the screws lie beneath the flat-bottomed after run of the hull, and in the case illustrated a balanced rudder is set in the slipstream of each. Turning at rest there will be little pressure and suction, or lateral wash effect on this flat bottom, but the screw, or paddle-wheel effect, will be large, because there is no deadwood to check the flow of water laterally; with big screws the pressure on the lower blades will be considerably greater than that on the upper ones. When one of these screws turns ahead it will create an immediate flow past the rudder, which will therefore be effective even though the ship has no way through the water. When, however, this engine goes astern, even though the ship has headway, there will be strong turbulence around the rudder which will reduce its effectiveness. In the merchant ship type of hull the unbalanced rudder is hung on a sternpost and the screws are tucked well away under the counter with a barrier of hull between them. Clearly the forces acting will be substantially different, and, moreover, this arrangement of rudder will be ineffective until the ship has headway. On the other hand, there will be less turbulence round it when the engines are put astern. When the rudder is set in the screw slipstream its effect will be the biggest of all the turning forces when that screw is going ahead. Thus, in a single-screw ship turning short, the main turning forces are the deflexion of the slipstream by the rudder when the engine is going ahead, and the paddle-wheel effect of the screw when it is going astern. In most ocean-going vessels with twin screws the push of one screw and the pull of the other on the thrust blocks when turning at rest is the least of the turning forces. This may readily be discovered in ships with twin in-turning screws, which are most difficult to turn at rest because the paddle-wheel effect is counter to the turn. In some cases these ships will turn "against" the screws, i.e. to port when port engine is ahead and starboard astern. In ships with triple screws the centre screw can be used with excellent effect at dead slow ahead to keep an effective flow past the rudder, even when the ship has no headway. Small, fast craft with internal combustion engines and multiple screws often have all propellers of the same hand—usually left-handed. Since such propellers are frequently small, and turning at high speed, the paddle-wheel effect is not so pronounced when all engines are going astern as it would be with larger ones. In planing craft with a large beam-length ratio the thrust on the thrust blocks with one engine going ahead and the other astern is a large turning force. When a ship is proceeding with all engines ahead she turns under the action of her rudder only. Turning circle data for various angles of rudder should be known and tabulated in terms of advance and transfer. In general the speed of the ship does not greatly affect the turning circle in calm weather. The chief effect of high speed is to increase the advance. A contributory cause of keeping down the tactical diameter at high speed is that the ship heels outwards during the turn, and this immerses more water on the outer bow, which increases the rate of turning. If the inner screw is reversed on putting the rudder over the effect will be to reduce the tactical diameter, but also to increase the length of time taken to turn.—*Captain C. J. Wynne-Edwards, D.S.C., R.N.; The Journal of the Institute of Navigation, April 1956; Vol. 9, pp. 198-220.*

Air-sea Rescue Launch

Trials were recently carried out in the Holy Lock of the air-sea rescue launch *Naomh Lua,* built for the Government of Eire by Alexander Robertson and Sons (Yachtbuilders), Ltd., Sandbank. The launch, which is intended for service at Shannon Airport, will be housed on a slipway from which she can be launched quickly in an emergency. Before construction commenced, tank tests for resistance and propulsion were carried out by the Ship Division, National Physical Laboratory, Teddington, to secure the maximum efficiency. The principal particulars are:—

Length overall	45ft. 6in.
Breadth	12ft. 0in.
Depth	5ft. 0in.
Draught (extreme)	3ft. 0in.
Speed on trials, knots	11

Planking is of selected double-skin mahogany, the frames of American elm, the keel and stern of teak (the latter laminated) and the longitudinal members mainly of mahogany. Buoyancy tanks are fitted in the wings of the principal compartments. Propelling machinery consists of two Thornycroft Diesel engines, each developing 125 h.p. at 1,600 r.p.m. The engines are fresh water cooled and fitted with electric starters. Large capacity batteries and dynamos are provided for each engine. One of the engines drives a bilge pump and, in addition, there is a Whale hand pump to each compartment. Control of the engines is effected by means of a telegraph-type transmitter mounted alongside the helmsman's position. The instrument panel is arranged on the bulkhead beside the engine room entrance. The propellers work in tunnels as in the R.N.L.I. lifeboats.—*Shipbuilding and Shipping Record, 3rd May 1956; Vol. 87, pp. 311-312.*



General arrangement of the air/sea rescue launch Naomh Lua

New Cargo Liner for Far Eastern Service

The first of two similar cargo liners ordered for the Far Eastern service of the Peninsular and Oriental Steam Navigation Company has been handed over to her owners. This vessel, the *Salsette,* 11,300 tons d.w., has been built at the Clydebank yard of John Brown and Sons (Clydebank), Ltd., where the second vessel, the *Salmara,* is now fitting out. The *Salsette* is propelled by a Brown-Doxford Diesel engine driving a single screw. Her design includes a number of novel features: among these are folding hatch covers, bipod masts, glass fibre lifeboats and glass fibre sounding pipes in the water tanks. The *Salsette* is fitted with the Cargocaire ventilation system in the cargo holds, and has four tanks arranged for the carriage of palm or other vegetable oils. The principal particulars of this vessel are as follows:—

Length o.a.	498ft. 3in.
Length b.p.	470ft. 0in.
Breadth moulded...	64ft. 6in.
Depth moulded	42ft. 0in.
Draught loaded	28ft. 9½in.
Deadweight, tons...	11,300
Gross tonnage	8,400
Service speed, knots	15½
Machinery output, s.h.p. ...	8,000

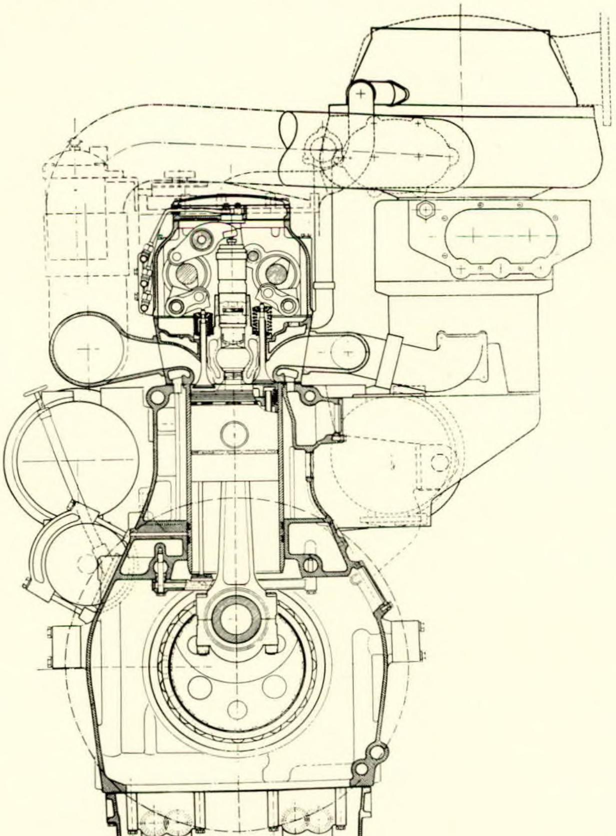
The construction of the cargo oil tanks is somewhat unusual, in that the framing has been arranged so that all stiffeners are on the outside of the tank walls, leaving the inside entirely clear for easy cleaning. Even the deck above the tanks has its construction reversed, with the deck beams above the deck plating. Cofferdams are fitted all round the tanks. These allow different tanks to be kept at different temperatures, and also make inspection of the tanks easy when they are under test. One of the four tanks has been treated by the Jenolite process. The scale was removed with the Jenolite rust remover and the tank then sealed with a chemical sealer. The main engine in the *Salsette* is a six-cylinder Brown-Doxford heavy oil engine developing 8,000 b.h.p. at 110 r.p.m. The cylinders are of the 750-mm. size with a combined stroke of 2,500 mm., and the engine is the largest yet built by the shipbuilders.—*The Shipping World, 11th July 1956; Vol. 135, pp. 32-34.*

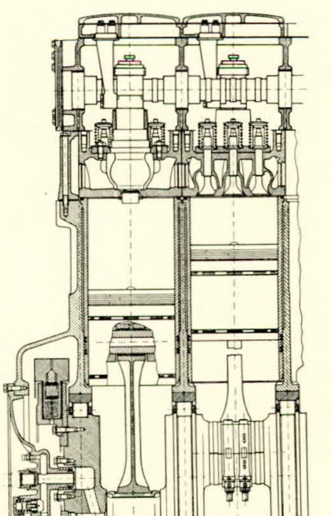
St. Lawrence River Canals Vessel

This paper presents the growth and development of an outstanding Canadian vessel type, the Saint Lawrence River Canals vessel, or "Canaller". The Canaller is a tailor-made vessel specifically designed to meet the severe limitations of the physical features of the canal system and its specialized trades. Descriptions, photographs, and drawings of the various types of ships which have plied the canals are given, together with an analysis of the design and constructional features of representative ships at present in service. A tabulation of existing owners, fleets, and vessel particulars is also given. The paper traces the history of the earlier canals and the vessels associated with them, from the first effort made by the Sulpician Brothers in 1700 to bypass the Lachine Rapids, to the present system now on the eve of being superseded by the St. Lawrence Seaway. The future of the large number of canal vessels which will be in service when the Seaway is opened is also discussed.—*Paper by J. Gilmore, read at the Spring Meeting of The Society of Naval Architects and Marine Engineers on 3rd May 1956.*

German High-speed Diesel

The main design details of the Maybach MD engine can be seen from Figs. 1 and 2, and the following features are particularly noteworthy. Seven roller main bearings are used to carry the crankshaft, the shaft itself being designed as a so-called disc-webbed crankshaft where the discs form the inner races for the roller main bearings. Individual cylinder heads are provided for each cylinder and no less than six valves are disposed around a central combustion chamber. Divided type oil-cooled pistons are used, the piston being made up of a





FIGS. 1 *and* 2—*Transverse and longitudinal arrangement drawings of the Maybach engine*

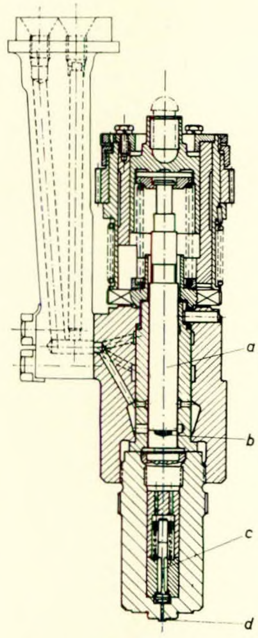


FIG. 3—*Sectional view of a Maybach-L'Orange unit injector. The pump and single hole nozzle are combined in one body dispensing with pressure lines. Pintle valve "c" replaces the otherwise customary jet needle*

(*a*) Plunger; (*b*) Suction valve; (*c*) Pintle valve: (*d*) Single-hole nozzle, 1·4 mm. diameter

steel crown fastened by six screws to a cast iron body. The three compression rings are carried in the steel crown. An unusual feature is the use of two overhead camshafts, one for the inlet and one for the outlet valve operation. Automatic hydraulic adjustment is provided for the valve mechanism which completely eliminates valve backlash. Unit type Maybach-L'Orange injection equipment (Fig. 3) is arranged in the middle of the cylinder head and combines, in a single unit, the pump and the injection valve. In the past, some considerable doubts have been expressed as to the suitability of high-speed highly rated Diesel engines for marine main propulsion service, and being convinced that these units would constitute a desirable step forward in marine propulsion practice, the Federal Minister of Communications in Western Germany, with the co-operation of the Minister of the Interior, arranged for a series of tests to be carried out in various ships. A number of high-speed Diesel engines were subjected to tests as main propulsion units, including units built by Maybach, Daimler-Benz and Henschel-Pielstick, all of which have been developed since the end of the second World War.—*Gas and Oil Power, May 1956; Vol. 51, pp. 116-119.*

Non-ferrous Metal Research

The thirty-sixth annual report of the British Non-ferrous Metals Research Association contains a review of the research programme carried out in 1955. In respect of the mechanical properties of non-ferrous alloys, the report states that the accelerated progressive loading "fatigue" test earlier developed gives results which correlate with those of long time tests sufficiently well to justify its use as a preliminary exploratory test. It has also been used to study notch sensitivity in certain light alloys, and although the results have not yet been compared in detail with those of conventional tests on notched specimens, there are strong indications that the accelerated test provides useful information in such studies, with notable saving in time and material. Titanium alloys have also been under investigation and a range of alloys with promising properties at elevated temperatures has been developed. These are now being examined in materials produced on a larger scale. The continued study of condenser tube materials in polluted waters has thrown light on the factors affecting the susceptibility of certain materials to intercrystalline attack. The order of corrosion resistance of available materials in waters artificially polluted to increasing degrees is consistent with earlier findings using naturally polluted waters, and this correlation, states the report, confirms that the conditions encountered in practice are being experimentally reproduced. In badly polluted waters none of the existing materials is sufficiently resistant, and a programme with a variety of other materials is planned. The study of the resistance of various copper alloys to the products of combustion of gas turbines at temperatures of the order of 500 deg. C. has been terminated, as while certain of the copper alloys are in many conditions rather more resistant to attack than mild steel, the same is not true under other conditions, and it is doubtful whether the higher cost of the copper alloys would justify their use as materials for heat exchangers. Small scale field tests on aluminium alloys with anodic claddings have continued, and larger scale trials of such materials are under consideration. A limited amount of laboratory work has also been done to throw more light on the mechanism of pitting corrosion in supply waters and of the influence of trace constituents in the water on the incidence of this type of attack. Field tests have been put in hand to assess the protective value of sprayed coatings on certain aluminium alloys and the results up to now are extremely promising. An extensive programme was begun to study the stress-corrosion cracking of high strength alloys of the aluminium-zinc-magnesium-copper type. There were some doubts at the outset whether corrosion in fact played a part in the failure of these materials under sustained stresses at room temperature, but the experimental work so far leaves no doubt that an active environment is essential.—*The Shipping World, 4th July 1956; Vol. 135, p. 19.*

Habitability in the Ships of the Royal Canadian Navy

The paper touches briefly on the factors leading up to the decision to revise completely the habitability arrangements in the ships of the Royal Canadian Navy. It then offers a description of these features as they are today, referring in particular to the change from hammocks to bunks, and from the old British system of feeding to cafeteria and dining halls. A description is given of the principal items of furniture provided in the ship and of the methods used to fit them. Plans are included of galley, washroom, dining hall and mess deck and cabin layouts. An outline is given of the system of ventilation and air conditioning, and remarks are offered indicating means which may be available for the extraction of excess heat. A brief description of the heating system calls attention to the need for care in the fitting of vapour seals to insulation. Improvements to habitability can be made by rearrangements of existing spaces, but many improvements can only be effected if more space, weight, and equipments are provided. The paper shows that the effect of these increases in the ship overall is not large, certainly not prohibitive. The paper recommends that consideration be given to "stylizing" not only the actual crew berthing spaces, but the arrangement of, and allocation of space for, accommodation spaces generally.—*Paper by R. Baker, read at the Spring Meeting of The Society of Naval Architects and Marine Engineers on 3rd May 1956.*

Vibration Measurement of 32,000-ton Tanker

This report describes the results of vibration measurements carried out on a 32,000-ton d.w. Japanese-built supertanker during trial runs. The natural frequencies from the fundamental mode to nine-node, six-node, and five-node modes in vertical, horizontal, and torsional vibrations respectively were clearly recorded using four Geiger vibrographs and one specially-designed rotational vibrograph for measuring the torsional angles. Throughout the trials, no objectionable vibration was discovered, except when going astern. It was found that the higher modes of flexural vibration were in resonance with the blade frequency, but the fundamental mode was independent of propeller revolutions. The largest amplitudes were observed in two-noded horizontal vibration, seven-noded vertical vibration, and four- and five-noded vertical and horizontal vibrations respectively when going astern. All the critical frequencies of both the flexural and torsional vibrations were almost proportional to the number of nodes in the respective types of vibration. From this it is concluded that the higher modes of flexural vibrations are shearing vibrations, and that one of the reasons for the serious vibration of the stern of the ship when going astern is insufficient shear rigidity. It is considered that the primary cause of these vibrations is the hydrodynamic periodic forces induced on the surface of the hull by the propeller.—*T. Okabe, K. Hirata, and T. Kumai; Report of Research Institute for Applied Mechanics, Kyushu University, No. 13, 1955; Vol. 4, p. 13.*

Swing Indicator

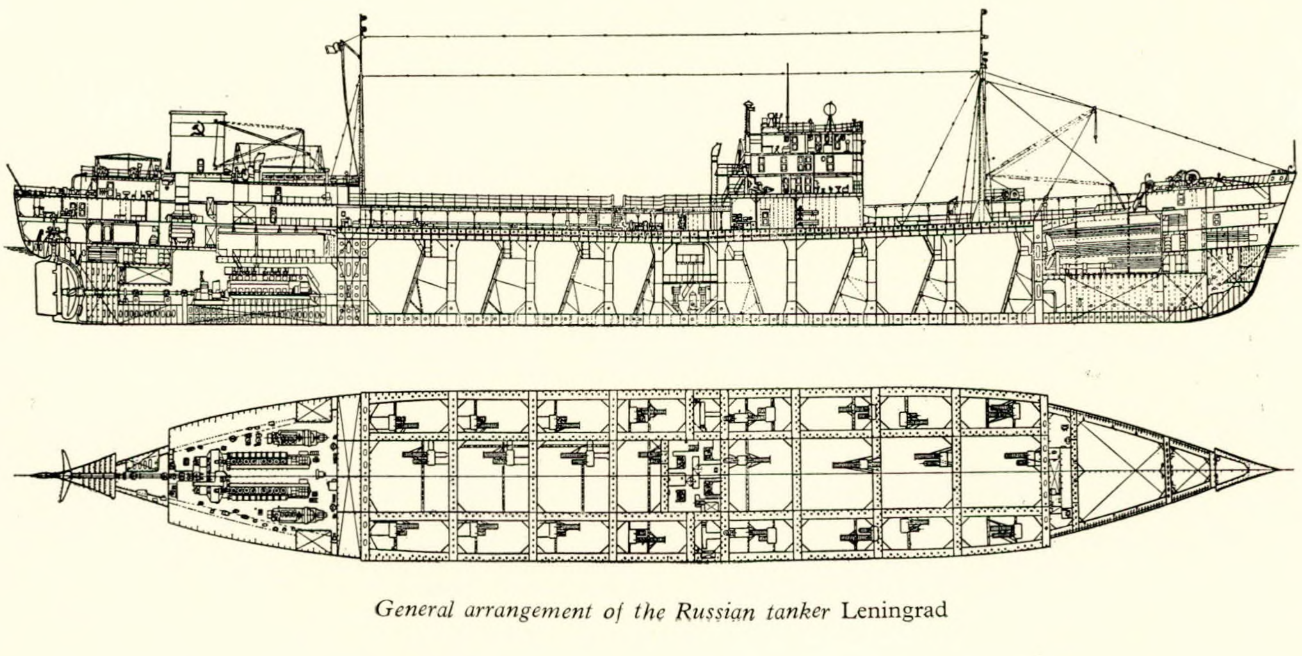
The newest navigation aid for inland waterways tug and towboat use is the Rate of Swing Indicator manufactured by Decca Radar, Inc. Essentially, the instrument consists of three small basic components, one of which is the indicating unit in the pilot house. This unit is frequently mounted next to the radar set but is so small and unobtrusive that it can be situated anywhere in the pilot house. It must be mounted horizontally, however, because the heart of the instrument is a sensitive gyro motor, this turning at extra high speed and resting in a cradle. When the gyro's axis is altered by even the boat's slightest turn from course, the swinging of the boat and tow tips a needle geared to the cradle and the needle records the rate of swing in degrees per minute. The indicator acts as a sort of co-pilot. It catches the swing of the tow far in advance of radar and, as the tow swings the indicator needle instantly marks the speed and direction of the swing. As the pilot corrects for swing, the needle simultaneously indicates the effect on the tow until, once the tow is righted to a straight course, the needle returns to zero. Other benefits of the Rate of Swing Indicator are that it (1) enables the pilot to maintain an absolutely straight course at night or in heavy fog, snow or rain—once he has located his bearing point on radar; (2) indicates continuously and smoothly, not by steps or fractions of dgrees, with the needle fluctuation varying according to the variation in speed of swing; and (3) eliminates over-correction with rudders.—*Motorship (New York), April 1956; Vol. 41, pp. 24-25.*

Oil-ore Carrier

The *Sinclair Petrolore* is the world's largest combination oil-ore carrier. The 56,500-ton vessel is 789ft. long, has a beam of 106ft., a draught of just over 40ft., and a cargo capacity of 447,600 b.b.l., of which 44,230 b.b.l. are bunker oil for the running of the vessel. Thus the *Sinclair Petrolore* has a net cargo capacity of 403,000 b.b.l., which can be pumped at the rate of 29,600 b.b.l. per hr. The *Sinclair Petrolore* is designed to carry ore on its return trips. There are sixty-five compartments in the vessel, all of which are used to carry petroleum products but only twenty-six of the centre line cargo holds are used for ore cargo. The ore carrying capacity of the vessel is 67,300 tons. For discharging the load, a unique conveyor belt has been designed. Running under the core carrying compartment is a 60-ft. wide conveyor belt, 485ft. long. With a speed of 600ft. per min., the vessel can unload its ore at the rate of 4,000 long tons per hour. The self-unloader boom is 205ft. long, and is carried on deck when not in use. Built in Japan by Welding Shipyards Division of National Bulk Carriers, Inc., the vessel is equipped with steam generators of Foster Wheeler design and manufacture. Each of the two D-type steam generators evaporates 68,000lb. of steam per hr. at 555lb. per sq. in. and 835 deg. F. at the superheater outlet at normal operation. At maximum load, the evaporation is 90,000lb. per hr. Economizers of the extended surface type raise feedwater temperature from 240 deg. F. to 330 deg. F.—*Heat Engineering, March/April 1956; p. 146.*

Russian Geared Motor Tanker

The single-screw tankers of the Leningrad type are destined for oil transport between all Russian harbours. The overall length is 145·5 m., the length between perpendiculars is 138 m., the breadth is 19·2 m., and the moulded breadth is 10·4 m. The full load draught is 8·5 m., when the coefficient of displacement is 0·704 and the metacentric height is 1·48 to 1·45 m. The trial speed is 13·3 knots and the radius of action is 10,000 miles. The hull is welded throughout with the exception of the bilge strake seams and is strengthened for navigation in broken ice, carbon steel ST-45 being used for plates up to 15 mm. thickness, whilst low alloy plate SHL-1 steel is employed for plates in excess of 15 mm. The hull is divided by sixteen transverse and two longitudinal bulkheads into



General arrangement of the Russian tanker Leningrad thirty-three compartments, which include twenty-four cargo tanks and two cofferdams. A dry cargo hold and deep tank are arranged forward and the pump room provided amidships permits the simultaneous carriage of two types of fuel. The steering gear consists of a single streamlined rudder with a total area of 17·5 sq. m., operated by an electro-hydraulic gear developing a torque of 21 t.m. at the rudder head. The main machinery consists of a pair of two-stroke Russki Diesel engines. Each develops 2,000 h.p. at 250 r.p.m. The power is transmitted to the single screw via hydraulic couplings and 2·912 to 1 reduction gear. The ship auxiliary services are supplied by two two-stroke engines each developing 400 h.p. at 300 r.p.m. and driving alternators. Steam for cargo pumps and cargo heating is supplied by two watertube boilers having an evaporative capacity of 8 tons of steam per hour at 220lb. per sq. in. pressure.—*The Marine Engineer and Naval Architect, May 1956; Vol. 79, pp. 162-163.*

Stress Analyser for Use on Board Ship

In this article a brief description is given of a special stress analyser, built for the Shipbuilding Department of the Technological University at Delft, Holland. The strains are measured by means of strain gauges, forming a complete Wheatstone bridge. The output of this bridge is supplied to the analyser, and in this instrument the amplitude and level of the stress-cycles are registered by means of a number of counters. The strain range is divided into nine levels, and this leads to forty-five counters. With the help of these counters every possible combination of amplitude and level within the range of the instrument may be registered. The analyser is designed to give information about the occurrence of various phenomena on board ship during a chosen period. In the first place it is the intention to investigate in which way stresses vary in ships' parts over a longer period, but it is also possible to measure roll and pitch angle, accelerations, etc. It will be clear that data about the variation of stresses are extremely useful to the designer, as there is still a lack of information about the load to which a ship is subjected during its life. The first attempts to get an idea of stress variation on board ship were made by means of continuous records of the stresses, but the analysis of the curves obtained is so laborious that it is practically impossible to get the desired information over a period of more that a few days. The stress analyser is designed to give this information immediately on a certain number of counters, as already mentioned.—*C. J. D. M. Verhagen and J. C. De Does, International Shipbuilding Progress, May 1956; Vol. 3, pp. 285-289.*

Improving Heat Transfer in Tubular Heat Exchangers

A new method has been devised for improving the convection efficiency in tubular heat exchangers. It also permits controlled variation of the efficiency along the length of the tube, in order to obtain isothermal or any other desired temperature conditions. These advantages are obtained by means of a wire bent into a repeated sine curve, which is coiled around the outside of the exchanger tube in such a way that it touches the surface at every point. This wire sets up within the boundary layer a turbulence favouring heat transfer. Experimental work with tubes and wires of various dimensions is described, and the results are illustrated by curves giving the mean convection coefficient for different air flow velocities. Both radial and axial air flow conditions are considered, and tests were carried out on tube systems as well as on individual tubes. An exchanger of 220 tubes fitted with these wires was found to give the same performance as a 385-tube exchanger which was not so fitted. The improvement in convection efficiency is accompanied by an increased pressure drop in the fluid circulating outside the tubes, but for most applications the increase is not prohibitive. Various ways of fixing the wire on the tube have been tried. In many cases the elasticity of the wire suffices. But if, for example, periodic cleaning is necessary, a coating known as Plastamique may be used, provided the temperature is always below 390 deg. F. For higher temperatures metallization (e.g. with stainless steel) is to be preferred. The process is not limited to tubes of circular section, but may be applied to tubes of any shape. Tubes to which a turbulence wire has been attached may subsequently be flattened. The basic principle of the method (turbulence promotion by means of attached wires) may in fact be applied to any surface at which it is desired to promote heat transfer.—*E. Fournel, Chaleur et Industrie, 1956; Vol. 37, p. 53. Journal, The British Shipbuilding Research Association, June 1956; Vol. 11, Abstract No. 11,742.*

Shipboard Use of 400-cycle Electric Power

The use of higher frequency electric plants, such as 400-cycle plants, offers certain advantages which are very attractive, particularly in installations where weight and space requirements are of importance. An increase in system frequency increases maximum speed of rotation, thereby decreasing the weight of rotating electric machinery. In addition, high frequency transformers and reactors require a lower value of maximum flux, and hence a smaller iron core. As is the case in most efforts to advance, there are other factors to consider which partially offset the advantages. Inherent characteristics of small, lightweight high frequency equipment require that special consideration be given in the equipment design to noise reduction, higher operating temperatures, and mechanical problems that arise with the higher rotational speeds and smaller air gaps. The smaller heat dissipation surface requires that more consideration be given to ventilation and equipment protective features to prevent burn-out. Also, the advantages offered by the use of a higher frequency in marine applications have to be great enough to compensate for the high costs associated with the development, design, and manufacture of electric equipment for a 400-cycle frequency. Realizing the advances that could be achieved by a complete investigation of such items as increased electric plant frequency, the U.S. Navy decided to build a destroyer of advanced design in which the maximum number of new design components and systems would be incorporated. This ship is the U.S.S. *Timmerman,* formerly the DD828, and now the EAG152. A 1,000-volt 400-cycle electric plant was selected. The decision to use 1,000 volts and 400 cycles in the EAG152 took into account the fact that the design is not a prototype but an experimental advanced design offering an opportunity to explore the advantages of higher voltage and higher frequency electric plants. The electric generating plant consists of two 600-kW synchronous turbogenerators. One unit is driven by a 2,000-lb. per sq. in., 1,050-deg. F. turbine of the package unit design, direct-coupled, turning at 12,000 r.p.m. and having a rotary exciter. In addition to these there are two 1,000-volt 400-cycle 3-phase emergency generators. The forward unit is driven by a gas turbine while the after unit is driven by a Diesel engine. All pumps and other auxiliary machinery, with the exception of turbine driven feed pump and main forced draught blowers, are driven by 950-volt 400-cycle motors. These high-speed motors utilized silicone insulation, which is inherently resistant to moisture and can be operated at higher temperatures. —*J. M. Apple and E. W. Lusby, Applications and Industry, No. 24, May 1956; pp. 116-124.*

Turning Circles

An article published in the Ships' Bulletin describes tests on the T-2 tanker *Esso Paterson* and the supertanker *Esso Lima* in which turning circles were measured at various speeds, in both ballast and loaded condition. In theory, the rudder angle for a minimum turning circle is 45 degrees; but it is found in practice that the use of more than 36 degrees of rudder increases the diameter of the circle, and acts as a drag to slow down the vessel. An analysis of the measurements made on the *Esso Paterson* and the *Esso Lima* during the eighteen tests that were undertaken substantiated previous experimental data. It was found that the speed at which a vessel makes a turn has little effect on the diameter of the circle, although it does have a bearing on the time required to complete the circle. In both ships the circle diameters showed little variation with changes in speed, but the times consumed making the turns varied considerably. The average speed at which each turn was completed revealed that, regardless of the revolutions, the percentage reduction in speed of both vessels was surprisingly consistent. Both sets of results indicated that on an overall basis the reduction in speed amounted to approximately 34 per cent. It may be inferred from the results of the tests that in order to avoid a stationary object dead ahead, putting the rudder hard over would probably prove ineffectual unless the distance was greater than three ship lengths. Further, if two similar vessels were approaching head on, on reciprocal courses and at comparable speeds, their helms would have to be put hard over in the same relative direction, i.e. both to port or both to starboard, at least six ship lengths apart in order to avoid collision.—*Journal, The British Shipbuilding Research Association, May 1956; Vol. 11, Abstract No. 11,566.*

Passenger Liner ***Bergensfjord***

Technically, one of the notable features of the *Bergensfjord* is that alternating current electricity supply is utilized throughout the ship, which is the first British-built passenger vessel to be so equipped. The generating plant totals 4,160 kVA and is the largest Diesel auxiliary installation in a ship. The main characteristics of the ship are:—

Length overall		577ft. 0in.
Breadth moulded		72ft. 0in.
Depth moulded to main deck ...		38ft. 6in.
Draught		27ft. 6in.
Gross register, tons, about ...		18,750
Displacement, tons, about ...		17,500
Cargo carrying capacity, tons ...		1,200
Cargo hold capacity, cu. ft. ...		100,000
Passengers:		
First class	100	
Tourist class... ...	775	
		875
Number of crew		335
Machinery, b.h.p.		18,400
Normal service speed, knots ...		20
Trial trip speed, knots		22·1

The *Bergensfjord* was built to comply with the requirements for the highest class 1A1 of Norske Veritas, to the rules of the Norwegian Board of Sea Control and in accordance with those of the International Convention of 1948. With the exception of the frames and beams which are riveted, and the bolted connexions between the aluminium and steel structures, the vessel is of all-welded construction. Large sections of aluminium were prefabricated before lifting on board to form the all welded aluminium structure. The deckhouse on the promenade deck, and the deck and deckhouses above, are all of welded aluminium alloy, some 315 tons of the alloy B54S having been supplied by the Nordiske Aluminiumindustri, to the requirements of Det Norske Veritas, these corresponding to the specifications of Lloyd's Register of Shipping. The ship is fitted with Denny-Brown stabilizers which, although they do not entirely eliminate the rolling of a ship, do reduce the rolling by an appreciable extent, to the point that the remaining movement is not objectionable. To stabilize the ship when it is in motion the fins are rotated through a moderate angle synchronously and in opposite senses. It is of primary importance that the oscillation of the fins should be effected rapidly to counteract the roll and, as in the *Bergensfjord,* the time of the double roll should not exceed twenty seconds. The time allowed, therefore, for complete reversal of the angle of the fins, is about 1¾ seconds, during which period each fin may have passed through an angle of 40 degrees. Rapid oscillation of the fins is achieved by a gear consisting of two electrically driven variable delivery pumps which operate the hydraulic rams oscillating the fins. Two small gyroscopes are installed, one reacting to any departure of the ship from the upright position while the other reacts to the angular velocity of the rolling motion. These reactions are combined electrically and operate a small piston valve which is the first step in a series of hydraulic servo mechanisms leading finally to the main variable delivery pumps. The main technical particulars of the stabilizing gear are:—

Fins	
Outreach	9ft. 6in.
Fore and aft width	4ft. 9in.
Area of one fin	45 sq. ft.
Working angle, degrees aside of midship	20
Load on one fin at 20 degrees angle and 20 knots, tons ...	39
Righting moment on ship, tons/ft.	3,120
Power Units	
Main power unit electric motor, b.h.p....	50
Servo power unit electric motor, b.h.p....	10
Weight of stabilizer, tons ...	62

The main double acting Stork propelling machinery is, generally, similar to that of the *Oslofjord,* except that the engines have eight cylinders instead of seven, with a bore of 720 mm. and a piston stroke of 1,100 mm. The output of each engine is 9,200 b.h.p., developed at 128 r.p.m. with a corresponding b.m.e.p. of 4·7 kg. per sq. cm. (67lb. per sq. in.) and a mean piston speed of 4·7 m. per sec. (920ft. per min.). Scavenging air is applied by four blowers driven by electric motors, this resulting in a high mechanical efficiency—87 per cent—with a mean indicated pressure of 5·67 kg. per sq. cm. (80lb. per sq. in.) which is normal for Stork engines of this class. Each blower can supply sufficient air to operate both engines at three-quarter load and as they will normally operate under these conditions the full service speed can be maintained even if one blower were out of action. On shop tests the fuel consumption was 154 gr. per b.h.p./hr (0·34lb.) to which, of course, must be added the equivalent consumption of the motors driving the blowers, bringing the consumption up to 170 gr. per b.h.p./hr. or 0·374lb. The power supply is at 440 volts, three-phase, 60 cycles, and distribution is by an earthed neutral system with an earthing resistance which prevents the earth fault current exceeding about 500 amp. The four main generating sets each comprises a 1,040-kW 450-volt alternator direct coupled to a Ruston eight-cylinder pressure-charged Diesel engine with Napier exhaust gas turboblowers. Each engine develops 1,500 b.h.p. at 360 r.p.m. The cylinder diameter is 15 inches and the piston stroke 20 inches.—*The Motor Ship, June 1956; Vol. 37, pp. 76-89.*

Japanese Diesel Engine

The Mitsubishi Nagasaki type 9 Diesel engine which was installed in the *Sanuki Maru* is of the uniflow scavenging two-stroke, single-acting crosshead type fitted with exhaust gas driven turbochargers. There are two models of this engine, one with a cylinder diameter of 750 mm. and 1,500 mm. stroke, and the other with a cylinder diameter of 650 mm. and 1,250 mm. stroke. The former develops 1,250 to 1,333 b.h.p. per cylinder at 115 to 120 r.p.m., and the latter 850 to 925 b.h.p. at 125 to 135 r.p.m. Both engines have from six to twelve cylinders in groups of three or four, and are capable of developing the maximum horsepower with twelve cylinders up to 16,000 b.h.p. in the UEC former and 9,250 b.h.p. in the latter model. The *Sanuki Maru* was the first vessel to be fitted with the type 9 engine. The second engine, a model 6 engine of 8,500 b.h.p. was installed in the *Kohchu Maru,* 9,197 tons gross. Both vessels are now in regular service. In addition, two other type 9 engines of 12,000 b.h.p. have been constructed. One was installed in a sister ship to the *Sanuki Maru,* and the other is to be installed in the *Ryuei Maru,* a tanker of 32,800 tons d.w. now under construction. The turbocharg-

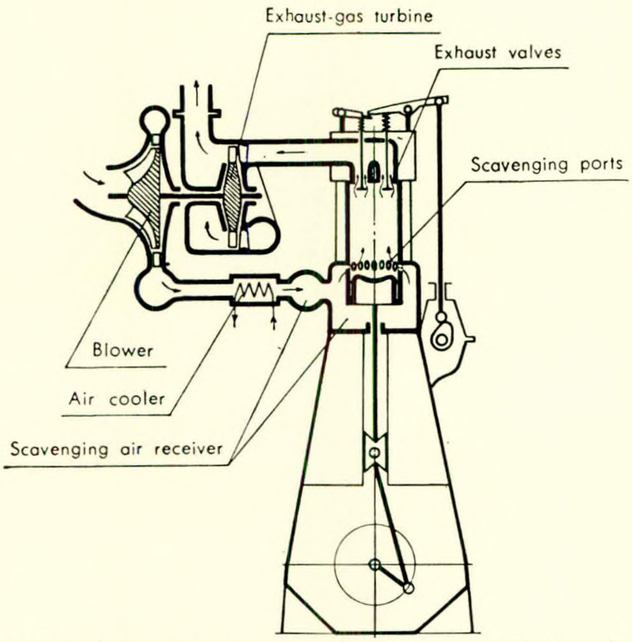


FIG. 1—*Scavenging arrangement of UEC type Diesel engine*

ing system is shown in Fig. 1. Exhaust gas is led to the gas turbines which are directly coupled to the blowers; air being delivered to the cylinders after first passing through air coolers, a scavenging air receiver and scavenging ports provided at the lower part of the cylinder liner. As a result of extensive research and experimental work the following novel features are claimed for the design: the scavenging system, the arrangement of the exhaust valves, the design of the turbocharger and the fuel injection system. The production of the UEC type engine has made it possible to build an economical vessel of high speed. A notable feature of the new engine is its light weight and the small space that it occupies compared with a conventional non-turbocharged engine of similar horsepower. It is at least 30 per cent lighter in weight. In addition, the main engine auxiliary equipment is of a lower capacity, thereby reducing the weight and the space required in the engine room. Compared with conventional Diesel engines the fuel consumption is remarkably low, namely from 8 to 12 gr. per s.h.p. per hr. less.—*The Shipping World, 4th July 1956; Vol. 135, pp. 15-16.*

Corrosion Resistance of Aluminium Alloys

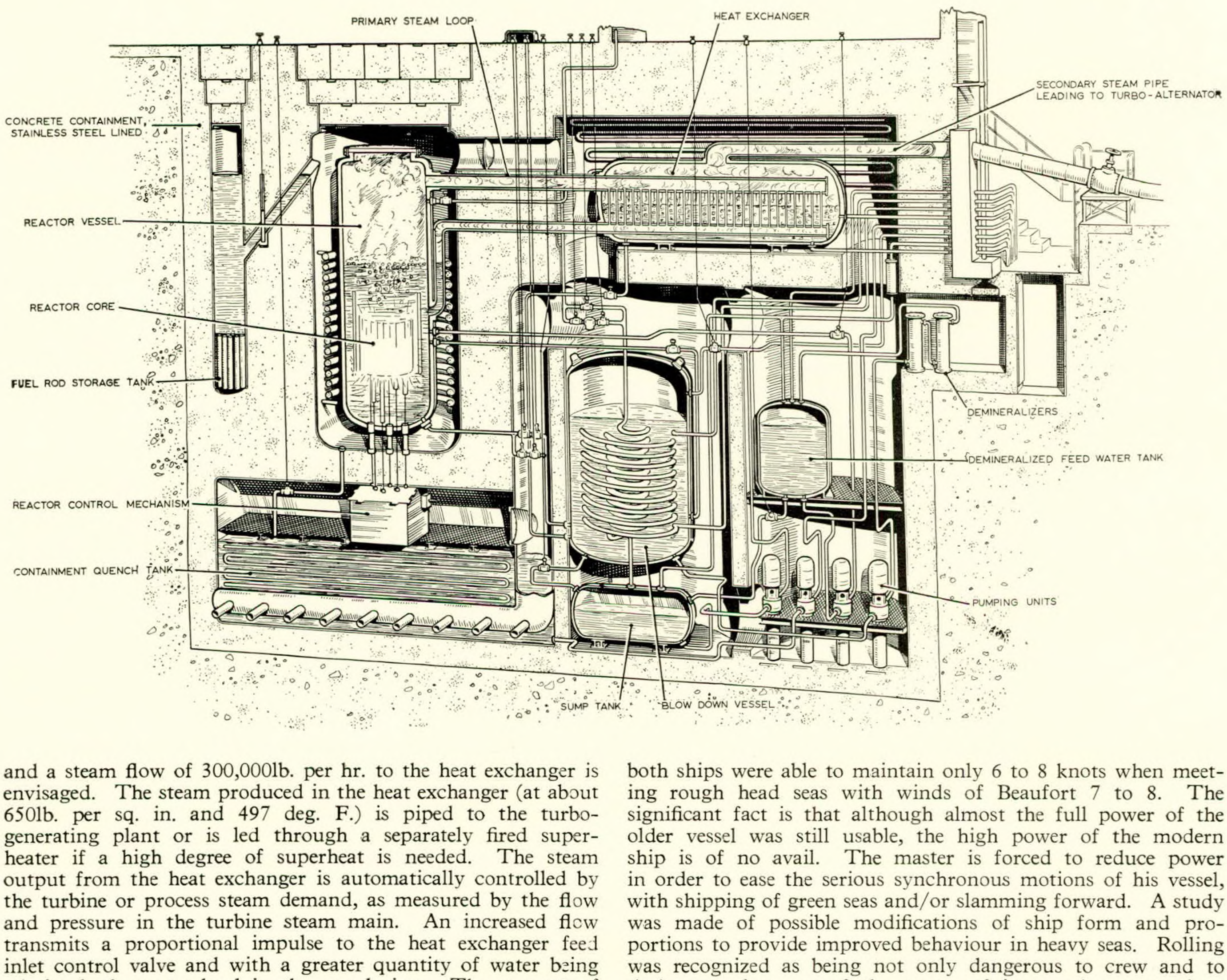
It has been found by experiment that some aluminium alloys can resist corrosion for at least twenty years. The alloys studied included those which can be hardened by heat treatment, and those not susceptible to such treatment. Specimens were exposed at Washington, D.C., Norfolk, Virginia, and the Panama Canal Zone. The latter constituted a tropical marine atmosphere, whereas Washington and Norfolk were temperate inland and marine locations. All the marine specimens were exposed near the shoreline, where they were occasionally wetted by spray. The samples were removed at intervals from the racks, beginning three months after the start of the test, and were subjected to tensile tests. Improperly heat-treated aluminium-copper alloys failed by intergranular corrosion and severe exfoliation with no measurable elongation after exposure, while those properly heat-treated performed satisfactorily. But alloy 2017, when clad with a thin, low strength alloy, resisted corrosion very well even if incorrectly heat-treated. The alloys 3004-H34, 5050-H34, and 5254-H34 showed excellent resistance to corrosion, as did an alloy containing cadmium, but alloys containing both magnesium and silicon showed evidence of intergranular attack. Spot welded specimens of 3004-H34, clad 2017-T4, and clad 2024-T36 showed no decrease in breaking strength after 1,044 weeks in a marine atmosphere or 1,140 weeks in an urban atmosphere. When tested, these specimens ultimately sheared through the welds, or the nuggets pulled out of one of the pieces of metal. Similarly, there was no decrease in the breaking strength of clad 2017-T31 joined with 2017-T31 alloy rivets or of aluminium-magnesium 5254-H34 joined with 3004-H32 rivets after the same periods of time. But rivets made of X5056-H32, an alloy containing about twice as much magnesium as 5054, were attached intergranularly, and the heads fell off during the exposure tests. One of the protective coatings studied was a paint consisting of a long-oil ester gum varnish combined with aluminium powder. When applied over the various oxide coatings, this paint increased protection considerably in most cases. Two coats of varnish and aluminium powder applied over a zinc chromate pigmented primer gave complete protection to the bare alloy 2017 for over twenty years. The elongation of 2017 clad alloy, even when not painted, was not changed by exposure for twenty years. The copper-free alloys, such as 3004 and 5254, which were found to be highly resistant to corrosion, are in wide use.—*Journal, The British Shipbuilding Research Association, May 1956; Vol. 11, Abstract No. 11,659.*

Vosper Roll Damping Fins

An essential quality of roll damping equipment for small craft is simplicity combined with compactness. There is usually little unoccupied space going begging inside the hull. Simplicity demands non-retractable fins, thus eliminating complex withdrawing mechanism and the need for housing space in the ship. But non-retractable fins have to be limited in aspect ratio if they are not to extend beyond the hull's maximum beam and draught. The aspect ratio of the Vosper fins is 0·7, while that of retractable fins may exceed 2·0. Simplicity also militates against split-flap fins, having an independently moving tail that takes up a greater angle of incidence than the main fin. Such were tried in the early Vosper experiments. It is an arrangement that may give double the coefficient of lift of a solid fin. Yet the losses in theoretical efficiency imposed by the need for simplicity do not, in practice, seem to impair the effectiveness of these roll damping fins. This is evident from the rolling record, and may be attributed in part to the rapid, initial movements of the fins, which allows the generation of brief but considerable lift in the early stages of a roll. The whole of the internal equipment of the Vosper roll damping installation may be placed, without severe demands on space, in the engine room. The gyro unit in the trial vessel is on the centreline close to the engine room's forward bulkhead. This transmits, by the action of precession, a signal proportional to the velocity of roll. Hydraulic pressure in the gyro unit actuates a lever to which are connected the control rods, and these operate the hydraulic valves, with their hydro-boosters working at a pressure of 2,500lb. per sq. in. This pressure actuates the damping fin stocks, the hydraulic pressure being obtained from a pump, belt-driven from one main engine. —*D. Phillips-Birt, Shipbuilding and Shipping Record, 28th June 1956; Vol. 87, pp. 592-593.*

Boiling Water Reactor

A boiling water reactor for use in small land plants has been designed by Mitchell Engineering Co., Ltd., of London and A.M.F. Atomics of New York. In the course of their initial studies gas cooled, liquid metal cooled, pressurized water, and boiling water reactors were investigated, the last named finally being adopted. Most of the fuel elements in the core are of natural uranium in thin plate form and canned in zirconium alloy. The remaining elements which "spike" the core are of a fuel enriched with U 235, which is also canned in zirconium. The use of natural uranium throughout and heavy water as moderator was ruled out because of expense. The reactor control system, comprising ten or eleven rods, a number of which are employed for shut-off and the remainder for fine control, maintains the steam in the reactor vessel and primary loop at a constant pressure. Heat is conveyed from the core by the natural circulation of the steam and water mixture through the uranium fuel elements. A riser pipe is fitted above the core to ensure the required speed of circulation. Steam from the reactor is delivered into the upper part of the reactor vessel, thence through a large pipe to the tubeside elements in the heat exchanger. The water of the secondary non-radioactive water is in contact with the external surface of these elements. The primary loop steam condenses into water and then flows back by gravity to the reactor vessel. The circuit is so designed that a few feet of hydraulic head are sufficient to overcome the frictional resistance of the pipes and heat transfer elements and no pump is needed. Under normal conditions steam in the reactor vessel—conservatively designed to withstand an operating pressure of 1,000lb. per sq. in.—is produced at 534 deg. F. and 900lb. per sq. in. Water circulation in the core corresponds to a flow of 12,000,000lb. per hr. and a steam flow of 300,000lb. per hr. to the heat exchanger is envisaged. The steam produced in the heat exchanger (at about 650lb. per sq. in. and 497 deg. F.) is piped to the turbo-generating plant or is led through a separately fired super-heater if a high degree of superheat is needed. The steam output from the heat exchanger is automatically controlled by the turbine or process steam demand, as measured by the flow and pressure in the turbine steam main. An increased flow transmits a proportional impulse to the heat exchanger feed inlet control valve and with a greater quantity of water being admitted, the water level in the vessel rises. The amount of primary loop surface in contact with the feed water is thereby increased and steam is produced at a proportionately increased rate.—*H. J. Coles, Nuclear Engineering, June 1956; Vol. 1, pp. 123-124.*



Speed of Cargo Ships in Rough Weather

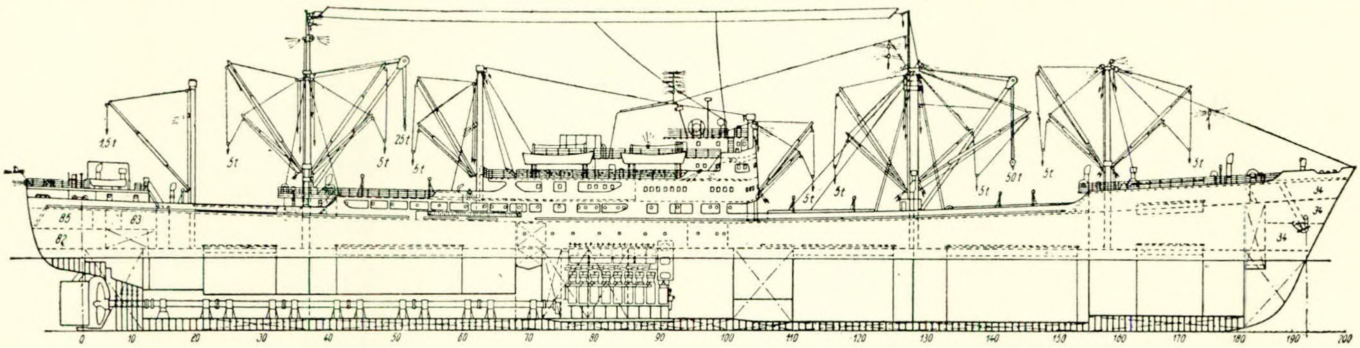
Brief consideration of the development of cargo ships over the past forty years indicates several trends: gradually increasing size from around 400ft. to 500ft. length, more rapidly increasing speeds from 9 or 10 knots to 12, 14, 16, 18 and recently even 20 knots, with corresponding reduction in fullness of form and increasing power from 1,500 to 8,000, 12,000 and even 17,500 s.h.p. The most significant factor was believed to be the increase of design speed, but it was noted that although ship fullness and power have been modified to obtain increasing speed efficiently under trial and good weather conditions, most modern cargo ships are very little better off than their predecessors with respect to maintaining speed in rough head seas. This is strikingly illustrated by comparing a typical moderate size present-day American cargo ship, the Victory (AP-3), with a typical cargo ship of twenty-five or thirty years ago. In good weather the former is capable of 17½ knots fully loaded, using 8,500 shaft horsepower; the latter could make 10 knots with perhaps 1,600 s.h.p. But recent log studies of Victory ships and Kent's 1924 data on a slightly smaller vessel, the old 2,000 i.h.p. tanker *San Tirso,* show that both ships were able to maintain only 6 to 8 knots when meeting rough head seas with winds of Beaufort 7 to 8. The significant fact is that although almost the full power of the older vessel was still usable, the high power of the modern ship is of no avail. The master is forced to reduce power in order to ease the serious synchronous motions of his vessel, with shipping of green seas and/or slamming forward. A study was made of possible modifications of ship form and proportions to provide improved behaviour in heavy seas. Rolling was recognized as being not only dangerous to crew and to deck cargo but one of the causes of increased passage time. Logs frequently show course changes to reduce rolling in heavy weather, and when the change results in head sea conditions, a speed reduction usually follows. An obvious step was the reconsideration of required stability and if possible a reduction in beam to give lower operating metacentric heights. This would lead immediately to a longer period of roll and easier rolling, with reduced transverse accelerations. The installation of fin-type stabilizers, which have proved so successful in a variety of types of ships, also appeared to be a likely possibility. From the point of view of pitching and heaving motions, it was noted that it would be helpful to increase freeboard, to provide ample flare forward, to clean up and strengthen the forecastle deck, to provide more effective break-waters for clearing the deck of water, and to give more attention to the shape of bottom sections forward in order to minimize slamming. It was also realized that increasing V-shape in the sections forward would tend to provide damping of pitching motion, but since it would also have an unfavourable effect on resistance in calm and moderately rough seas, the possibility of a net gain appeared doubtful. In view of the fact that the greatest speed reduction occurs when heading into the seas, it seemed that the factor of greatest importance was the reconsideration of ship proportions, particularly length in relation to size and displacement. The most effective means of minimizing serious synchronous pitching appeared to be the increase of length, with corresponding reduction in beam and draught. Such a trend would have the further advantage of being beneficial in good as well as bad weather, and having a favourable effect on rolling.—*E. V. Lewis, International Shipbuilding Progress, June 1956; Vol. 3, pp. 341-346.*

Polish Cargo Liners

The largest cargo ship hitherto built in Poland, the *Marceli Nowotko,* was launched in November 1955 and will shortly be completed. A sister ship has also been launched. She is named the *Boleslaw Bierut* and it is intended that both ships shall be completed during the course of the year. The details are:—

Deadweight capacity, tons ...	10,800
Length overall	494ft. 8in.
Length b.p.	464ft. 5in.
Breadth moulded...	63ft. 7in.
Draught loaded	27ft. 4in.
Machinery, b.h.p.	8,000
Speed, knots	16

Each is of modern design with three holds forward of the engine room and two aft. An eight-cylinder two-stroke single-acting Fiat engine of 8,000 b.h.p. is installed. The vessels are being built at the Gdansk Shipyard, and it is stated that, in all, fifteen ships similar to the two now building will be constructed. It is understood that plans have been made for the Gdansk yard to build 18,000-ton Diesel engined tankers, also a 9,000-ton fish factory ship.—*The Motor Ship, August 1956; Vol. 37, p. 166.*



Profile of one of the two 10,000-ton Polish motor cargo liners

Cylinder Wear in Marine Diesel Engines

An article published in "Schip en Werf" points out that even though the rate of cylinder wear is increased twice or three-fold when boiler fuel is burnt in Diesel engines, an appreciable saving is possible amounting to some 30 per cent of the fuel bill. Nevertheless, it is desirable to reduce the cylinder wear to a minimum. It has been suggested that this can best be done by improving the quality of the fuel itself, but this would largely defeat its own object, since a higher price would be demanded for a fuel that meets a more stringent specification. There are, however, certain precautions that can be taken when burning normal boiler fuel which will assist in reducing cylinder wear to a minimum; in the main these are designed to ensure that the fuel is properly cleaned. One of the most effective ways of cleaning the fuel is by centrifuging, and this should be carried out at as high a temperature as possible. Tests are described in which the wear that took place when the fuel was passed once through a centrifuge running at its full capacity was compared with that occurring when the fuel was centrifuged three times in a machine not running at full capacity; the reduction in wear in the latter case amounted to some 10 to 20 per cent. To enable heavy fuels to be atomized properly and to obtain perfect combustion, the fuel must be injected at the correct viscosity; this requires that the fuel be heated. Brief mention is made of a continuous recording viscometer which enables continuous observation to be kept on the viscosity of the fuel, and hence on the necessary degree of heating. A description is then given of the development of a new Shell cylinder lubricant known as Shell Alexia oil. A table shows the reduction in cylinder wear obtained in a number of engines of different manufacture when using this lubricant.—*Journal, The British Shipbuilding Research Association, May 1956; Vol. 11, Abstract No. 11,608.*

Problems in Steam Machinery

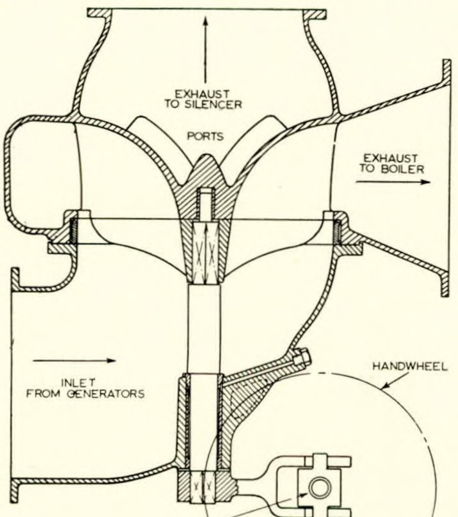
In a paper read at the Third International Congress of Naval Architects at Brussels, H. N. Pemberton gives a review of some of the more serious troubles in modern steam turbine machinery investigated by the Engineering Research Department of Lloyd's Register of Shipping. Differential thermal expansion is probably one of the main factors contributing to damage in steam turbine machinery on ships, particularly when steam temperatures exceed 850 deg. F. Bending of the rotor and distortion of the casing may result from this cause, and the author summarizes the operating conditions that are believed to have led to this type of damage in a number of cases. Piping in a high temperature steam installation presents difficulties because alloy steels must be used to satisfy the requirements of creep resistance and toughness. Such materials, which are not readily weldable, require care in normalizing heat treatment. The author makes some recommendations as to the manufacture, welding, and fitting of high temperature steel piping. There are also sections mentioning frettage in turbine tooth couplings, pitting and erosion of blading and casing, loosening and damage to labyrinth packings, failure of turbine supports due to lack of provision for thermal expansion of the casing, and heavy vibration of the main condenser and distortion to l.p. turbine casing caused by severe transverse vibration of the hull.—*Journal, The British Shipbuilding Research Association, May 1956; Vol. 11, Abstract No. 11,633.*

Notch Ductility of Weld Metal

It is generally recognized that a steel which fractures in the conventional ductile manner under a given set of conditions may fail in a brittle manner under other conditions, particularly if a sharp notch or crack is present. Stresses slightly above yielding are required in the general area of the point of origin in order to initiate brittle fracture from a notch, no matter how sharp. This holds true for all temperatures below the temperature defined as the "nil ductility transition temperature". The conditions for propagation of a brittle fracture are not as severe as conditions for fracture initiation. Below a critical temperature, brittle fractures propagate if a certain minimum stress level is exceeded. With only moderate increase in temperature above this critical temperature the stress required for crack propagation rises rapidly to values approaching the yield strength. This sharp rise is designated the "fracture transition temperature for elastic loading". Above this temperature range, some plastic deformation is associated with the fracture and a temperature soon is reached in which only ductile tearing is observed. This final transition represents a "fracture transition temperature for plastic loading". These three critical transition temperatures, i.e., nil ductility transition, transition for elastic loading and transition for plastic loading, can be determined by any one of several types of notch tests. Comparative values are determined by any one of several types of notch tests. Comparative values as determined by the Charpy V-notch test, the crack-starter explosion test and the drop weight test are discussed. In welded construction, the weld can, and frequently does, influence the fracture behaviour of the structure. To properly evaluate the influence of the weld it is necessary to compare the fracture characteristics of the weld metal with those of the various base metals over a range of temperature and, also, to determine the transition temperature of the welded joint as there are four possible paths along which brittle fracture may propagate. These are the plate, the heat affected zone, the fusion line and the weld metal. Propagation through any given path becomes possible only if the service temperature is below the critical fracture temperature for that zone. The transition temperature of the weld metal can vary with the type of welding electrode. A lower transition temperature in the weld metal than in the plate metal is always desirable. If the transition temperature of the weld metal is appreciably lower than that of the adjoining base metal the weld can, under certain conditions, stop a brittle crack. Transition temperatures determined by notch tests furnish valuable information for design, but as yet these data are qualitative because test data for only a few steels have been correlated with actual service performance.—*W. S. Pellini, The Welding Journal, May 1956; Vol. 35, pp. 217-s - 233-s.*

Exhaust-gas Bypass Valve

When the exhaust gases from Diesel engines are utilized in firing an auxiliary boiler, provision is made for bypassing

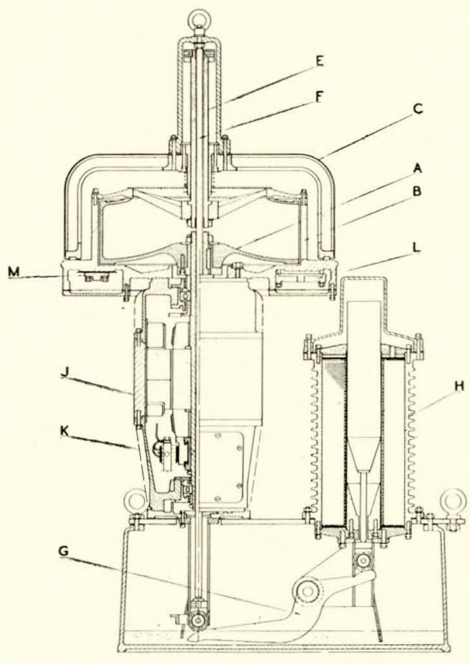


Cockburn exhaust-gas bypass valve

the boiler, thus exhausting straight to the silencer. This often entails the use of a three-way piece and two stop valves. Cockburns, Ltd., of Glasgow, have developed the changeover rotary-slide exhaust-gas bypass valve, shown in the illustration. The material is cast steel and the valve can be obtained in sizes ranging from 4-in. up to 30-in. diameter at the inlet. The position of the inlet and outlet branches may be arranged to suit different requirements. In the past, with some designs of exhaust bypass valve, notably of the flap type, it was sometimes difficult to change their position, especially against the gas flow. The rotary valve does not suffer from this disadvantage, and the engine exhaust pulsations do not cause any valve flutter irrespective of position. The streamlined design enables the gas flow to be maintained even at high flow speeds and thereby minimizes the pressure drop. The changeover is made by one control without the possibility of the flow being interrupted, and it is impossible to close one branch with the other open. In the illustration the valve lid is shown in position for bypass to the boiler. The lid is so designed and the outlet ports so arranged that rotation of the handwheel through an angle of 30 degrees to 45 degrees causes the valve to move round, thereby closing the gas ports to the boiler and, at the same time, opening the ports to the silencer. The valve may be completely dismantled.—*The Motor Ship, July 1956; Vol. 37, p. 127.*

Electric Whistle

Secomak Whistles are available for use on d.c. or a.c. supply and have passed the Ministry of Transport's test for audibility. Referring to the diagram, the sound head contains



Section through the Secomak electric whistle

(A) Rotor; (B) Stator; (C) Shutter; (E) Guide rod; (F) Push rod; (G) Rocking lever; (H) Solenoid; (J) Motor; (K) Brush gear; (L) Anti-icing; (M) Thermostat

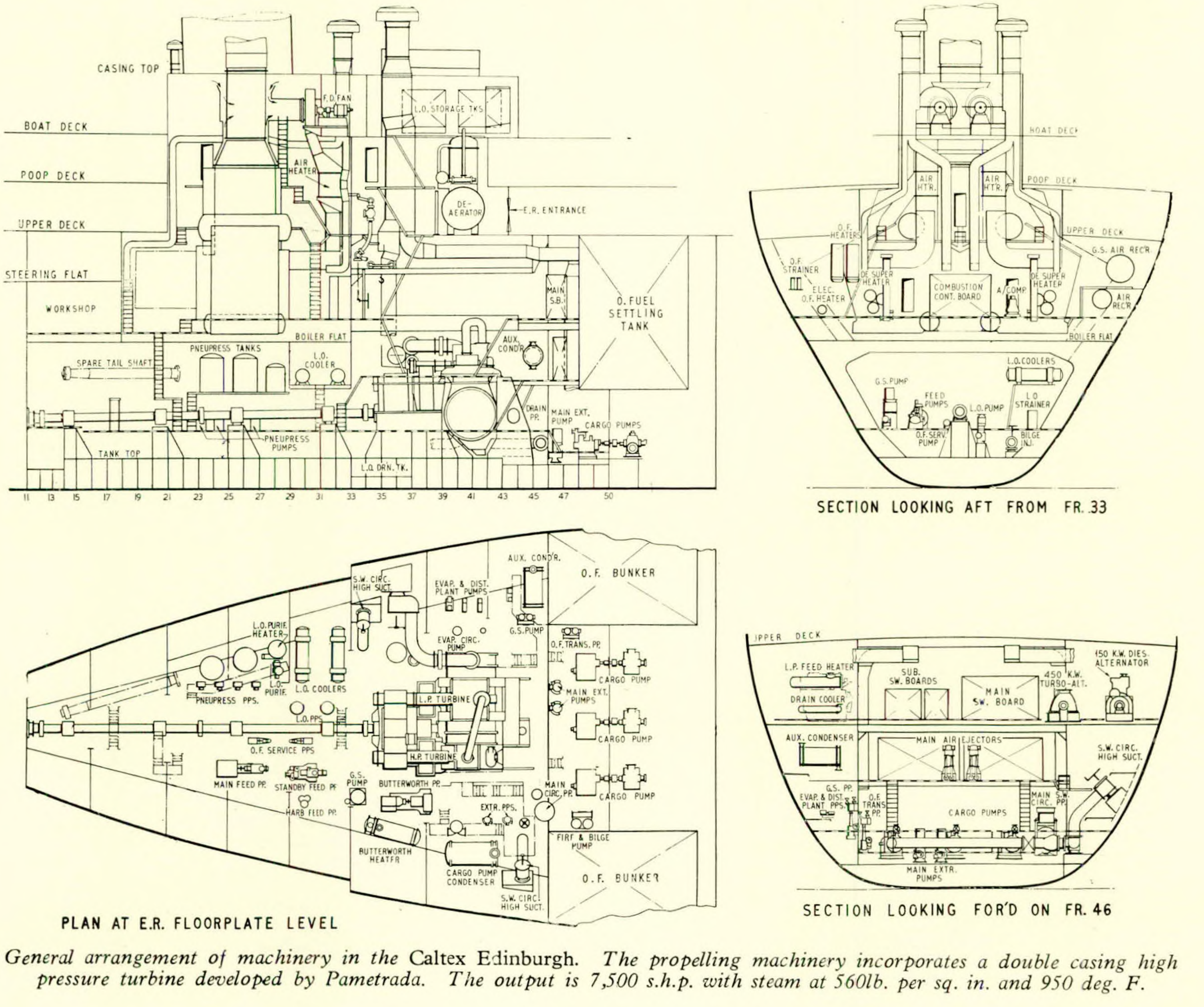
the motor driven rotor, which when rotating draws air through the rectangular holes in the stator. A note is produced having a sound frequency of 233 cycles per second and signals are made by raising and lowering the dome cover by means of the electromagnetic solenoid. Electric heating elements are fitted to prevent any damage from icing-up in cold weather. The largest whistle has a range of four to five miles and weighs approximately 660lb., and the two smaller ones are audible from four to two miles respectively, the distance being measured in still air conditions.—*The Motor Ship, July 1956; Vol. 37, p. 137.*

Tanker with Turbines of Novel Design

The first of two oil tankers of 18,000 tons d.w., fitted with steam turbine machinery of advanced design, has recently been delivered to the Overseas Tankship (U.K.), Ltd. This vessel, the *Caltex Edinburgh,* was built by Scotts' Shipbuilding and Engineering Co., Ltd., Greenock, and is the first British ship to be fitted with machinery incorporating a double casing high pressure turbine. The principal particulars of the *Caltex Edinburgh* are as follows:—

Length o.a.	559ft. 1in.
Length b.p.	530ft. 0in.
Breadth moulded...	71ft. 0in.
Depth moulded	39ft. 9in.
Draught, summer	30ft. 1¼in.
Deadweight, tons...	18,255
Displacement, tons	24,463
Gross tonnage	12,492
Net tonnage	7,176
Service speed, knots	15
Machinery output, s.h.p. ...	7,500
Cruising radius, miles	22,000

The *Caltex Edinburgh* is of the single deck type with poop, bridge deckhouse and topgallant forecastle, having a raked stem and cruiser stern. The bottom shell plating seams and butts are welded to the lower turn of the bilge and the side shell plating seams and butts are welded down to the upper turn of the bilge. One riveted lap seam of deck plating is arranged port and starboard for the full length of the tanks. The framing throughout the cargo spaces and pump room is on the longitudinal system and the deck longitudinals are continuously welded. Additional stiffening has been provided in way of the after peak and cruiser stern. Complete transverses forming a ring right round the tanks are fitted in the wing tanks. Overall a very high standard of construction appears to have been maintained. About 2,100 tons of oil fuel can be carried in the forward and after bunkers. The double bottom space under the engine room forms a tank for feed water supply for the boilers. The afterpeak, forepeak, and forward cofferdam serve as water ballast tanks. The main propelling machinery consists of one set of geared steam turbines, comprising one h.p. turbine of the all-impulse type and one l.p. turbine of the mixed impulse and reaction type. For astern working two turbines are fitted, one h.p. astern turbine overhung at the forward end of the h.p. ahead turbine and one l.p. astern turbine incorporated in the l.p. ahead turbine casing. Both astern turbines are of the all-impulse type. A double casing h.p. turbine forms part of the set. It comprises three main parts, a fabricated outer casing providing the main strength



General arrangement of machinery in the Caltex Edinburgh. *The propelling machinery incorporates a double casing high pressure turbine developed by Pametrada. The output is 7,500 s.h.p. with steam at 560lb. per sq. in. and 950 deg. F.*

girder for the ahead and astern turbines, a cast inner barrel housing the ahead nozzles and blading, and an astern cylinder. The inner barrel exhausts into the outer casing, which is therefore subject to exhaust steam pressure and temperature, and consequently relatively cool when compared with the inlet temperature (e.g. 400 deg. F. compared with 950 deg. F.). The barrel is of very simple design and is therefore better able to withstand transient temperatures such as occur during manœuvring. In addition, the open exhaust end considerably simplifies the boring of the inner barrel. The ahead turbines are capable of developing a total of 7,500 shaft horsepower in service with the propeller turning at 100 revolutions per min. when supplied with steam at 560lb. per sq. in. gauge, 950 deg. F. total temperature at the turbine inlet. The maximum ahead power is 8,400 s.h.p. with propeller revolutions about 104 per minute. The astern turbines together are capable of developing about 60 per cent of the ahead service power. The main gearing is of the double reduction articulated type with flexible couplings at the turbines and between the primary and secondary gearing. The drive from h.p. and l.p. primary gears is transmitted to their associated secondary pinions by means of quill shafts; the secondary pinions have been made hollow and the quill shafts pass through them to give maximum flexibility. The boiler installation consists of two Foster Wheeler D type watertube boilers built to design data and drawings furnished by Foster Wheeler, Ltd. The normal evaporation is arranged to allow continuous operation of the vessel at normal power (7,500 s.h.p.) but sufficient overload margin is provided to cover overload conditions (8,400 s.h.p.) or operation at service power with the tank heating or Butterworth tank cleaning system in use. In addition, the installation is so arranged as to permit the operation of all three cargo pumps at full output together with other auxiliary machinery normally required in harbour on one boiler only. The boilers are of the single furnace type with water walls on furnace sides, roofs and backs, and under normal steaming conditions the heat liberation does not exceed 45,000 B.Th.U. per hr. per cu. ft. of furnace volume. The boilers are fitted with superheaters and economizers and arranged to burn oil fuel only with hot air forced draught; the air heaters are steam operated. The principal particulars of the boilers are as follows: —

Evaporation (each boiler)—Normal, lb. per hr.	27,500
Maximum, lb. per hr.	42,500
Steam pressure (superheater outlet), lb. per sq. in.	600
Steam temperature (superheater outlet), deg. F.	950
Feed temperature (economizer inlet), deg. F.	225
Funnel temperature, deg. F. ...	300
Heating surface—Boiler, sq. ft....	4,725
Waterwalls, sq. ft.	610
Superheater, sq. ft.	2,300
Economizer, sq. ft.	4,520

The boilers are fitted with steam-operated soot blowers manufactured by Clyde Blowers, Ltd., and designed to use steam at 600lb. per sq. in. and 950 deg. F. To supply desuperheated steam for cargo pump turbines and other auxiliaries, an external surface type desuperheater is fitted to each boiler, capable of a maximum output of 25,000lb. of steam per hour at 560lb. per sq. in. at 560 deg. F. The boilers are equipped with steam-operated air heaters of Weldex heater design, one for each boiler, located in the air trunking between the forced draught fans and the burner air casings. The heaters are supplied with steam at about 30lb. per sq. in. absolute from the turbo-alternator exhaust line and designed to give an air temperature of 230 deg. F. at the burners with the boilers operating at normal load. The air passages and heating surface are of sufficient size to give an air temperature of about 215 deg. F. when the boilers are operating at maximum output.—*The Shipping World, 8th August 1956; Vol. 135, pp. 117-123.*

French Motor Cargo Vessel

The motor cargo vessel *Nabeul* has been built by the Ateliers et Chantiers de Bretagne at Nantes for the Compagnie de Navigation Daher, of Marseilles. The principal particulars of this vessel are as follows: —

Length o.a.	285·4 feet
Length b.p.	262·5 feet
Breadth	41·5 feet
Depth moulded	23·0 feet
Draught	16·7 feet
Deadweight, tons...	2,300
Service speed, knots	12·5

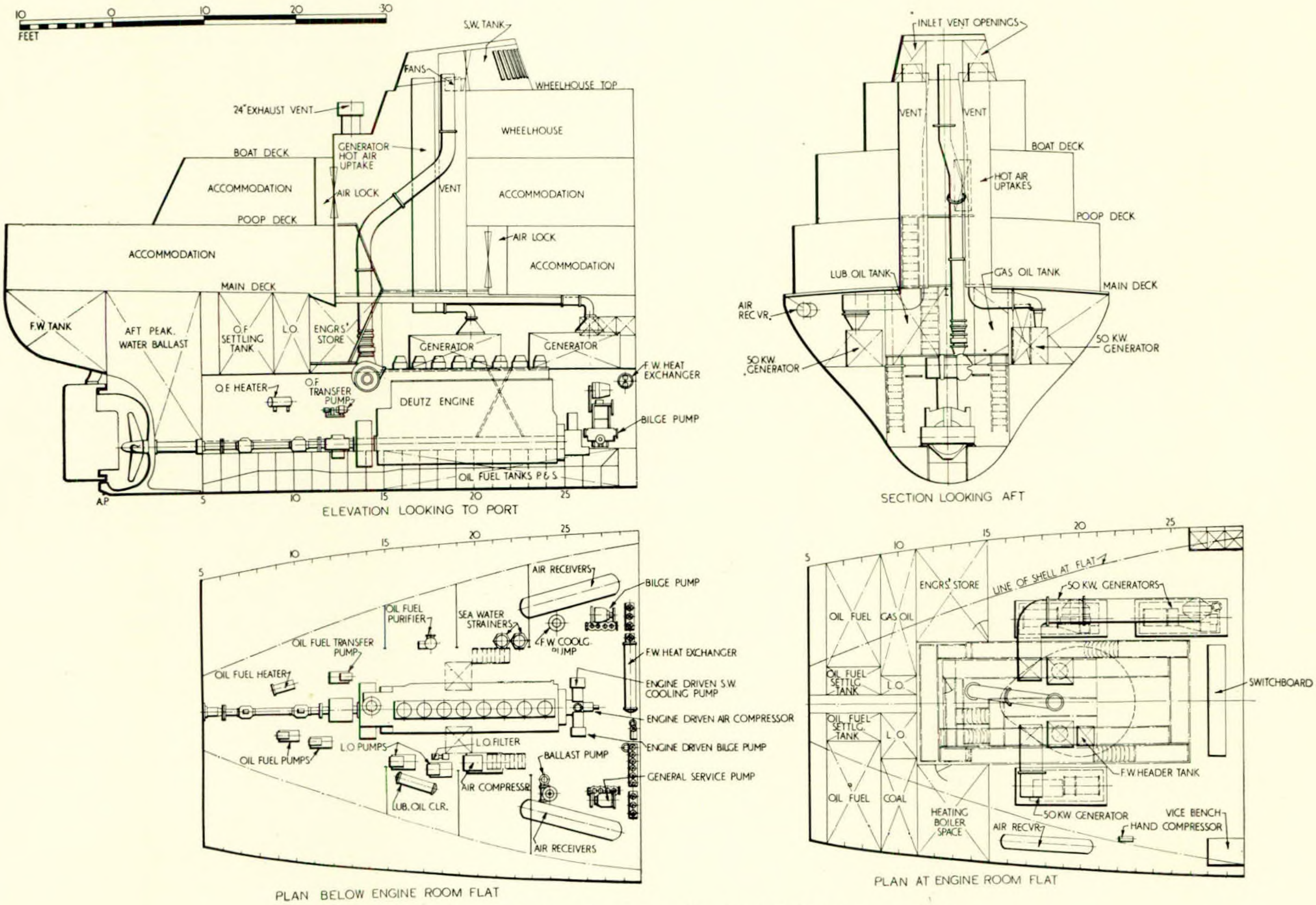
The ship has a raked and rounded stem and a cruiser stern. There are three holds and three 'tween-decks. The propelling machinery and all the living quarters are situated aft. Five watertight bulkheads divide the hull into six compartments, including the fore and after peaks. The hatch covers in the 'tween-decks are of the hinged non-watertight type, and are flush with the deck when closed. The auxiliary equipment includes an electric capstan, an electric warping winch, electro-hydraulic steering gear with hand hydraulic emergency steering, and several 5-ton and 8-ton winches. There is a Bipod mast forward, between holds 1 and 2, which is equipped with two 5-ton derricks for hold 1, and two 5-ton and one 15-ton derricks for hold 2. A pair of Samson posts at the front of the poop carries two 5-ton derricks and one 20-ton derrick. The vessel is powered by a four-stroke M.A.N. type Diesel engine driving a bronze propeller. The maximum continuous power rating is 2,250 h.p. at 250 r.p.m. Fuel is carried in two tanks under holds 2 and 3. Electric power at 220 volts d.c. is provided by two 115-kW generating sets, and by a 70-kW dynamo coupled to the shafting. Emergency power is furnished by a battery of lead accumulators.—*Journal Marine Marchande, 1956; Vol. 38, p. 839. Journal, The British Shipbuilding Research Association, June 1956; Vol. 11, Abstract No. 11,701.*

Deutz-engined Ship for Glasgow Owners

The m.s. *Amber*, completed by the Troon shipyard of the Ailsa Shipbuilding Co., Ltd., to the order of Wm. Robertson (Shipowners), Ltd., Glasgow, is a single-deck cargo ship of 2,415 tons on a draught of 17 feet, or 2,176 tons on 16 feet, with a stowage factor of 53·3ft. per ton. The main and auxiliary Diesel engines are of Deutz manufacture. Air-cooled auxiliary Diesel engines, which presumably represent a saving in first cost and in space for ancillary equipment, have been specified to some extent lately, generally for tugs, etc., but this installation of three air-cooled 75-h.p. engines is the first on a British vessel of this size. The *Amber* will be engaged largely in bulk carrying and is the first of the single-deck type built for these owners, whose fleet now numbers sixteen vessels. She is, furthermore, the fourth consecutive ship for this concern to be built by the Ailsa Shipbuilding Company. The principal characteristics are as follows: —

Length o.a.	268ft. 6in.
Length b.p.	252ft. 0in.
Breadth moulded	38ft. 6in.
Depth moulded	19ft. 9in.
Deadweight, tons...	2,415
Corresponding draught	17ft. 0in.
Cubic capacity (grain), cu. ft. ...	112,728
Cubic capacity (bale), cu. ft. ...	108,026
Gross register, tons	1,596
Net register, tons...	858·49
Machinery, b.h.p.	1,650
Service speed, loaded, knots (approximately)	12½

The main engine is a Deutz unit with eight cylinders, each with a bore of 420 mm. and with a piston stroke of 660 mm. As stated, the output at 250 r.p.m. is 1,650 b.h.p. with a b.m.e.p. of 8·12 atmospheres. The swept volume is 731·5 litres. It is a direct-reversing four-stroke exhaust gas turbocharged unit, with bedplate, framing, etc., of cast iron construction



Engine room plans of the Deutz-engined 1,650-b.h.p. m.s. Amber

The turboblower is of the Brown Boveri type. Of aluminium construction, the pistons are uncooled. A drive is fitted from the forward end of the crankshaft for a duplex lubricating oil pump, and a bronze reciprocating sea water and bilge pump. It is interesting to note that the auxiliary Diesel engines, which are mounted on flats at the port and starboard sides of the engine room, are housed in acoustic casings. Each develops 75 h.p. at 1,500 r.p.m. and drive a 50-kW 220-volt generator. As stated, these are air-cooled. Each has eight cylinders with a bore of $4\frac{3}{8}$ inches and a piston stroke of $5\frac{1}{2}$ inches. The b.m.e.p. under normal conditions is 87·8lb. per sq. in. Cooling of the engine is effected by means of a rotary blower, driven by vee-belts, which draws air from the engine room into a special housing and thence around the external surfaces of the cylinders. These are compact units with electric starting facilities. The weight complete with starting equipment is about 1,610-1,683lb. It is contended that this class of engine can be operated within a temperature range of − 40 degrees to + 140 degrees F. and that starting under cold conditions is much easier than with water cooled units. An oil cooler is fitted as standard on units of this class.—*The Motor Ship, July 1956; Vol. 37, pp. 132-133.*

Twin Screw Motor Tugs for Naval Dockyards

Recently the Admiralty released particulars of a new class of twin-screw motor tug fitted with geared machinery and controllable pitch propellers. Four of these craft have been ordered from A. and J. Inglis, Ltd., Glasgow, and one, H.M.S. *Confidence,* has already been completed. Experience with tugs moving large aircraft carriers and other large warships has shown the necessity of building the upper works with exaggerated tumble home in order that the tugs may come alongside without fear of damage to either vessel. Also, in order to be efficient when nosing these large warships, the bows of the tugs have been strengthened and fitted with a large bow fender. These features have been incorporated in the design of the tugs, which are of normal profile with fo'c'sle accommodation for the master and crew and include saloon, pantry, galley, bathrooms, etc. They are constructed under special survey of Lloyd's Register of Shipping Class 100A1 "For towing and salvage services". The principal particulars are:—

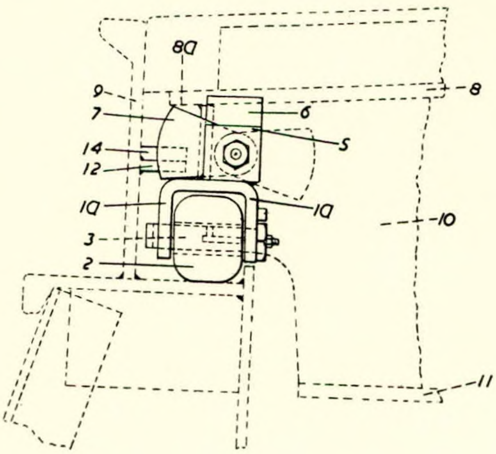
Length overall	154ft. 9in.
Length b.p.	140ft. 0in.
Breadth moulded	35ft. 0in.
Depth moulded	16ft. 0in.
Draught loaded	11ft. 0in.
Displacement loaded, tons ...	760
Speed running free, knots ...	13

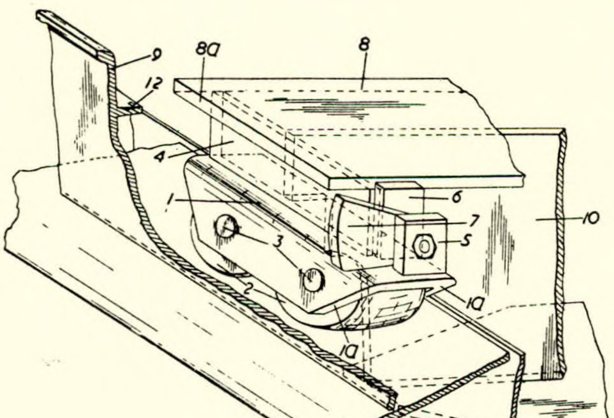
The propelling machinery consists of four Paxman engines coupled by Modern Wheel Drive reduction gearboxes with oil operated clutches to two controllable pitch propellers of the Stone Kamewa design, through flexible Triflex couplings. The machiney is operated through control pedestals on the bridge wings with alternative local control in the engine room. For harbour duties it will be possible to restrict power to a single unit on each shaft by means of a simple cut-out. Electric power for the deck machinery, heating, etc., is provided by two 100 kW generators, driven by Paxman engines and a 35 kW auxiliary Foden generator.—*Shipbuilding and Shipping Record, 28th June 1956; Vol. 87, pp. 590-591.*

Patent Specifications

Cargo Hatchway Beams

This invention relates to cargo hatchway beams of the kind mounted on rollers, and which are adapted to be moved over the hatch opening and located by snugs engaging recesses at predetermined distances apart, for the reception of metal or wood hatch covers, and to be moved to the ends of the hatch opening to give a clear space for loading or unloading of the cargo. In Figs. 1 and 3 the roller carriage comprises a length



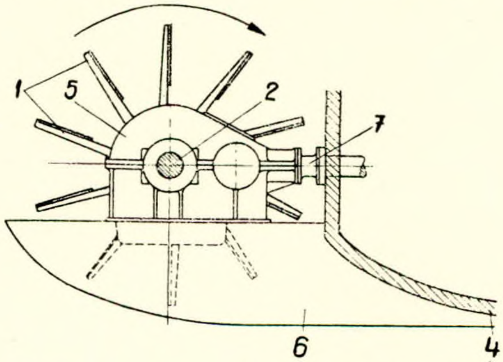


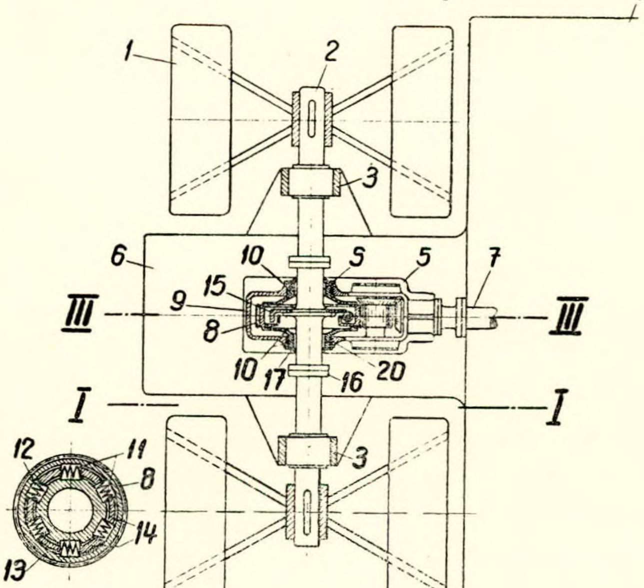
FIGS. 1 (above) and 3 (below)

of channel section (1) formed by a dished steel plate having its ends tapered from the web to the edges of the flanges (1a), the rollers (2) being mounted on spindles (3) supported between the flanges (1a). Along the upper face of the web of the channel there is welded a vertical connecting plate (4) which extends throughout the length of the web except at one end where it is cut short to accommodate two transverse lugs (5, 6). These are in the form of vertical spaced plates between which is pivotally mounted a snug (7) of segmental form. The snug is adapted to take up either of two positions at about 180 degrees to one another, i.e. the locking position in which the snug projects to the outside of the roller carriage, and the disengaged position in which the snug projects to the inside. The hatchway beam portion comprises a top face plate (8) which is welded to the upper edge of the connecting plate (4) and so as to project at the outside (8a) for an amount sufficient to give clearance to the hatch coaming (9), a central vertical web plate (10) which is shaped at its ends to fit against the top face plate (8), the connecting plate (4) and the web and inner flange (1a) of the roller carriage (1) and a bottom face plate (11), all of which plates are fabricated by welding.—*British Patent No. 751,769 issued to J. A. Rennison. Complete specification published 4th July 1956.*

Paddle-wheel Drive

This invention relates to paddle-wheel drives for ships of the type in which two opposite paddle-wheels are carried and driven by a common rigid transverse shaft, which itself is driven by a driving wheel arranged in substantially concentric

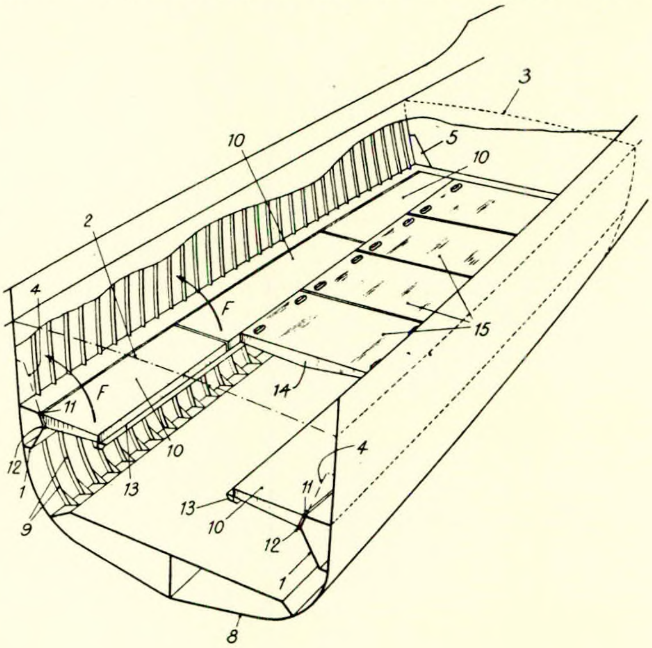


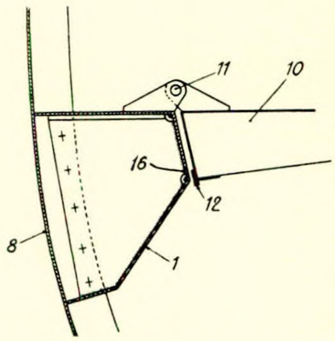


FIGS. 1 (above), 2 (centre) and 3 (lower left) relation to the shaft. According to the invention, the driving wheel is mounted to surround the transverse shaft with play all around the circumference of the shaft, and is connected for rotation with the shaft by means of a flexible coupling, but is mounted independently of the shaft. The flexible coupling is formed conveniently by an Oldham coupling or by a torsion-elastic coupling. Referring to Figs. 1, 2 and 3, the paddle wheels are keyed to a common shaft (2), mounted in two bearings (3). The shaft (2) is driven by a toothed wheel gear (5), including a bevel wheel transmission and a spur wheel transmission, the gearbox being supported by an extension (6) of the ship's hull (4). The longitudinally extending shaft (7) is connected to a motor not shown in the drawings. The spur wheel (8) is mounted in bearings (20), the hub portions (10) of the wheel surrounding the transverse shaft (2) so that a clearance is provided along the entire circumference of the shaft (2). The torsion-elastic drive of the shaft (2) is obtained by means of coiled springs (11) inserted in chambers (12) between spring engaging flaps (14) of an annular driver (15) which is screwed to the transverse shaft (2). In order to facilitate dismantling of the paddle wheel drive, the transverse shaft (2) is divided in three portions, one middle portion and two end portions, screwed together by means of shaft flanges (16). The box (9) is sealed by means of yielding packings (17). Owing to the fact that the spur wheel (8) is connected only with the shaft (2), but not mounted on the shaft, elastic deformations of the transverse shaft practically do not exert any influence on the magnitude of the bearing pressures to which the spur wheel bearings (20) and the shaft bearings (3) are subjected.—*British Patent No. 751,581 issued to Schweizerische Lokomotiv-und Maschinenfabrik. Complete specification published 27th June 1956.*

Platform in Ship's Hold

In the conventional methods of constructing decks, platforms or floors, the latter bear on gussets or brackets secured to vertical partitions or to the ship's hull. Consequently, these partitions or the hull have to withstand stresses resulting from the weight of the platforms and of the loads carried by them, and are thus subjected to bending stresses. To assist in withstanding these bending stresses, substantial reinforcing means are required on the partitions and hulls. According to this invention, the use of supporting members having excessive dimensions can be dispensed with. In Figs. 2 and 3, longitudinal beams (1) of hollow box-shaped profile are mounted in parallel relationship with respect to the hull (8). Each beam (1) is secured at either end to the relevant bulkheads (2, 3), which, if necessary, are reinforced by providing suitably designed gussets, brackets or like elements. On the beams (1) are secured the panels (10) constituting the floor or platform structure proper. This securing may be of the detachable, hinged or permanent type as desired. The panels (10) are shown to be secured by means of hinge devices (11) provided at the upper inner edge of the beam (1). A bearing surface (12) is provided on each panel (10) for properly engaging the lower inner portion (16) of beam (1). The hinge panels (10)





FIGS. 2 (above) and 3 (below)

may be formed with edge portions (13) adapted to support transverse battens (14) designed in turn to bear hatch-cover sections (15).—*British Patent No. 748,702 issued to MacGregor-Comarain. Complete specification published 9th May 1956.*

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Marine Engineering and Shipbuilding Abstracts

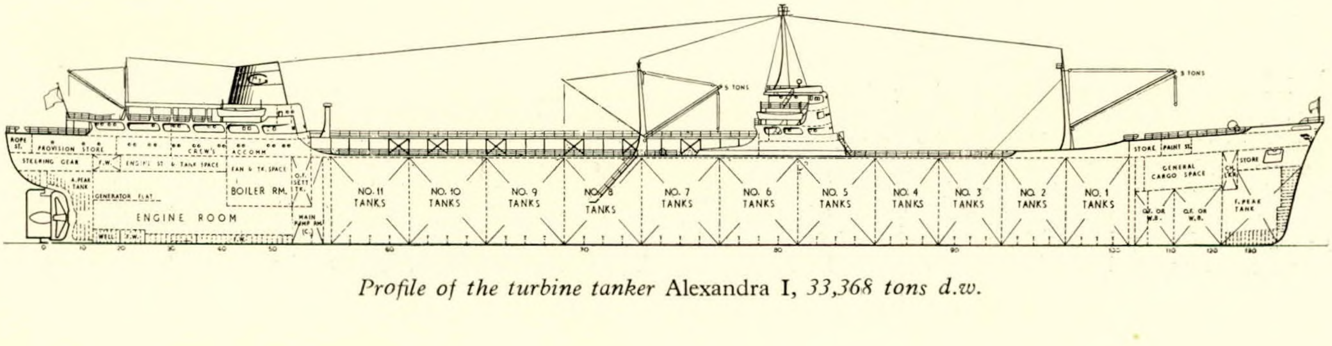
Volume XIX, No. 12, December 1956

Japanese-built Tanker for Liberian Owners

One of the deliveries from the Japanese shipyards earlier this year was the oil tanker *Alexandra I*. This vessel, of 33,368 tons d.w., was built by the Hitachi Shipbuilding and Engineering Co., Ltd., Innoshima, Japan, for the Liberian Trans-ocean Navegaceon Corporation. The *Alexandra I* is a turbine steamship vessel of attractive appearance with a raked stem and cruiser stern. She is fitted with a Costa bulb and on her trials attained a mean speed of over 18¾ knots, well within her designed consumption figure. It is of interest to note that the keel of this vessel was laid on 18th February 1955, the launching took place on 18th October of the same year and delivery was made on 24th February 1956, just twelve months and six days after the keel was laid. The principal particulars of the *Alexandra I* are as follows:—

Length o.a.	679ft. 0in.
Length b.p.	646ft. 4in.
Breadth moulded...	86ft. 7½in.
Depth moulded to upper deck ...	45ft. 11in.
Draught extreme...	34ft. 8⅝in.
Displacement, tons	43,430
Deadweight, tons...	33,368
Gross tonnage	20,926
Block coefficient	0·78
Service speed, knots	16
Engine output, s.h.p.	13,500
Cargo capacity, cu. ft.	1,617,000

The *Alexandra I* has been constructed on a combined longitudinal and transverse system of framing. The *Alexandra I* is propelled by a single screw driven by geared turbine machinery. The propulsion unit, which is of Hitachi manufacture, consists of a series-flow high pressure and low pressure turbine driving through double reduction gears. The normal output of the turbines is 13,500 s.h.p. at 105 r.p.m. of the propeller shaft, and the maximum continuous output is 15,000 s.h.p. at 108·5 r.p.m. Each turbine is connected by a flexible coupling to a separate high-speed pinion of the double reduction gear. The propeller is of manganese bronze, Aerofoil, five-bladed type with decreased pitch. A Costa bulb is fitted to the rudder. Steam is supplied at a pressure of 600lb. per sq. in. and a temperature of 850 deg. F. from two Babcock and Wilcox marine boilers manufactured by the builders. Each boiler has a heating surface of 8,520 sq. ft. Diamond sootblowers and Bailey automatic control are fitted. The main condenser is of the straight tube, reheating surface type, arranged for two passes of circulating water, and provided with an air cooling section and a condensate hot well. Two auxiliary condensers, one to serve each turbogenerator, are fitted. These are also of the straight tube reheating surface type arranged for two passes of circulating water. The electrical plant consists of two alternating current geared turbogenerators of 500 kW, 450 volt, 3-phase, 50 cycles capacity each, and one 100 kW, 450 volt Diesel driven generator for emergency lighting.—*The Shipping World, 27th June 1956; Vol. 134, pp. 595-597.*



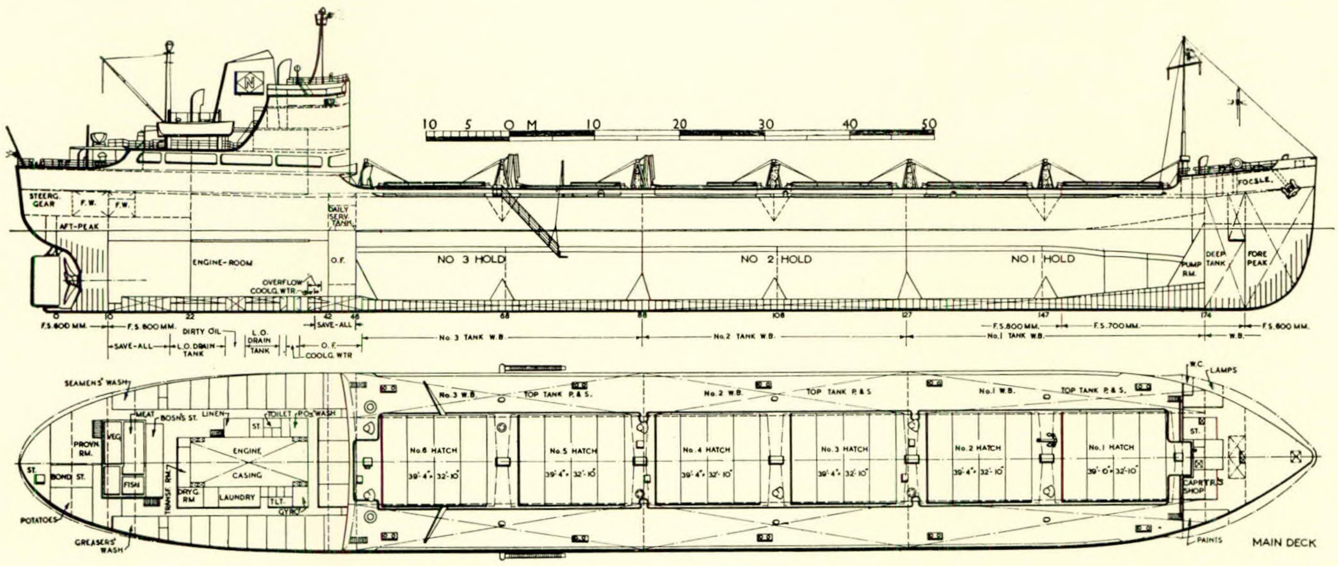
Profile of the turbine tanker Alexandra I, *33,368 tons d.w.*

German-built Bulk Cargo Carrier

The first of two Diesel engined single-screw bulk cargo carriers ordered by R. Nerdrum, Ltd., London, from the Emden yard of Nordseewerke, the *Lewis R. Sanderson,* is designed to carry about 16,500 tons d.w.c. on a draught of 30ft. 6in. or 15,000 tons d.w.c. on 28ft. 6in. On an eight-year charter to the National Gypsum Corporation, London, this ship is of distinctive design: the holds are hopper sided and water ballast is carried in the port and starboard sides of the double bottom, also in the cantilever tanks formed under the main deck. The principal dimensions of the *Lewis R. Sanderson* are as follows:—

Length o.a.	500ft. 5in.
Length b.p.	485ft. 3in.
Breadth moulded...	66ft. 3¼in.
Depth	41ft. 6in.
Machinery, b.h.p. (on trials) ...	5,680
Trial speed, knots	13·8
Gross register, tons	11,416·37
Net register, tons...	6,698·26

All accommodation is aft, as is also the navigating bridge, this making the ship one of the largest of her class without the usual 'midships structure. An interesting feature of this ship is that she is propelled by two four-stroke M.A.N. engines coupled to a single propeller shaft; each has eight cylinders with a bore of 520 mm. and a piston stroke of 740 mm.; the output at 225 r.p.m. is 2,840 b.h.p., or a total of 5,680 b.h.p. The engines drive through Bremer Vulkan gearing, the propeller speed being 110 r.p.m. Electrical requirements throughout the ship are supplied by three 180-kW generators, each driven by a Deutz four-stroke eight-cylinder engine with an output of 306 b.h.p. at 600 r.p.m. In addition, there is a Diesel driven compressor/generator set.—*The Motor Ship, June 1956; Vol. 37, p. 67.*



General arrangement plans of the Lewis R. Sanderson

Metal Spraying with Rockets

During the past year a new method of metallizing has been developed using the principles of rocket combustion. The high temperature, high velocity jet exiting through the rocket nozzle is used to melt and atomize a metal wire which is fed through the rocket throat. The atomized metal is sprayed on to a previously prepared surface. With this new type of metallizing gun, the procedure remains essentially unchanged from that used with the present commercial metallizing methods. The major difference between the two types of unit is in the method of heating and atomizing the wire. The air blast gun utilizes an open oxy-fuel flame to heat the wire, and a stream of compressed air atomizes the molten metal. The use of rocket energy to perform these functions obviates the use of the compressed air system. The rocket metallizer is not suited for the use of acetylene which is unsafe when used at gauge pressures over 15lb. per sq. in. Propane and similar fuels are used. The method of cooling is different in each of the two cases. The rocket must be water cooled. Fig. 2 is a schematic representation of the equipment necessary for trouble-free operation of the rocket metallizer. Oxygen and propane are led through pressure regulators at 100lb. per sq. in. gauge and 115lb. per sq. in. gauge respectively. These gases are forced through injectors into the combustion chamber of the rocket. The combustion temperature is about 5,400 deg. F. The exit gases composing the jet travel at a velocity of nearly a mile per second. The temperature of this jet is over 5,000

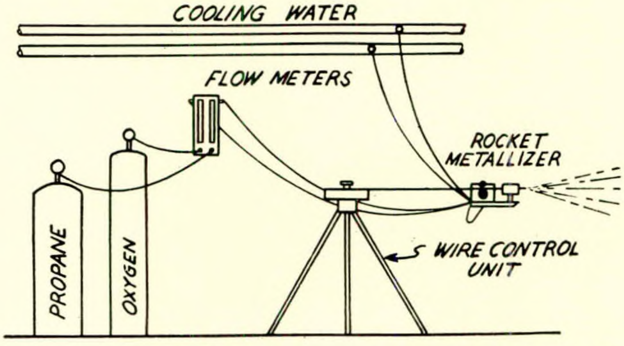


FIG. 2—*The installation required for trouble-free operation of the rocket metallizer*

deg. F. as determined by the fact that the flame melts molybdenum (melting point 4,750 deg. F.). Shock diamonds are visible in the exiting gas stream. Thus, it is known that the jet velocity is sonic, or greater. Wire is fed into the rocket's throat at a constant speed by means of a thyratron controlled d.c. motor. The critical part of the metallizing rocket is its throat (Fig. 4), which must have the correct cross-sectional area such that the wire can be heated to the desired temperature and still allow the gases to retain sufficient kinetic energy for adequate atomization. The length of the throat and the rod feed rate must be balanced so that atomization will take place beyond the throat exit. If the wire becomes molten within the

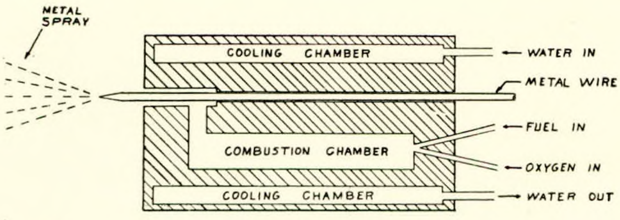
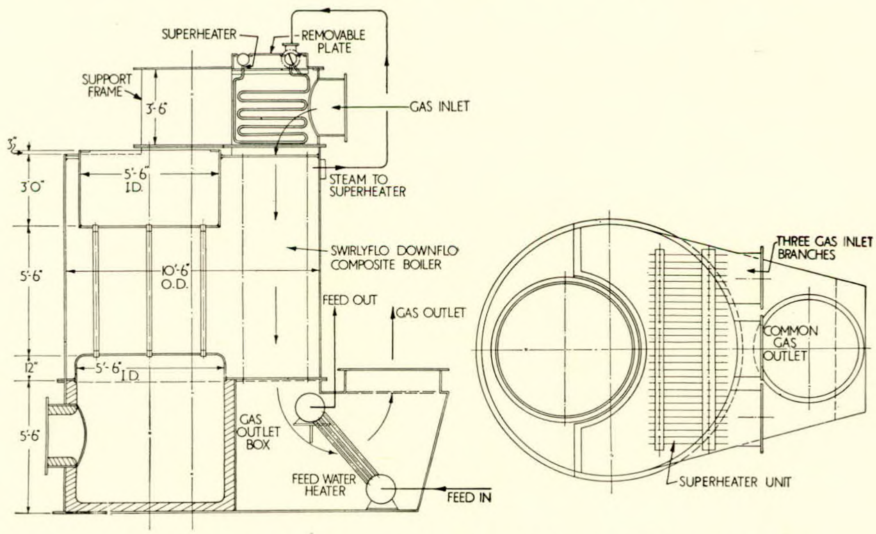


FIG. 4—*Cross-sectional view of rocket metallizer*

rocket, the throat is apt to become plugged and the flame is extinguished. On the other hand, if the wire emerges too quickly, the atmosphere will cool the wire before atomization can occur. It is quite possible that the rocket metallizer will be able to simplify the process of protective spraying. At present, protective metallizing is generally followed by a fusing operation to close the pores in the applied coat. If the metal can be sprayed in sufficiently small particles, it might be possible to eliminate the subsequent fusing operation. Furthermore, in the rocket metallizer the carrier gases are hot rather than cold as in the air blast guns. This inherently results in some fusing when the particles hit the surface being sprayed. It is believed that this intrinsic fusing coupled with the small particle size will render a simpler and more economic metallizing procedure for protective spraying.—*J. W. Buffington and J. A. Browning, The Welding Journal, May 1956; Vol. 35, pp. 468-471.*

Exhaust Boiler for 15,000 b.h.p. Diesel Engine

With the increasing number of single-screw Diesel installations of 12,000 to 15,000 b.h.p. now being projected and adopted, the requirements from the exhaust gas boiler become greater, and some larger units are being manufactured. The sectional illustration shows a composite boiler with a superheater and feed heater, designed and built by Spanner Boilers, Ltd., intended for use with these higher powered two-stroke turbocharged engines. The boiler in question is designed to produce 8,800lb. of steam per hour from the exhaust gas section and 2,500 kg. from the oil-fired section. The boiler is of the builders' Swirlyflo Downflo type and it will be noticed that a superheater unit is incorporated.—*The Motor Ship, July 1956; Vol. 37, p. 126.*



Exhaust gas boiler installation for a 15,000-b.h.p. Diesel engine

Large French Tanker

The Société des Transports Maritimes Pétroliers, Paris, has a fleet of post-war built motor tankers and one turbo-electric ship of the T-2 type. Their latest vessel, built by the Odense Steel Shipyard, Ltd., Odense, the *Champs Elysées,* is the largest of the fleet and is classed with Bureau Veritas, + 1 3/3 L.I.I. E.W. She is one of the highest powered Diesel engined single-screw tankers afloat, being equipped with an engine developing 12,500 i.h.p. or 11,200 b.h.p. The principal dimensions of the *Champs Elysées* are:—

Length overall	622ft. 8in.
Length b.p.	585ft. 0in.
Breadth moulded...	77ft. 0in.
Depth moulded	44ft. 7in.
Loaded draught	34ft. 1⅛in.
Deadweight capacity	26,440 tons of 1,016 kg.
Deadweight capacity	26,860 tons of 1,000 kg.
Gross register, tons	17,037
Net register, tons	10,182
Total tank capacity, cu. ft. ...	1,218,980

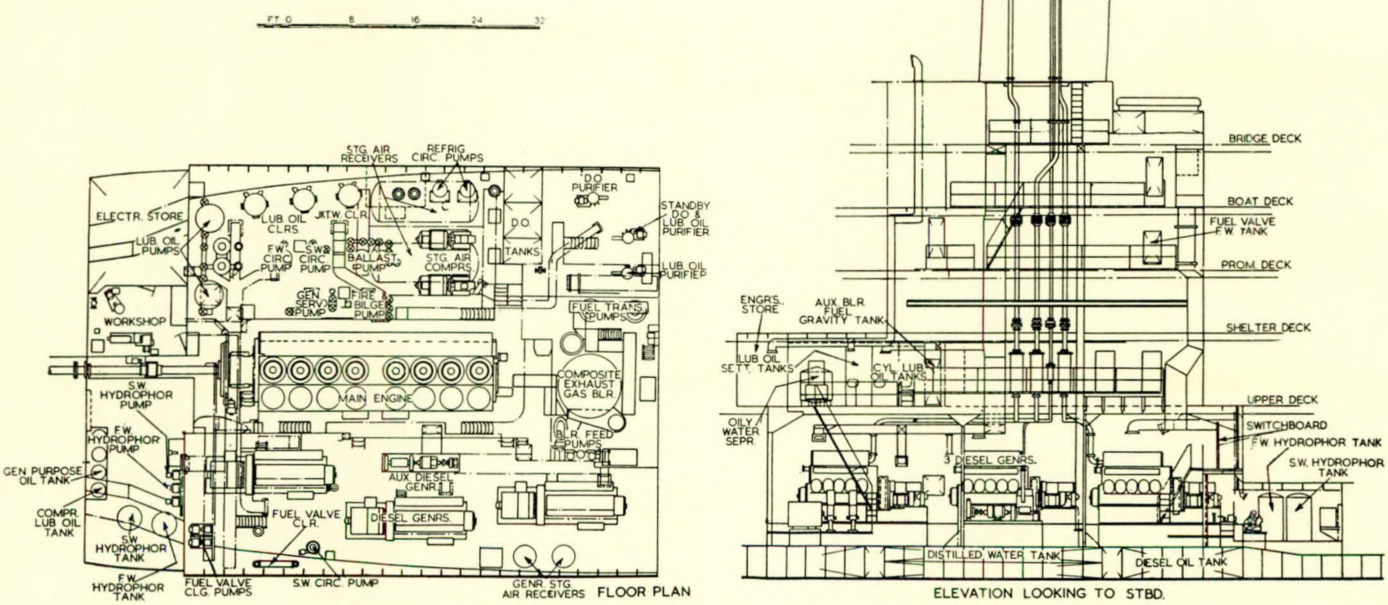
The propelling engine, constructed by Burmeister and Wain, is of their standard turbocharged type, with nine cylinders 740 mm. in diameter, the piston stroke being 1,600 mm. It is of the usual poppet exhaust valve design and of welded construction. It develops 12,500 i.h.p. for normal rating at 115 r.p.m., this being equivalent to 11,200 b.h.p., corresponding to a mechanical efficiency of nearly 90 per cent. At the output mentioned, the mean indicated pressure is 7·9 kg. per sq. cm. (112lb. per sq. in.), the brake mean effective pressure being 7·1 kg. per sq. cm. (100lb. per sq. in.). The exhaust gas is delivered to a Spanner waste heat boiler with a heating surface of 2,000 sq. ft. and a working pressure of 180lb. per sq. in. The three single ended oil fired Scotch boilers each have a heating surface of 2,675 sq. ft. There are two 90-kW. 110-volt Diesel engined generators for supplying current to the electrical auxiliaries and equipment, also a 90-kW steam driven generator receiving steam from the exhaust gas boiler. It is of the Swirlyflo Upflow type and the boiler acts also as a silencer. It is 7 ft. in diameter with 6-ft. lengths of tubes, designed for a heating surface of 158 sq. m. The steam production is 2,000 kg., or 4,425lb. per hr., at 180lb. per sq. in., the feed water temperature being 50 deg. C. This output is attained when passing 60,000 kg. (132,000lb.) of exhaust gas per hr. at the temperature of 320 deg. C. The boiler is designed to work in conjunction with one of the Scotch boilers. All the feed is supplied from the Scotch boiler to the exhaust gas boiler, and the steam from the exhaust gas boiler is delivered back to the steam space of the Scotch boiler. The amount of steam which can be produced, if necessary, is in excess of 2,000 kg. as specified, and with the exhaust gas available it should be possible to generate 2,200 kg. per hr.—*The Motor Ship, July 1956; Vol. 37, pp. 128-133.*

Motor Ship for Mediterranean Trade

Trials were recently completed of the 3,500-ton open shelterdecker motorship *Flaminian,* built by Henry Robb, Ltd., to the order of the Ellerman and Papayanni, Line, Liverpool. This is the second of two similar vessels for the owners' Mediterranean trade, the first, the *Florian,* having been built by Wm. Gray and Co., Ltd., and equipped with a 3,350-b.h.p. Swiss built Sulzer engine. The main engine in the *Flaminian* is similar and of equal power but was constructed by George Clark and North Eastern Marine (Sunderland), Ltd., Sunderland. It is the highest powered Diesel unit yet manufactured by these builders. The main characteristics of the *Flaminian* are: —

Length o.a.	351ft. 2¾in.
Length b.p.	325ft. 0in.
Breadth moulded	52ft. 0in.
Depth moulded to shelterdeck ...	30ft. 0in.
Depth moulded to upper deck ...	20ft. 10in.
Draught loaded, mean	20ft. 3in.
Deadweight total, tons	3,500
Cubic capacity (bale), cu. ft. ...	186,900
Speed loaded in service, knots ...	12½

The main engine is an eight-cylinder single-acting two-stroke crosshead unit with one lever driven scavenging air pump to each cylinder. The diameter of the cylinders is 600 mm., and the piston stroke 1,040 mm., and although the normal rating of this engine is 4,000 b.h.p. at 150 r.p.m., in this case it has been rated for continuous service at 3,350 b.h.p. at 135 r.p.m. with a corresponding b.m.e.p. of 69·4lb. per sq. in. and a mechanical efficiency of 82 per cent.—*The Motor Ship, June 1956; Vol. 37, pp. 70-73.*



Engine room plans of the m.s. Flaminian

Operation of Marine Diesel Engines on Class "B" Fuel

Interesting data have become available as the result of the operation of a group of nine R.N. Diesel engines of 9-E6 type (manufactured by Russell Newbery and Co., Ltd.), as marine auxiliary units, on Class "B" Diesel fuel. Many shipowners run both propelling and auxiliary units on the one type of fuel, because of the convenience or having only one bunkering space instead of two for different grades of fuel, and the fifteen months' operation, which involved over 8,000 hours of running time on one of the engines, was carried out in three vessels in a Scottish ferry service. The R.N. system, the manufacturers claim, with its simple pintle nozzle and high swirl rate, provides the best possibility of giving good service on a grade of fuel which generally does not produce the best results when used in the smaller marine auxiliary units. It has been found, from experience, that the four main requirements to give reasonable running on Class "B" fuel are as follows: —

CYLINDER LINER WEAR AND RUNNING HOURS OF NINE R.N. 9-E6 DIESEL ENGINES ON CLASS "B" FUEL

Engine No.	Hours	Liner wear, maximum, inches F. and A.	P. and S.
First ferry—			
1	8,113	+ ·002	+ ·004
2	7,730	+ ·003	+ ·004
3	5,471	+ ·002	+ ·004
Second ferry—			
1	5,286	+ ·003	+ ·005
2	6,104	+ ·003	+ ·005
3	5,840	+ ·003	+ ·004
Third ferry—			
1	3,760		+ ·001
2	4,287		+ ·0015
3	3,793		+ ·001

(1) The provision of some means of pre-cleaning the fuel to avoid nozzle and fuel pump wear.

(2) The maintenance of a reasonable load at all times—the minimum load not being less than 70 per cent of full load.

(3) The maintenance of a water jacket temperature of around 165 deg. F., by having fresh water cooling.

(4) The use of Supplement I lubricating oil, with strict adherence to oil filter cleaning and the oil change period.

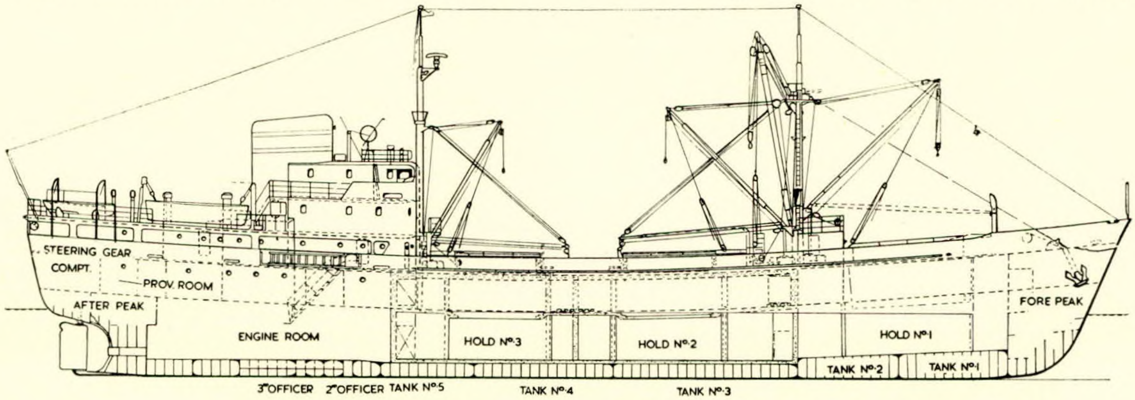
The 9-E6 engines of the three vessels are reported by the company to be giving very good service on Class "B" marine Diesel oil; the cylinder liner wear and the running hours are as stated in the table.—*The Shipbuilder and Marine Engine-Builder, June 1956; Vol. 63, pp. 397-398.*

New Type Norwegian Vessel

The first of two vessels of a new type for service between Norway and Grimsby, the *Tore Jarl,* was completed by A/S Trondhjems Mek-Verk., for Det Nordenfjeldske Dampskibsselskad, Trondheim. The vessel has three holds, two of which are fitted out as freezing rooms with a total refrigerated capacity of about 35,400 cu. ft. arranged for the carriage of frozen fish, from Bergen direct to Grimsby. General cargo will be loaded from this country to Stavanger, thence to other Western Norwegian ports up to Kirkenes. The main particulars of the ship are:—

Length overall	226ft. 9in.
Length b.p.	206ft. 9in.
Breadth moulded	36ft. 0in.
Draught	13ft. 10in.
Deadweight, tons...	1,060
Machinery, b.h.p.	1,260
Speed, knots	12·5

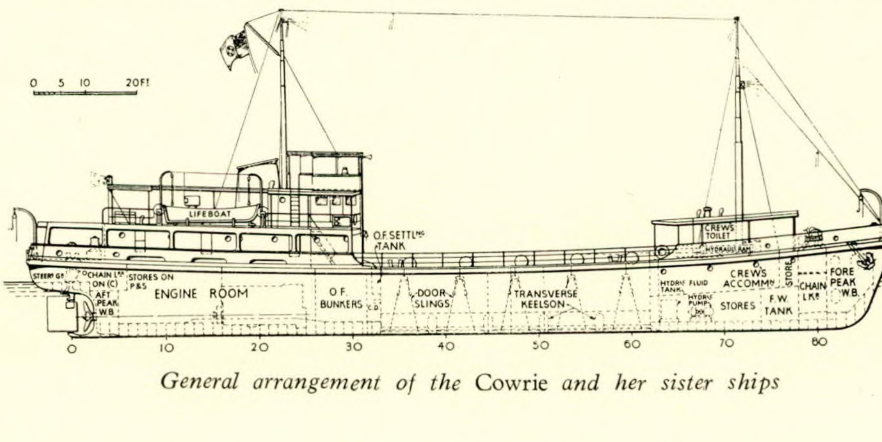
No. 1 hold has a capacity of 22,142 cu. ft. so that the total capacity of the three holds is 57,542 cu. ft. The machinery and the whole of the accommodation are aft, which is convenient for a vessel of this sort, providing the shortest possible discharge length when alongside the quay. The refrigerated holds are insulated with cork plates on the top of the tank and rock wool on the bulkheads, sides and under deck. The air ducts are of aluminium and the insulation is covered by aluminium sheets. The refrigerating plant, manufactured by A/D Atlas Maskinfabrik, is designed for Freon 12 and direct evaporation, with forced circulation through the cooling coils. The capacity of the plant is 237,000 k. cal. per hr. with a condensing temperature of 30 deg. C., a Freon temperature before the regulating valve of 25 deg. F. and an evaporating temperature of − 15 deg. C. There are three 60 h.p. motor driven Freon compressors, of which two are in service normally. The propelling engine is a four-stroke M.A.N. Diesel unit with six cylinders, 400 mm. in diameter, the piston stroke being 600 mm. It is supercharged and the normal output of 1,260 b.h.p. is attained at 275 r.p.m.—*The Motor Ship, July 1956; Vol. 37, pp. 122-123.*



Longitudinal elevation of the Tore Jarl

Self-propelled Hopper Barges for Australia

A series of three self-propelled hopper barges, the *Nautilus, Cowrie,* and *Trochus,* have recently been constructed for the Brisbane Harbour Authority by Brooke Marine, Ltd., Lowestoft. Although the craft are intended to operate initially in the Brisbane River area, they may eventually work as far north as the Gulf of Carpentaria. The vessels have therefore to have good seakeeping qualities, especially as their voyage to Australia has to be made under their own power. Of the flushdeck type with raked bow and cruiser stern, the craft are subdivided by watertight bulkheads as shown in the general arrangement. Diesel oil is carried in wing tanks at the forward end of the engine room, 30 tons each side of the ship and a built-in domestic fresh water tank of 28½ tons capacity is arranged at the forward end of the hold. The fore and after peaks are arranged for ballast. An open type forged steel sternframe with semi-balanced rudder is fitted and a Donkin electric-hydraulic steering gear of the single-cylinder piston type provides alternative hand and power steering from the bridge. A Donkin gland packed rudder carrier and bearings is also fitted. The main propelling machinery comprises a Crossley five-cylinder vertical two-stroke, single-acting marine Diesel engine, developing 840 b.h.p. at 280 r.p.m. The engine is fresh water cooled by a Hamworthy electric driven pump and sea water circulation and bilge pumping is carried out by engine driven pumps. Electric power is supplied by two 40 kW 110 volt, d.c. generators, each driven by a Crossley four-cylinder engine, developing 66 b.h.p. at 1,100 r.p.m. The fresh water cooling system is interconnected with that of the main engine to facilitate warming for easy starting. The hopper having a carrying capacity of 675 tons of dredgings is emptied through ten doors, five



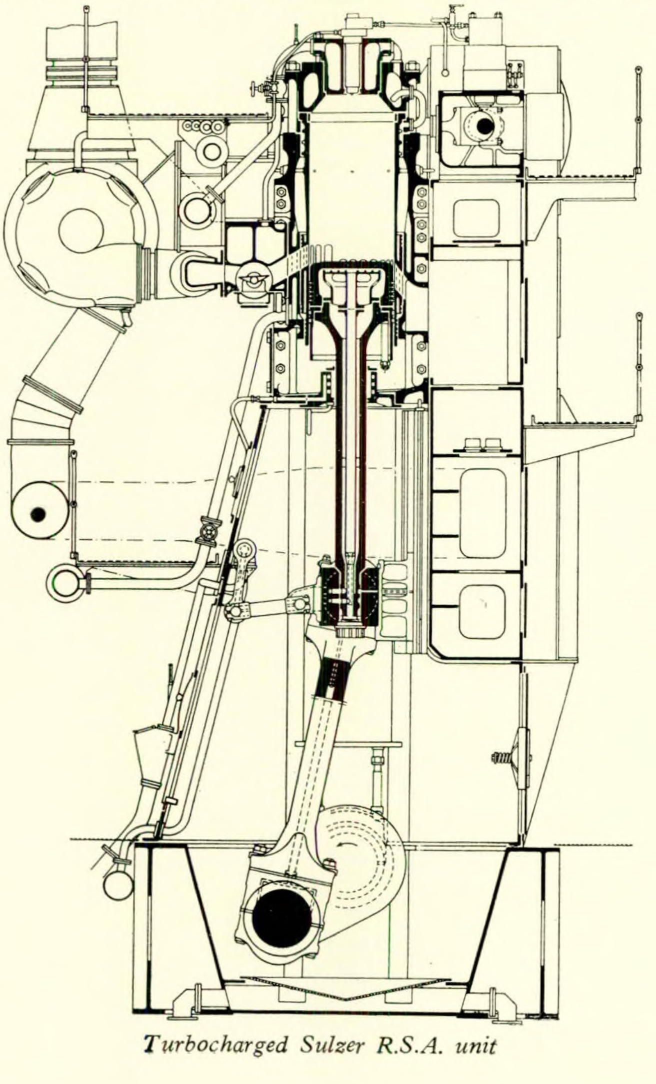
General arrangement of the Cowrie *and her sister ships* port and five starboard, each hingeing on the centre box keelson and recessed into the hull, so as not to project below the bottom plating when docking. The doors are operated by chain slings connected to main chains which are led over cast iron sheaves and secured to a fabricated steel drawbar operated by hydraulic rams. A rigging screw is fitted in each leg of the slings so that adjustments can be made. The hydraulic equipment, supplied by Donkin and Co., Ltd., comprises two cast iron cylinders, one port and one starboard, designed for a maximum working pressure of 1,800lb. per sq. in. A packed type piston fitted on a steel piston rod works inside the cylinders, the opposite end of the rod having a large forged eye for coupling to the drawbars. Each cylinder opens and closes five hopper doors simultaneously, and is operated by a Hele-Shaw variable delivery rotary pump flexibly coupled to an 8-h.p. electric motor situated in the forward hold.—*Shipbuilding and Shipping Record, 31st May 1956; Vol. 87, pp. 450-452.*

Sulzer Turbocharged Engine

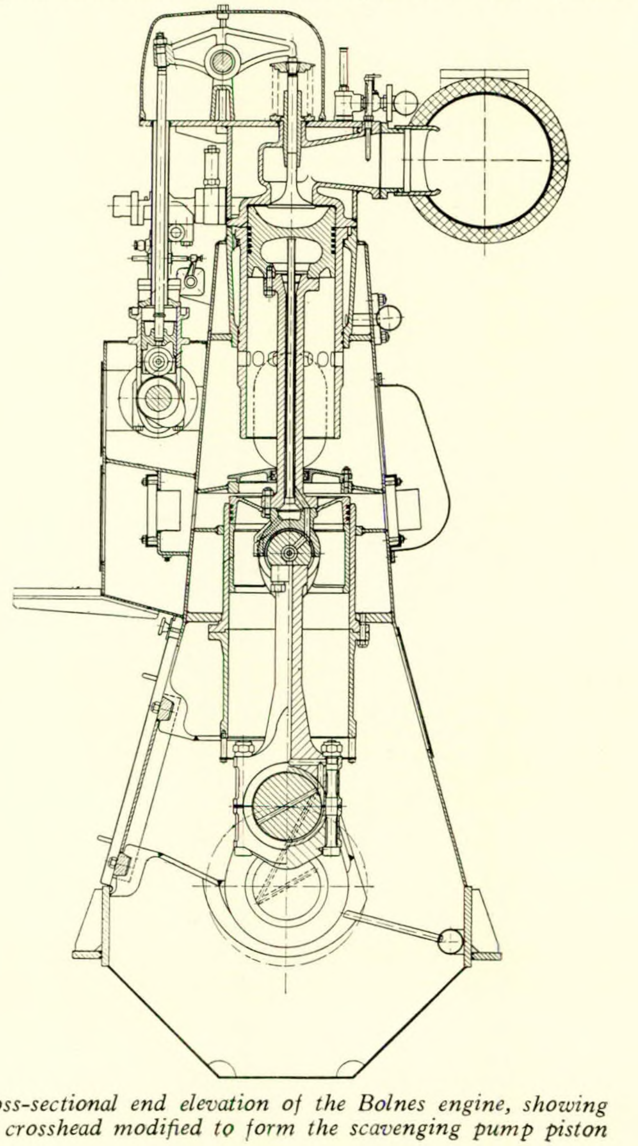
The new turbocharged single-acting two-stroke Diesel engine on test at the Winterthur, Switzerland, works of Sulzer Bros., Ltd., is a nine-cylinder crosshead type unit with a bore of 760 mm., a piston stroke of 1,550 mm., and a rated output of 11,700 b.h.p. (b.m.e.p. 7·05 kg. per sq. cm. or 100lb. per sq. in.) at 119 r.p.m., the maximum output being 13,500 b.h.p. This is the first turbocharged two-stroke engine to be built by Sulzer Bros. although in Japan a seven-cylinder engine of the same design and cylinder dimensions has been pressure-charged to give a continuous output in service of 1,200 b.h.p. per cylinder at 115 r.p.m., equivalent to a b.m.e.p. of 6·5 kg. per sq. cm. (92·4lb. per sq. in.). The engine, which is cross-scavenged, is turbocharged on the pulse system, the scavenging and charging air being supplied from three exhaust driven blowers of Sulzer design and manufacture. These turbocharged engines are manufactured with from five to twelve cylinders, thus giving a maximum output of over 18,000 b.h.p. or a rated output of 15,600 b.h.p. at 119 r.p.m.—*The Motor Ship, August 1956; Vol. 37, pp. 154-157.*

Dutch Diesel Engine

An enlarged version of the Bolnes Diesel engine is now built by L. Smit and Zoon, Holland, having a power range of from 500 to 1,250 b.h.p. at 275 r.p.m. and arranged for direct reversing. The engine is of the two-stroke non-pressurecharged type using longitudinal scavenging by crosshead pistons. These units, which are available with from four to ten cylinders, have a cylinder bore of 300 mm. and a stroke of 550 mm. The slightly unusual arrangement of the welded mild steel frames and bedplate allows the built-up crankshaft to be removed from the side of the engine. A feature of the design is the employment throughout of welding, which has resulted in a considerable weight reduction, together with a neat external appearance. The combustion chamber is of the open type formed with a depression in the piston crown into which the fuel injector sprays from the left side. Oil cooling is used for the pistons



Turbocharged Sulzer R.S.A. unit



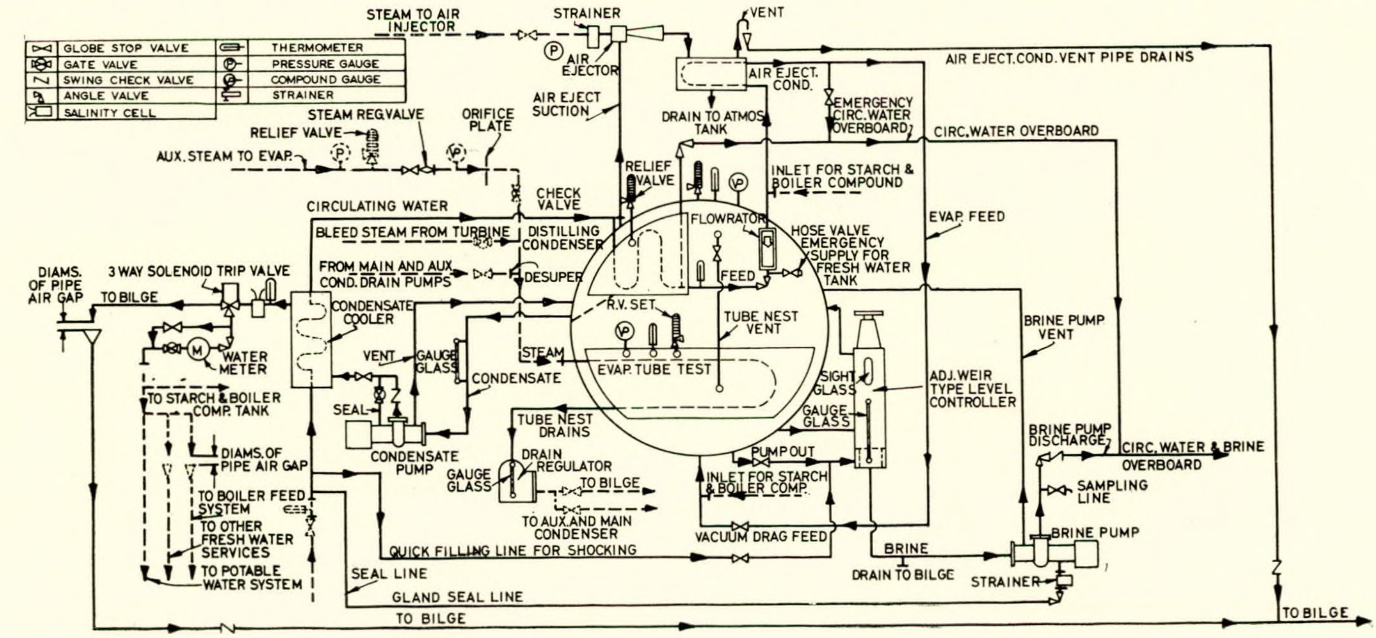
Cross-sectional end elevation of the Bolnes engine, showing the crosshead modified to form the scavenging pump piston and fresh water on a closed system for the cylinder liners and heads. The liner has scavenging air ports cut tangentially, so as to give the air a pronounced swirl. Below the working piston is the diaphragm sealing the crankcase and forming the top of the chamber of the crosshead piston scavenging pump. The liner for this pump extends down into the crankcase so that considerable rigidity is obtained. Individual fuel pumps of Bosch manufacture are provided for each cylinder, the fuel oil supply being under the direct control of the governor. The large single exhaust valve mounted in the centre of each cylinder head is operated by a short push rod running on the chain-driven camshaft. The cylinder head is of cast steel, but the frames, cylinder block and crankcase are built up by the welding of mild steel plates assembled in a specially constructed jig, each head having large circulating water passages. Fresh, salt water and lubricating oil pumps are all driven direct from the engine, sea water being circulated first through the lubricating oil cooler and then the fresh water cooler.—*The Motor Ship, July 1956; Vol. 37, p. 135.*

American Distilling Plant

A low pressure single-effect distilling plant has been installed in the oil tanker *Spyros Niarchos* and will also be fitted to her sister ship, the *Evgenia Niarchos*. This equipment, known as the Soloshell, was supplied by the Griscom-Russel Company, Ohio, U.S.A. The main advantage of the Soloshell plant is that, being of the low pressure type, it does not require frequent cleaning; since the water does not boil, no salts are deposited. There is also less tendency towards priming, and it requires very little supervision. The rating conditions of the Soloshell distillers are as follows:—

Normal rating, gallons per day ...	9,230
Clean tube rating, gallons per day ...	12,000
Steam pressure, lb. per sq. in. ...	5
Bled steam rating, gallons per day ...	6,000
Steam pressure, lb. per sq. in. ...	7·5
Feed temperature, deg. F.	85
Brine density, maximum	1·5/32
Salinity distillate, grains per gallon maximum	0·25

The distilling plant is of the low pressure, single effect, submerged tube type, the arrangement of the units being shown in the accompanying diagram. The Soloshell unit consists of a horizontal cylindrical shell within which are incorporated the evaporating unit, the distilling condenser and the vapour separator. The distilling condenser vacuum is maintained by a single-stage air ejector discharging into a condenser externally mounted on the evaporator shell, and cooled by the evaporator feed. Sea water passes through a condensate cooler, then through the distilling condenser and overboard. A portion of the sea water circulated through the condenser is used for evaporator feed. A hand-regulated valve at the distilling condenser outlet may be adjusted to obtain sufficient back pressure to force the feed through the air ejector condenser and into the evaporator shell. The rate of evaporator feed flow is controlled by a hand-regulated valve between the air ejector condenser outlet and the evaporator shell. An indicating flow meter in the feed line between the distilling condenser and the air ejector condenser serves as a guide. An overboard discharge line, with controlling valve, is provided in the evaporator feed circuit on the outlet side of the air ejector condenser to permit proper circulation of cooling water through this unit when feed flow is reduced or stopped. The water level in the evaporator shell is maintained by an externally mounted overflow type level controller. The brine passes from the level controller to the brine pump and is discharged overboard. Heating steam for the evaporator may be auxiliary exhaust, bled steam from the turbine or some other source reduced to low pressure. If the supply is above atmospheric pressure, a pressure regulating valve (preferably of the weight-loaded type) and an orifice is used to control the flow of steam. When supply steam is bled from the turbine at sub-atmospheric pressures (preferably 12lb. per sq. in. abs. or less) control of the steam flow is not usually necessary, and no control devices other than a stop valve need be provided. In the case of the *Spyros Niarchos* bled steam is used. The condensate from the evaporator tubes is usually drained to a vacuum condenser. A float-controlled automatic drain regulator maintains a water seal. In some cases, this condensate may be discharged to the drain collecting system at a pressure above atmospheric, by means of a drain pump. The vapour produced in the evaporator passes through a vapour separator to the distilling condenser. The condensate then flows to the condensate pump, which discharges it through the condensate cooler to the ship's tanks. A solenoid-operated valve is installed in this line at the condensate cooler outlet in order to divert automatically the condensate to the bilge whenever its salt content exceeds the allowable maximum. There are vent lines leading to the evaporator shell or the distilling condenser from all points where air may enter the system or where it may accumulate



Diagrammatic arrangement of Soloshell single-effect low pressure distilling plant

All of the air eventually reaches the condenser and it is then removed from the system by the air ejector. There is a brine sampling cock in the brine discharge line from which samples may be obtained for brine density tests. Electric motors (usually constant speed) drive the condensate and brine pumps. These pumping units are mounted on the distilling plant foundations. In addition, some plants may be equipped with a condenser circulating water pump and an evaporator tube nest drain pump. Usually, however, these pumps are omitted since the circulating water may be obtained from the auxiliary circulating water or the sanitary flushing systems, while the evaporator tube nest may be drained to a vacuum condenser without a pump. The evaporator tube bundle consists of ⅝-in. outside diameter tubes, 0·065 inch thick, expanded into a tube sheet at each end and supported by an intermediate support plate. The tubes are arranged for two passes of the heating steam. The vapour separator consists of an assembly of vertical baffles bolted directly over the vapour inlet to the distilling condenser. A pan is fitted to the bottom of the separator baffle assembly, and large drain lines suitably located to prevent any accumulation of water drain back to the evaporator shell. The distilling condenser is of the straight tube type, having ⅝-in. outside diameter tubes, 0·049 inch thick, expanded into a tube sheet at each end. At one end there is an expansion joint between the tube sheet and the shell cover, which allows for differential expansion between the shell and the tubes. A tube support plate is fitted about midway between the tube sheets. A portion of the condenser is arranged by means of suitable baffles to serve as a precooler for the air going to the air ejector suction. The air ejector condenser is of the straight tube type having ⅝-in. outside diameter tubes, 0·049 inch thick, expanded into a tube sheet at each end. The air ejector steam passes through the shell and the evaporator feed makes several passes through the tubes. The air is discharged to the atmosphere through an open vent pipe on the shell. A drain connexion at the bottom of the shell permits the condensate to be removed. Suitable vent and drain connexions are provided on the heads. An air ejector is provided to maintain the required vacuum at the distilling condenser by removing the non-condensable vapours and air which enters the system dissolved in the feed water, and possibly by leakage at the various vacuum joints.—*The Shipping World, 22nd August 1956; Vol. 135, pp. 172-173.*

New Cargo Liner for Australia-China Service

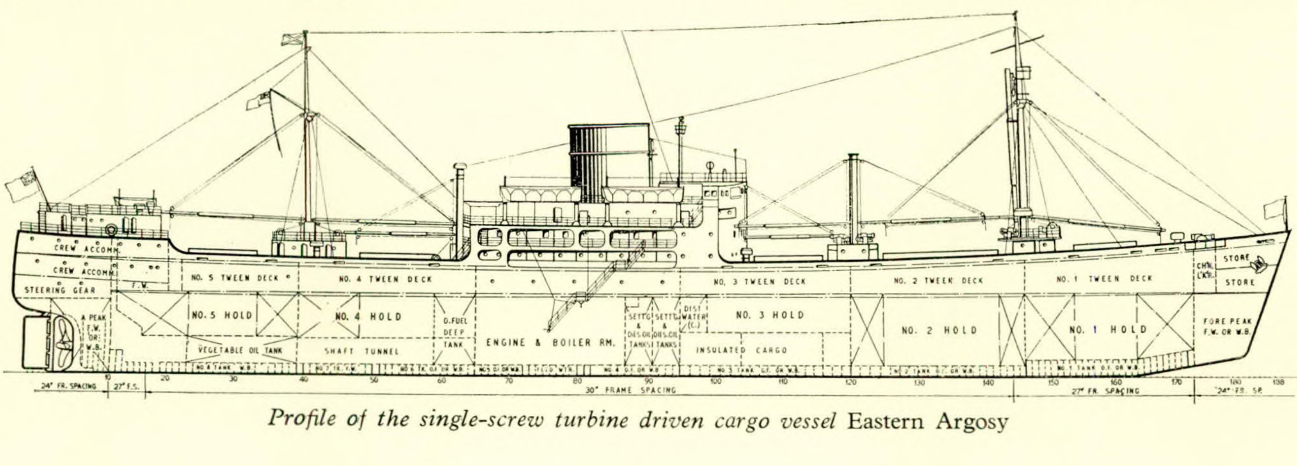
A single-screw turbine driven cargo vessel has been delivered to the Indo-China Steam Navigation Co., Ltd. This vessel, the *Eastern Argosy,* has been specially designed and built by William Denny and Brothers, Ltd., Dumbarton. Designed primarily for the Australia-China service, the *Eastern Argosy* will carry general cargo, vegetable oils, refrigerated cargo, etc., and is also provided with various Grain Act fittings so that she may be readily and quickly convertible to grain carrying duties. Refrigerated cargo is carried in one hold. The principal particulars of the *Eastern Argosy* are as follows:—

Length o.a.	467ft. 6in.
Length b.p.	444ft. 0in.
Breadth moulded...	63ft. 0in.
Depth moulded to upper deck ...	29ft. 6in.
Depth moulded to shelter deck...	39ft. 0in.
Deadweight maximum, about 26ft. draught, tons	8,400
Deadweight, about 25ft. draught, tons	7,800
Gross tonnage, about	6,906
Service speed, knots	17

The *Eastern Argosy* has been built with a raked stem, cruiser stern, streamlined unbalanced rudder and two steel masts. Her appearance is a little unusual in one respect: she has a poop but no forecastle. The cargo is carried in five holds and 'tweendecks, three forward and two aft of the machinery space, also in special lock-up spaces, with separate compartments provided for the carriage of mail. Refrigerated cargo is carried in No. 3 lower hold and No. 3 'tweendeck, this cargo being cooled by means of electrically driven refrigerating machinery. The *Eastern Argosy* is propelled by a set of double reduction geared turbines designed by Pametrada, consisting of one h.p. turbine of all-impulse type and an l.p. turbine of the impulse-reaction single-flow type, each driving a separate pinion which meshes with a primary wheel, this wheel in turn driving a common secondary wheel through a quill shaft and pinion. A separate h.p. astern turbine is fitted in tandem with the h.p. ahead turbine; and an l.p. astern turbine is incorporated in the l.p. ahead casing. The turbines are arranged to drive a propeller of 17ft. 10in. diameter, and 18ft. 6in. pitch of Denny's "Aquadal" design. The turbines are capable of developing 8,400 s.h.p. continuously at 105 revolutions of the propeller. Steam for the main and auxiliary machinery is supplied by two Babcock and Wilcox single pass boilers fitted with superheaters and air heaters, and designed to generate steam at a pressure of 450lb. per sq. in. and a temperature of 750 deg. F. at the superheater outlet.—*The Shipping World, 18th July 1956; Vol. 134, pp. 57-58.*

Scott-Doxford Turbocharged Engine

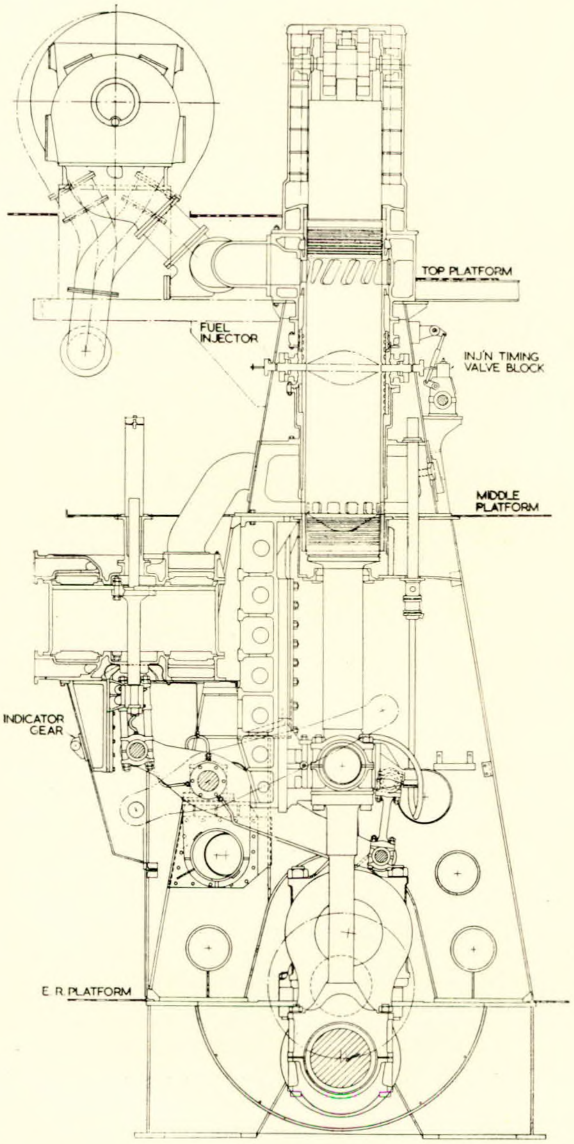
A six-cylinder Scott-Doxford turbocharged Diesel engine has been on test bed trials at the Greenock works of Scott's Shipbuilding and Engineering Co., Ltd. This engine, which has a rated power of 8,000 b.h.p., is the first of its type to be built. It has been designed and manufactured in close collaboration with Wm. Doxford and Sons, Ltd., Sunderland, and D. Napier and Son, Ltd., London, and is to be installed in the cargo vessel *Egori* now nearing completion at Scott's shipyard. The new engine is fitted with two Napier turbochargers. The new turbocharged engine has been designed for the same output as the Scott-Doxford six-cylinder normally-



Profile of the single-screw turbine driven cargo vessel Eastern Argosy aspirated engine fitted in the *Eboe,* a sister ship to the *Egori* built in 1952. The turbocharged engine has a cylinder bore of 670 mm. and a combined stroke of 2,320 mm., while the engine in the *Eboe* has a cylinder bore of 725 mm. and a combined stroke of 2,250 mm. In the *Egori* alternative connexions have been provided so that the engine may operate on Diesel fuel if required, but it is the owners' intention to run on heavy fuel only, and the whole of the shop trials were carried out on heavy marine fuel. At full speed the exhaust was very clear. The fuel consumption of the turbocharged engine on heavy fuel is 0·36lb./b.h.p.-hr. The principal technical particulars of the new engine are as follows:—

Number of cylinders	6
Bore of cylinders, mm.	670
Total stroke, mm.	2,320
Revolutions per minute	116
Rated power, b.h.p.	8,000
Brake mean pressure, lb. per sq. in.	91·2
Maximum combustion pressure, lb. per sq. in.	760
Maximum power, b.h.p. ...	9,000
Brake mean pressure, maximum, lb. per sq. in.	103
Number of exhaust turbochargers	2
Type of exhaust turbocharger ...	Napier M.S. 600/3
Number of lever-driven scavenge pumps	3

The frame size is the same as for the standard 6-cylinder 670-mm. bore normally-aspirated Doxford engine, but the running parts have been so arranged that the stresses and bearing pressures are no greater than normal practice; the weight, therefore, is increased but is considerably less than for a larger size normally-aspirated engine developing the same maximum power. The crankshaft proportions have been approved by Lloyd's Register of Shipping for 9,000 b.h.p. with 800lb. per sq. in. maximum combustion pressure. The side cranks have a lead of 6 degrees. Excepting that the exhaust and scavenge port lengths and positions are adjusted to suit the designed timings, the cylinder liners are of normal design. The liner reinforcing jacket is of a new design which completely eliminates the possibility of failures due to welding cracks, the barrel consisting of a thick weldless steel ring to which the valve housings are separately attached without gas or water pressure joints. Only the lower supporting flange is welded on; thus the cylinder assembly, which is a very vital part of the engine, is well able to cope with the increased gas pressures in the combustion zone. The exhaust belt passages are streamlined to give an easy outflow for the gases. The exhaust pipes between the cylinders and the turbochargers are of heat-resisting cast iron with expansion pieces of coiled steel wound with asbestos made by the United Flexible Metallic Tubing Co., Ltd. The jackets and upper pistons are cooled with inhibited distilled water and the lower pistons with lubricating oil. Diaphragms are fitted under the lower ends of the cylinders to separate them from the crankcase, as is now current practice with the Doxford engine. The two Napier M.S.600 turbochargers operate on the pulse system with the three scavenge pumps in series. These blowers are designed for maximum continuous operation at compressor ratios of 1·5 : 1 at 6,400 r.p.m., with a sea level delivery pressure of 7·35lb. per sq. in., the maximum turbine inlet temperature being 1,200 deg. F. The free air capacity of this size of blower is between 11,100 and 17,250 cu. ft. per min. The blowers discharge air through Serck coolers and Howden moisture separators into an air main, from whence the lever-driven scavenge pumps draw and pass the air into the engine entablature. For this prototype engine it was preferred to retain the lever-driven scavenge pumps, which are a feature of normally-aspirated Doxford engines, because they facilitate starting and manœuvring, ensure running at the lower powers with good combustion, are able to cope with increased resistance if the condition of the engine and exhaust boiler is allowed to deteriorate in service, and permit running without the turbochargers in an emergency. The displacement of these pumps



Section through the Scott-Doxford turbocharged 6-cylinder Diesel engine

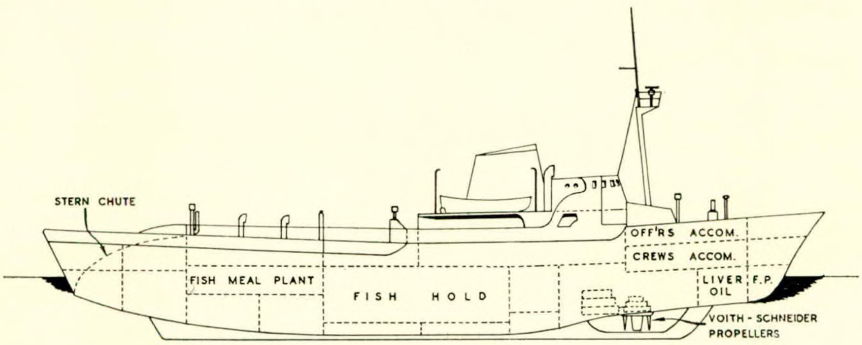
is substantially less than for the normally-aspirated engine, as their size has been reduced. Moisture separators are fitted in the air system mainly because the ship is to trade in waters where the atmosphere is very humid, but they are also useful for trapping other unwanted contaminants which may get into the system, and collecting water if air-cooled tubes develop leaks. They also add volume which minimizes pressure fluctuation. For starting the engine, the gear employed is the latest Doxford type whereby a rotary distributor driven from the camshaft by bevel gear transmits compressed air in the proper sequence to control pistons incorporated in the non-return spring-loaded air starting valve fitted in each cylinder, this taking place when the starting lever in the main control pedestal is operated. Two distributors are installed, one connected to the three forward cylinders and one to the three aft cylinders. Normally the distributor sleeve runs idly within its casing in its lowest position, which is the ahead position. Movement of the main starting lever at the controls actuates an air piston slide valve, which passes compressed air to the distributor to keep the sleeve down for ahead running or up for astern running. At the same time, the air slide valve also passes air to the underside of the control piston of an automatic non-return valve in the supply pipe to the starting air main, which causes it to open, letting air up to the cylinder valves. Subsequent release of the pilot air results in the valve shutting automatically, as it would also do if a flash back from a cylinder occurred during the starting process, thus protecting the air storage reservoirs. When the starting lever is in its full ahead or astern position, the fuel pressure regulating level controlling the injection timing valves can be moved to a low notch sufficient to enable the engine to pick up on fuel. Thereafter it cannot be advanced any further until the air start lever is returned to neutral, interlocks being provided to prevent errors in operation.—*The Shipping World, 19th September 1956; Vol. 135, pp. 253-255.*

German Fish Factory with Bow Voith-Schneider Propellers

A twin propeller stern chute fish factory ship has been ordered in Germany. The machinery and Voith-Schneider propellers are to be situated forward—on the tractor principle —giving close control under all weather conditions when trawling or hauling the net. The clean and unbroken hull form aft makes for low resistance and, being void of obstructions, there is nothing to foul the warps, nets or doors. The ship is being built at the Rickmers-Werft, Bremerhaven, and will be owned by the Gemeinwirtschaftlichen Hochseefischerei G.m.b.H. of Bremerhaven. The dimensions of this remarkable vessel will be as follows:—

Length between perpendiculars...	187ft. 0in.
Breadth	32ft. 0in.
Depth	16ft. 0in.

Two 600 b.h.p. Deutz Diesel engines will each drive one of the Voith-Schneider propellers to give free running speed of 13 knots.—*The Marine Engineer and Naval Architect, May 1956; Vol. 79, p. 157.*



Sketch of the German fish factory ship

Netherlands-built Coaster for Scottish Owners

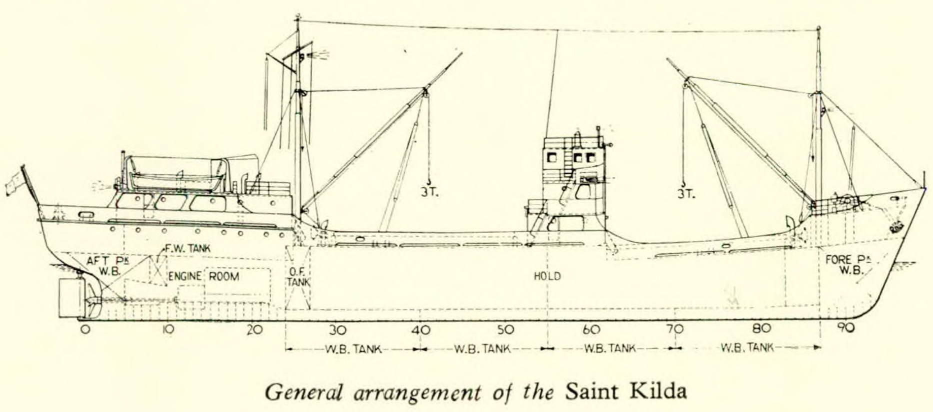
Trials were recently carried out in Holland of the single-screw motorship *Saint Kilda,* built to the order of J. and A. Gardner and Company, Glasgow, by N.V. Scheepswerf Gideon, v/h J. Koster Hzn., Groningen. The ship is of the raised quarterdeck type with machinery aft and has a single hold with two hatches. The principal particulars are:—

Length overall	196ft. 2in.
Length b.p.	180ft. 0in.
Breadth moulded	29ft. 6in.
Depth moulded to main deck ...	12ft. 10in.
Draught	12ft. 5¼in.
Gross tonnage	708
Net tonnage	354
Deadweight tonnage	880
Cargo capacity (grain), cu. ft. ...	44,050
Service speed, knots	11·4

Cargo handling facilities are provided by two 3-ton derricks operated by hydraulic winches supplied by Hydraulik A/S Brattvag, Norway, each capable of lifting 3 tons at 100ft. per min. and with a light load speed of 213ft. per min. The windlass and capstan are also of Hydraulik make. Steering gear of the Donkin electro-hydraulic type is controlled by telemotor from the bridge. The propelling machinery consists of an eight-cylinder turbocharged four-stroke English Electric Diesel engine developing 765 b.h.p. at 710 r.p.m. The engine drives the propeller shaft through Modern Wheel drive oil operated reverse reduction gearing, the reduction being 3:1.—*Shipbuilding and Shipping Record, 7th June 1956; Vol. 87, pp. 485-486.*

Nuclear Propulsion Plant

Although the first nuclear propulsion machinery for a merchant ship may consist of a reactor and a steam turbine, the closed-cycle gas turbine installation has many advantages which should not be overlooked. Use of this cycle with a nuclear heat source permits the use of fission energy at a high temperature level, resulting in a highly efficient unit. Highly important, too, is the fact that an atomic marine propulsion unit of 20,000 s.h.p., including the reactor and shielding is lighter in weight than a steam turbine installation of the same power and including the weight of the fuel carried. The reactor which would be used in a nuclear powered closed-cycle gas



General arrangement of the Saint Kilda turbine installation would probably be of the direct gas-cooled type. The possibility of eliminating the heat exchanger, interconnecting a primary heat transfer loop with the working cycle, the relatively non-corrosive nature of the gases, and the potential of materials that could be used at high temperatures in gas-cooled reactors make them attractive for the generation of power. Since the reactor for a gas turbine installation must operate at high temperatures, special materials will be required and ceramics may have to be used. In this field further experimental work has still to be carried out, and the problems of stability and safety have yet to be fully studied. Fig. 3 shows a nuclear installation of 20,000 s.h.p. operating in conjunction

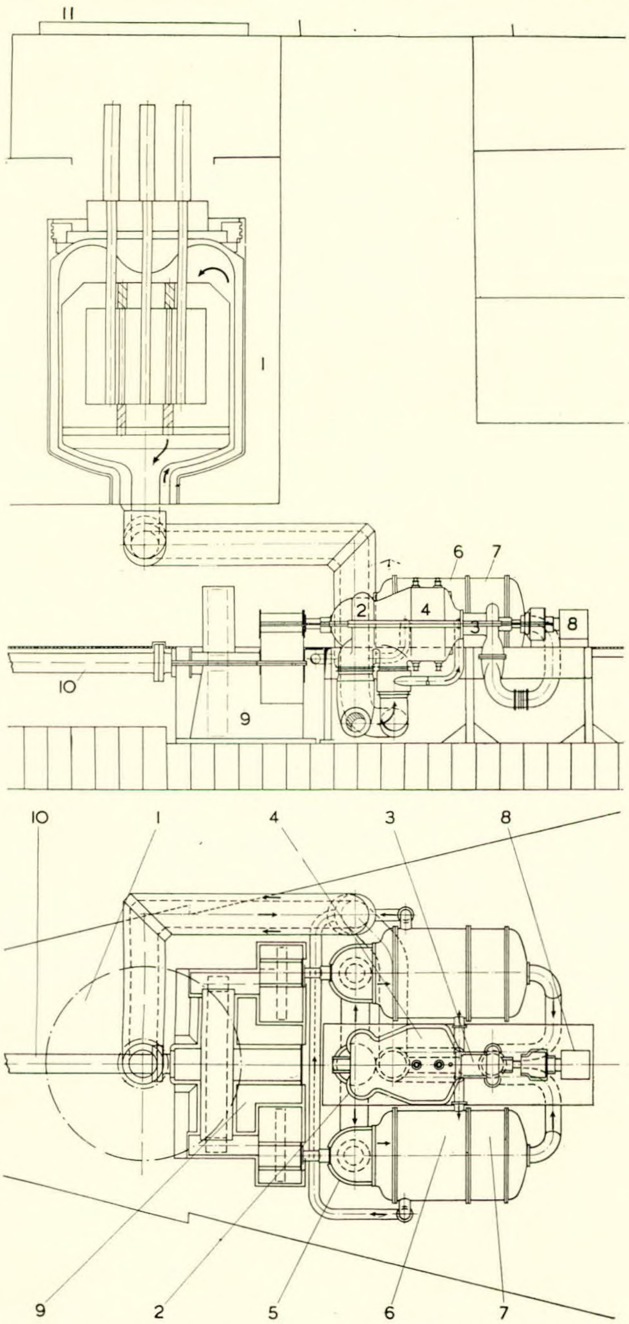


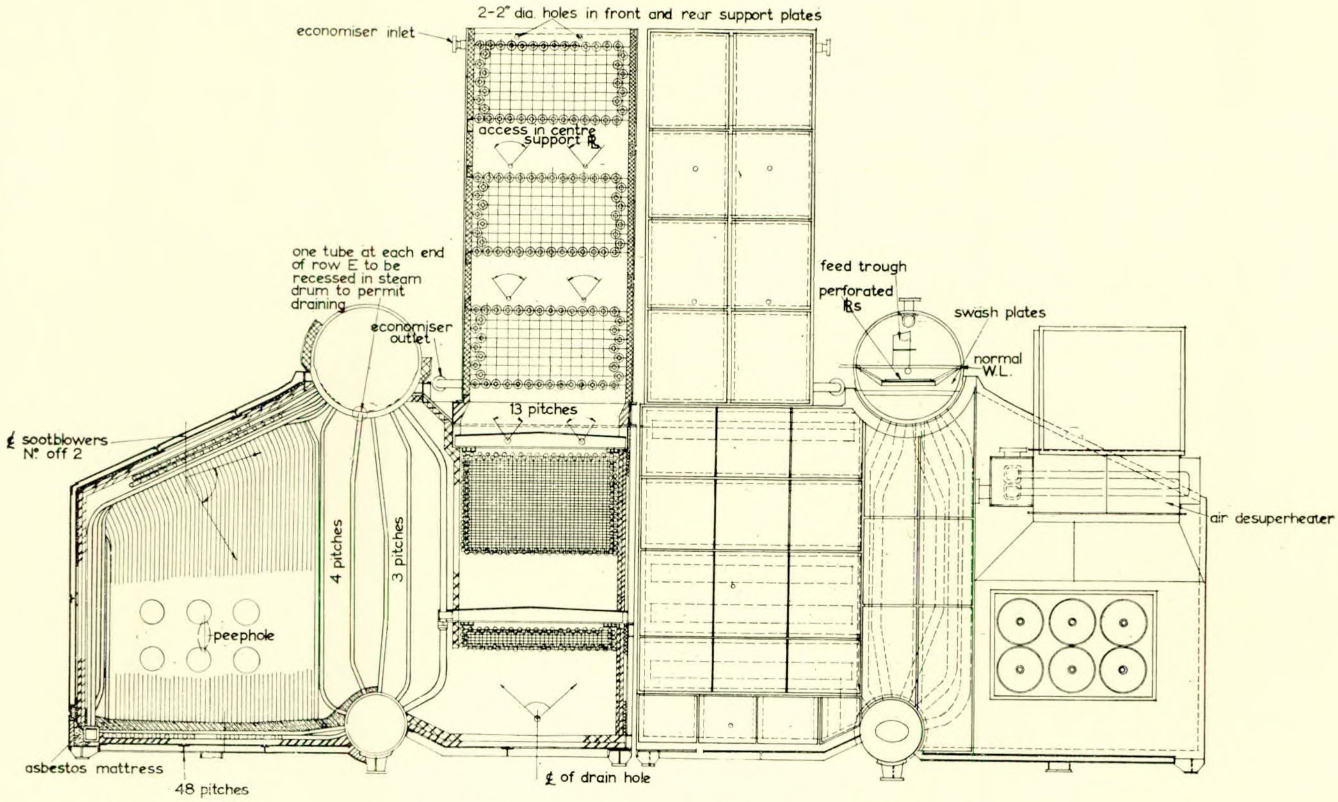
FIG. 3—*General arrangement of 20,000-s.h.p. installation with two radial inflow turbines of the reversible type*

(1) Nuclear reactor; (2) High-pressure turbine; (3) Low-pressure compressor; (4) High-pressure compressor with built-in intercooler; (5) Power turbines; (6) Heat exchanger; (7) Precooler; (8) Starter; (9) Reduction gear; (10) Fixed propeller shaft; (11) Refuelling deck.

with an Escher Wyss closed-cycle gas turbine with nitrogen as a working fluid. The high-pressure compressor has a built-in intercooler. The Escher Wyss TUCO gas turbine is a closed-cycle unit with turbine and compressor on the same shaft and supported by two bearings. In the latest design a five-stage turbine and a three-stage radial flow compressor are united in one casing. The TUCO unit now adopted has been made possible by recent progress in the development of high temperature-resisting materials, and practical experience gained by operation of closed-cycle gas turbine machinery for over a long period in industrial service at temperatures of 1,250 to 1,300 deg. F. In order to be able to arrange the turbine so near to the compressor without the risk of the one interfering with the other, it was necessary to carry out extensive studies on high temperature-resisting steels of normal coefficients of heat conductivity. The use of double walls in the piping as well as in the casing of the turbine has made possible a minimum use of high temperature-resisting steels. In the turbine itself the rotor, including the blading and the inner shell with the stator blades, are made of the aforementioned material. The heat insulating space between the inner and outer casing is under circuit pressure and the inner casing therefore is relieved from the pressure. It can thus be made as thin as casting methods permit. The outer shell, which has only to take the circuit pressure, is exposed to low temperatures not exceeding 200 deg. F., and can be made of ordinary cast steel. The turbine has been designed in such a manner that conventional commercially available austenitic steels can meet all requirements. A systematic separation of heat stresses from pressure stresses by means of the double-shell principle has made it possible to house the turbine and compressor in one casing. It is due to this arrangement that only two bearings are required and two sealing glands to seal the lower circuit pressure. The fact that the working medium circulates in a closed cycle and is externally heated makes this type of gas turbine particularly suitable for operation in conjunction with a gas-cooled nuclear reactor. In addition, since the working fluid cannot become contaminated in use, the gas flow path is never soiled and periodic cleaning is not necessary. The method of control is simple and consists of regulating power variations in the developed output merely by changing the quantity of working medium in circulation. For example, when the load falls off, working fluid is withdrawn from the cycle as required so as to maintain a constant speed on the turbine. To meet an increase in load, working medium is added to the cycle. In general this method of control is used for large changes in power level, or for power changes of long duration. Small changes of power or power changes of short duration are effected by bypassing a small amount of the working fluid round the compressor.—*The Shipping World, 26th September 1956; Vol. 135, pp. 275-278.*

New Boiler Design for Liner

The Cunard passenger liner *Carinthia,* third and latest to be completed of the four ships which this company is building for its service to Canada, is the first ship to enter service with a new type of boiler designed by Foster Wheeler, Ltd. They are ESD type boilers, designed to operate at a pressure of 550lb. per sq. in. and 850 deg. F. The principal feature of interest in the design is the use of an external superheater. There are various advantages in the use of the external superheater. Its location (after the main tube bank) is designed in the first place to limit the gas temperatures to the superheater elements in order to reduce the tube metal temperatures and also to avoid the associated problems of slagging, support plate corrosion and the like. The layout also facilitates access for inspection and maintenance, and simplifies cleaning and water washing. Placed as it is, the superheater depends for heat entirely upon convection, receiving no radiated heat from the furnace. A superheater between the rows of the main bank tubes gave a superheat temperature which remained sensibly constant as the load varied due to the combination of the two forms of heating. The ESD boiler, on the other hand, is controlled by an attemperator to give the design steam tem-

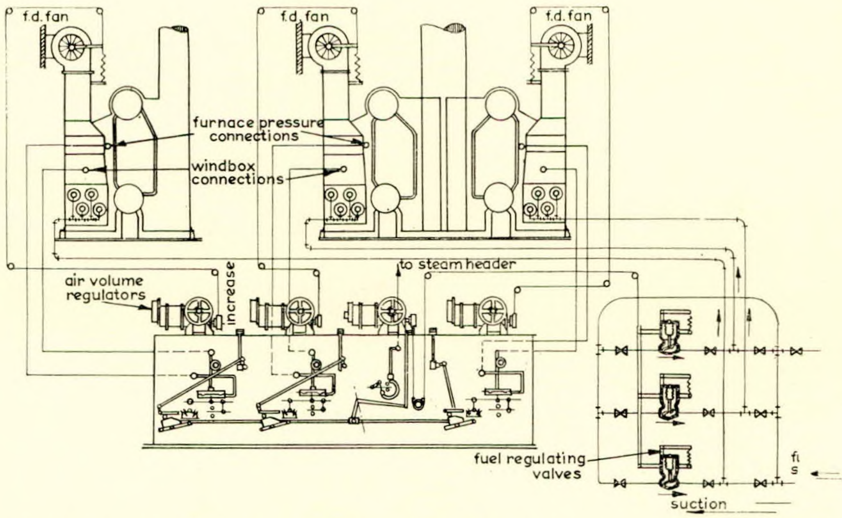


Sectional and external elevations of the ESD boiler

perature over the usual service loads and up to the maximum output. At lower powers the superheat temperature is allowed to fall off naturally, and this gives an automatic reduction for standby manœuvring, when it is advantageous. The three main boilers in the *Carinthia* were built under licence by John Brown and Co. (Clydebank) Ltd. The steam output of each boiler is 65,000lb. per hr. at normal load, and 97,500lb. per hr. at maximum load. Each is fitted with a bled steam air heater, air attemperator, and a Foster marine economizer manufactured by E. Green and Son, Ltd. The arrangement of the boiler can be seen from the accompanying drawing. The superheater is of the multiloop type comprising two passes, and is manufactured by The Superheater Co., Ltd., with support beams of heat-resisting steel supplied by the Cronite Foundry Co., Ltd. Control of the final steam temperature is by means of a Foster Wheeler air attemperator through which the steam flows continuously, positioned between the two superheater passes. The attemperator contains extended surface gilled tubes which will give a large reduction in steam temperature when swept by the full air weight; simple interlocked air bypass and shut-off dampers regulate the flow of air through the attemperator on its way to the burners to give the necessary control of the superheat temperatures over the full service range. Air heaters of the bled-steam type are used, these being Weldex heaters manufactured by Wellington Tube Works, Ltd. Wallsend oil burning equipment is used, six burners being fitted to each boiler.—*The Shipping World, 29th August 1956; Vol. 135, pp. 187-188.*

Electrically-operated Boiler Control

During the past decade the use of pneumatically-operated automatic combustion controls for marine boilers has increased considerably, and most ships with medium and high temperature steam conditions have this equipment installed. One of the reasons for fitting compressed air-controlled systems is that they are robust and give trouble-free operation, and it may be for this reason that electrical control systems have not been so widely used, anyway not in the British Merchant Navy. In spite of this fear, electrically-controlled equipment of American manufacture has been installed in the oil tanker *Spyros Niarchos,* recently completed by Vickers-Armstrongs, Ltd., at their Barrow shipyard, and the same type of equipment wil be installed in the sister ship, *Evgenia Niarchos,* which was launched in August. This combustion control system, which is made by the General Regulator Corporation, New York, consists of four regulators mounted in a single cabinet, the four motor-driven actuators being mounted on top of this cabinet. The purpose of the control system, as in the case of the pneumatically-controlled system, is to maintain constant steam pressure at the superheater outlet header for all loads by varying the rate of combustion in the boiler furnaces. The control also maintains the proper ratio of fuel and air at all rates of combustion. The *Spyros Niarchos* has three Foster Wheeler "D" type watertube boilers supplying steam at a pressure of 600lb. per sq. in. and at 860 deg. F. at the superheater outlet. The boilers have a normal evaporation of 60,000lb. per hr. The three forced draught fans each have a capacity of 33,000 cu. ft. of air per min. The oil burning installation has been supplied by Todd Oil Burners, Ltd. The accompanying drawing shows the general arrangment of the electrically-controlled system. The steam pressure regulator controls the loading of the fuel oil pressure regulating valves and the loading of the air volume regulators for all three boilers, in response to steam pressure variations in the superheater outlet header. The fuel oil pressure regulating valves automatically regulate to the spring loading which is controlled by the steam pressure regulator. The position of the steam pressure regulator therefore is directly proportional to the fuel oil pressure at the burners, and is approximately proportional to the quantity of fuel being burned. Air volume regulators control the air flow through the burner registers in response to the mechanical loading from the steam pressure regulators. The ratio of fuel to air to each boiler is adjustable by means of a fuel/air ratio knob and indicator, the ratio adjusting mechanism being connected in the loading linkage between the steam pressure regulator and the air volume regulators. Each



General arrangement of General Regulator electrically-operated combustion control system

air volume regulator maintains a balance between the mechanical loading from the steam pressure regulator and the air flow pressure differential, which is connected to the differential diaphragm of the air volume regulator. The air flow pressure differential is measured across the burner register, therefore no adjustment should be necessary when the burners are taken out or put in service. When a burner is taken out of service, the fuel oil is shut off and the register is closed. The total air flow to the furnace, therefore, is proportional to the number of burners in service without changing the relationship between the air flow pressure differential and fuel oil pressure at the burners. Each regulator is equipped with a separate actuator consisting of a reversible motor which drives the power arm through a double worm gear reducing unit. A handwheel and disengaging clutch are mounted on the secondary worm shaft at the front of the unit so as to provide the operator with a self-locking manual control which is instantly available in case of power failure. Adjacent to each manual control handwheel a mechanical position indicator is located so as to indicate the position of the power arm of each regulator and the equipment being controlled.—*The Shipping World, 5th September 1956; Vol, 135, p. 211.*

Outlook for Nuclear Merchant Fleet

Present indications are that the most promising commercial application of nuclear propulsion would be in tankers and combination oil and ore carriers operating at relatively high speeds over long trade routes. An average tanker spends 80 per cent of its time at sea, and so would permit high utilization of nuclear fuel. The elimination of fuel oil would mean an increase in payload which, in the case of a 20,000-ton tanker, might earn an additional one million dollars per year. It would also simplify design by eliminating bunkers, fuel lines, pumps, etc., and trim and stability problems would be less than cargo or passenger vessels because tankers usually dock in relatively unpopulated areas, require few shore personnel, and spend only brief periods in port. Pumping of the cargo requires about 40 per cent of normal steam load, and this would further increase the utilization of the reactor. On board, shielding requirements would be eased by installing all propulsion machinery aft, as usual, and by using the oil cargo as secondary shielding. The U.S. Maritime Administration is of the opinion that in five or six years' time it will be possible for large nuclear-powered tankers to compete successfully with those of conventional design. Between 1960 and 1965, about 93 per cent of the existing U.S. merchant fleet will become due for replacement. The Maritime Administration therefore recommends that construction of experimental vessels should be started as soon as possible, so that the experience gained may be applied in the large building programme that will be necessary. Bids have been invited and received for two tankers, one propelled by a pressurized-water reactor and the other by a gas-cooled reactor. If construction were to be approved, the first could be delivered in 1959 and the second in 1961. Two of the four bids received for the first vessel would provide the reactor, the initial core loading, and all main propulsion equipment for less than ten million dollars. In one proposal, the estimated cost of hauling one ton of oil from the Persian Gulf to the East Coast of the United States is only 20 per cent more than the present estimated cost. It is thought that the nuclear tanker may prove competitive, if capital costs do not exceed those for a corresponding conventional tanker by more than ten million dollars. Reactors of the type installed in the *Nautilus* are unlikely to be economic for merchant ships, but experience with them may help in reducing costs. Estimates made by Rear-Admiral Rickover, U.S.N., who was responsible for the *Nautilus*, are more pessimistic. He considers that fabrication and cladding material costs will for many years prevent nuclear fuel from competing commercially with fuel oil, and that construction of nuclear-powered merchant ships should not be undertaken until design studies show economic advantages.—*Journal, British Shipbuilding Research Association, July 1956; Vol. 11, Abstract 11,812.*

Patent Specifications

Directing Device for Ships' Funnels

This device is intended to regularize the flow of air immediately forward of the funnel in order to keep the smoke clear of the superstructure and decks. By regularizing is meant to fill out and/or homogenize the lines of the flow and/or to diminish the loss of head and/or reduce the extent of the scale of the turbulence. As will be seen from Figs. 1 and 2, the device is constituted by two or more thin surfaces or planes *a* arranged forward of and at a suitable distance from the funnel *b*. These surfaces are parallel to one another, disposed perpendicularly to the plane of symmetry of the

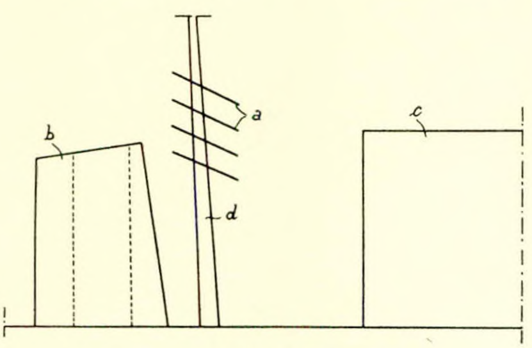


FIG. 1

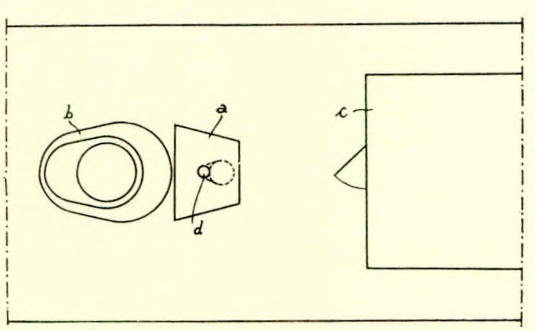


FIG. 2

ship and slightly inclined to the horizontal, rising from the front towards an angle determined as a function of the trajectory which it is desired to impart to the smoke or fumes in order to avoid their encountering all or part of the superstructure situated astern of the funnel *b*. At *c* there is shown an obstacle such as a deckhouse, which disturbs the flow of air forward of the funnel, this superstructure causing at the same time a generally downward inclination of the air flow, which will be compensated by the slight upward inclination of the surfaces *a*. In order to avoid the necessity of providing supports especially for the device, the surfaces or planes *a* can advantageously be supported by mast structure situated forward of the funnel. In the example represented in Figs. 1 and 2, this mast structure is constituted by a single mast *d*, upon which the surfaces or planes *a* are fixed.—*British Patent No. 755,910 issued to Société des Forges et Chantiers de la Mediterranée. Application in France made on 28th October 1953. Complete specification published 29th August 1956.*

Anti-corrosive Coating for Metals

In a previous patent (No. 721,510) there is claimed a method of protecting the interior surfaces of oil tanks, especially those built into oil tankers and including floating lids and separator tanks, in which there is applied to the surfaces at least two thin layers comprising hydraulic cement, such as Portland cement and especially high-alumina cement admixed with an aqueous oil resistant synthetic resin emulsion, adapted to key the cement to the metal surface and reduce the brittleness of the protective layers, the layers having a rough woven fabric sandwiched between them. This invention is a modification of that described in the above-numbered patent, in that the method is applied to the protection of the surface of metals generally, especially iron and steel, and also in that natural rubber latex may replace the synthetic resin latex. The fabric minimizes the danger of fracture at joints and other places where expansion movements are liable to take place, and generally toughens the protective coating. Hessian may be used, or woven asbestos or glass cloth, especially a woven glass scrim. In operation, a first cement-latex coating is applied, the fabric is pressed on to the surface before it sets, and afterwards a second coating of the cement-latex mixture is applied, before or after the first coating has set. Alternatively, the protective coating may be painted. The invention finds particular application to the protection of ship hulls. The protective coating may comprise 75 parts Ciment Fondu, 20 parts water and 10 parts polyvinyl acetate latex of 50 per cent solids content. In use, the coating is brushed on to the metal surface and, whilst still wet, a layer of reinforcing fabric such as hessian is applied followed by a second coat of the coating, which is brushed over the fabric immediately.—*British Patent No. 757,592, issued to V.G. (London), Ltd. Complete specification published 19th September 1956.*

Hull of Boat Formed from Glass Fibre

This invention relates to hulls of boats formed from synthetic-resin-bonded glass fibre and its object is to simplify the manufacture of such boats. One disadvantage of moulding the hull in one piece in a single mould is that it does not permit projections on the hull to be formed since it may not be possible to separate the finally formed hull from the mould. For example, where a hull requires to be provided with an inwardly extending gunwale, this has usually required to be attached after the moulding operation has taken place. A

further object of the invention is to overcome such difficulties. According to this invention, a boat hull formed from synthetic-resin-bonded glass fibres (Figs. 1 and 3) is characterized by the fact that the hull is formed in a number of parts disposed on opposite sides of a vertical central plane and the opposed edges of these parts on either side of this plane are provided with flanges between which is clamped a keel plate of greater width than the width of the flanges. For small boats the hull may be formed in two single parts, one on either side of the keel plate.—*British Patent No. 756,239, issued to Watercraft, Ltd., and A. G. W. Hall. Complete specification published 5th September 1956.*

Propeller Allowing Navigation in Waters Cluttered up with Weeds

The primary object of this invention is to provide a simple and inexpensive construction of propeller which, when navigating waters which are cluttered up with weeds or aquatic plants, will not be hindered or stopped by the latter accumulating around and finally becoming wrapped around the blades. According to Figs. 1 and 2 the propeller comprises three blades.

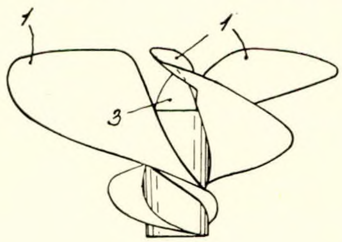


FIG. 1

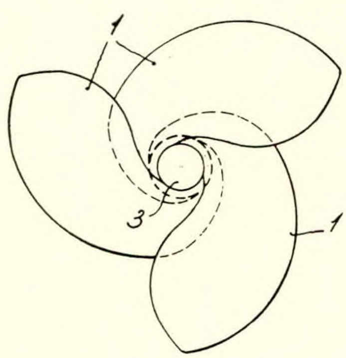


FIG. 2

It may be seen that the leading edge of a blade (1), begins tangentially at a point (2) of the hub (3) and extends at an angle (4) of 240 degrees minimum. This minimum value was found by experiment; the efficiency is insufficient with a smaller angle, and its optimum from 240 degrees up. The blade could be extended beyond this value but a prohibitive bulk would rapidly be reached, with no equivalent increase in efficiency. The type of operation of this propeller gives it the advantage that no cavitation can occur, hence there is an improvement in mechanical efficiency. The dimensions of the propeller, the number and length of the blades, the value of the pitch may vary in each particular case, since the use of this propeller is not limited to the propulsion of a boat navigating on waters cluttered up with aquatic plants.—*British Patent No. 758,190, issued to J. C. Loiseau. Application in France made 9th July 1952. Complete specification published 3rd October 1956.*

Ship Log

The object of this invention is to provide a ship log which is of inexpensive construction, yet gives a highly accurate reading and in which a generated signal may be transmitted to remote indicating dials, as for instance to dials

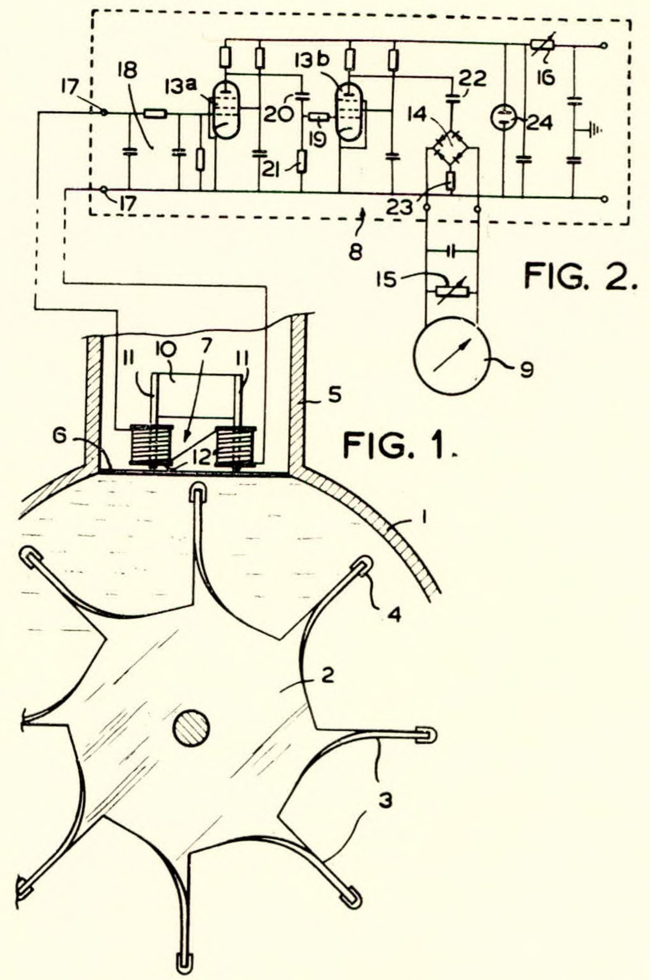


FIG. 2.

FIG. 1.

in the chart house. In Figs. 1 and 2, a turbo-rotor or propeller (2) with a number of vanes (3) is mounted in a housing (1). The housing is provided with an inlet tube opening forwardly at the bottom of the ship and an outlet tube opening aft. Each vane (3) carries on its outer end a shoe (4) of a magnetic, non-corrosive material, preferably stainless steel. During the rotary movement of the blades the pole shoes successively pass an extension (5) in the housing separated from the water passage of the housing by a thin metal wall (6) on non-magnetic material. In the extension (5) an electromagnetic pulse generator (7) is arranged. The pulse generator may comprise windings coupled to the input of an amplifier (8), the output of which is coupled to a speed indicator instrument (9).—*British Patent No. 758,755, issued to S. Woldseth. Application in Norway made on 9th March 1953. Complete specification published 10th October 1956.*

Feedwater and Air Preheater System

The subject of this patent provides an arrangement for preheating feedwater and air for a boiler in which the temperature of the flue gases may be controlled, and in which expansion tanks and suchlike are not necessary. Referring to Fig. 3, in the operation of the plant gases of combustion from the combustion chamber (15) flow into the tube bank (13) and pass in an upward direction over some of the tubes to the top of the baffle (14) and thence downwards over the remainder of the tubes and into the gas passage (18). From the latter passage, the gases flow over the tubes of the lower economizer section (30), then over the tubes of the centre economizer section, and finally over those of the economizer section (23). The feedwater is delivered by feed pump (33) through the conduit (34), a portion passing into the lower section (30) of the

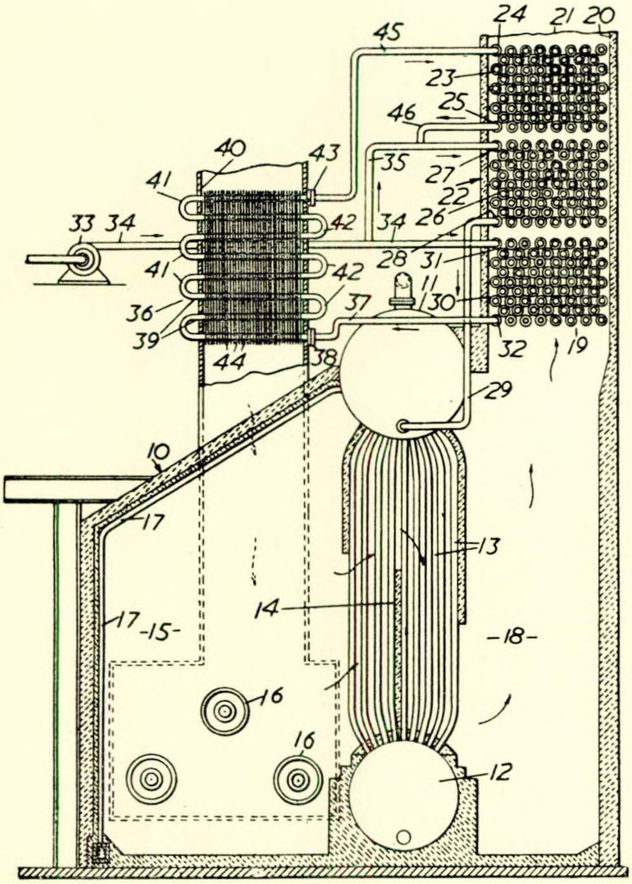


FIG. 3

economizer (22) through pipe (34), and another portion passes into the centre section of the economizer through pipe (35). The feedwater passing into sections (30 and 26) is heated by the combustion gases from the furnace—that in the lower section (30) being heated to a much higher temperature than that in the centre section, since the temperature difference between the gases and the feedwater is greater. The relatively hot feedwater thereafter flows out of the economizer section (30) through pipe (37) to the air heater (36) and passes in indirect heat-exchange relationship with cold air flowing through the air conduit (40) of the heater. Since the mean temperature difference between the cold air passing through the heater and the hot feedwater is considerable, the air can be heated to a high temperature with a small heater. The heated air then passes to burners (16) to support combustion in the boiler, and the feedwater, which is now relatively cool, passes to upper section (23) through pipe (45). In section (23), the feedwater is reheated by passing in indirect heat exchange relationship with flue gases which have had their temperature previously reduced in heat exchange with feedwater in the lower and centre sections of the economizer. Feedwater then flows out of section (23) through pipe (46) and joins the feedwater flowing into the centre section (26) of the economizer through pipe (35). Here is then effected an increase in temperature of the feed-water, and a corresponding decrease in the temperature of the flue gases. The heated feedwater finally passes into the steam and water drum (11) of the boiler, through pipe (29).—*British Patent No. 753,714, issued to Foster Wheeler, Ltd. Complete specification published 25th July 1956. Engineering and Boiler House Review, October 1956, p. 347.*

Fender for Jetties

This invention relates to fenders for jetties or the like. The operation of the fender and cushioning arrangement when a ship is berthing is shown in Figs. 4, 5 and 6. If the ship is moving broadside on to the jetty, when it strikes the members (10) the fender moves in sympathy with the ship and both

Fig. 4.

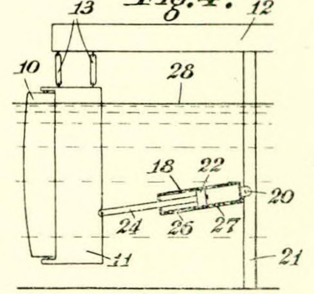


Fig. 5.

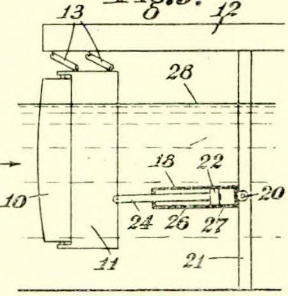
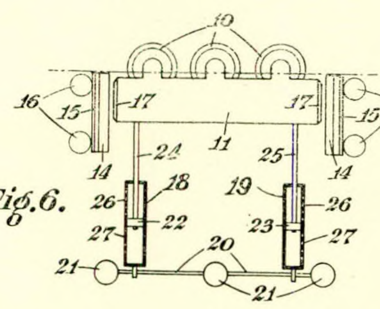


Fig. 6.



pistons (22 and 23) move towards the far end of their cylinders, causing water to be expelled through the ports (27) and to be drawn in through the ports (26). As the ports (27) are covered or passed in turn by the pistons the resistance to the movement of the pistons gradually increases and the counter thrust on the ship increases correspondingly. Also, as the fender is moved into the position shown in Fig. 5, it rises higher in the water and a further thrust is provided by its own weight. More usually the ship strikes the fender obliquely, in which case initially only one of the pistons (22) moves inward and the other piston may tend to move outward as the suspension arrangement is sufficiently loose to allow the fender to swing round to some extent.—*British Patent No. 758,566, issued to British Tanker Co., Ltd., and W. M. Hutchison and K. W. Hopkins. Complete specification published 3rd October 1956.*

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